

USE OF CAVES BY HUMMINGBIRDS AND OTHER SPECIES AT HIGH ALTITUDES IN PERU

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Most hummingbirds live in the tropics. Those living in cold climates are faced with the problem of supporting their exceedingly high rate of metabolism over long periods of darkness and bad weather. Four courses are open to them:

Feeding before dark.—This course is adopted by most small birds. By intensive feeding before dark, small passerine birds are able to maintain a nearly normal metabolism until daybreak. The colder the night temperatures encountered, the more food energy is required for survival until daylight.

Feeding at night.—At high latitudes "night" feeding is possible in the summer because the days are long. At low latitudes, as in Peru, the nights encountered by the non-migratory birds are 11 hours or more long throughout the year. No hummingbirds or passerine birds are known to have adopted the course of feeding in darkness.

Retreat to warmer places.—Many birds seek shelter at night, but frequently it is impossible to say whether this is primarily to avoid low temperature or to avoid predators. A few retreat to holes or caves where the thermal advantages are obvious. On Mount Orizaba in Mexico, hummingbirds feed as high as 14,500 feet, but in cloudy weather and at night they retreat to lower altitudes (Swan, *Ecology*, 33, 1952:109). In Peru, however, many hummingbirds would have to fly more than 70 miles to reach an altitude under 12,000 feet.

Torpidity.—If a bird is physiologically capable of lowering its body temperature at night and raising it again to normal in the morning, it can survive the night with relatively little drain on its energy resources. Some hummingbirds do this (Pearson, *Condor*, 52, 1950:145). However, while in a torpid condition the birds must not be exposed to temperatures below freezing or they will either perish or be forced to awaken and thereby lose the advantages of torpidity. A bird essaying nocturnal torpidity in a region of freezing temperatures must, therefore, also be endowed with the instinct and ability to find retreats where the temperature will not fall below 0°C.

In view of these considerations it is of interest to examine the habits of hummingbirds in southern Peru where these birds live even above 15,000 feet. In this region the eastern and western Andes enclose a high plateau more than 150 miles across that never drops below an altitude of 12,500 feet. This is for the most part a land of bare earth and rock, bunch grass, scattered low shrubs, and mats of cushion-shaped plants that hug the ground to escape wind and cold. Despite the tropical latitude, nights are always cold, and in the higher parts of the plateau night temperatures drop below freezing almost every night of the year. In the dry winter season (May to September) the days are sunny with temperatures usually between 12° and 18°C., the nights clear, crisp, and far below freezing. Summer, which is the nesting season of most of the birds of the region, coincides with the wet season. Consequently, nesting is at a time of much hail, snow, and cold rain. The accompanying cloudiness prevents night temperatures from falling much below freezing even at the higher altitudes, but the frequent afternoon snowstorms drive birds to shelter, thereby taxing their resources by imposing a fast of 15 hours or more before the return of favorable feeding weather the following morning.

ESTELLA HUMMINGBIRD

The commonest hummingbird at high altitudes between Lake Titicaca and the Pacific slopes of the Andes in Peru is *Oreotrochilus estella*, a bird about the size of the Blue-throated Hummingbird (*Lampornis clemenciae*). It uses caves, crevices, and mine

tunnels not only for shelter at night, but for nesting. Several hummingbirds were seen in such places in the daytime, and in addition three nesting and five non-nesting adult hummingbirds were captured in caves and tunnels at night. All were female *Oreotrochilus estella*. Two other nesting hummingbirds, probably females, escaped at night without being captured. It is likely, therefore, that the males have other roosting habits.

Temperatures.—In regions where temperature extremes are common, caves and tunnels provide an intermediate and more constant temperature. On December 8, 1951, the temperature conditions in a tunnel sheltering hummingbirds at night at 11,200 feet on the western slope of the high plateau just described were as follows:

	12:30 night	12:30 day
In tunnel at nest	15°C.	16½°C.
In shade outside tunnel	5°C.	18°C.

In winter, outdoor temperatures at night would be much colder, yet this tunnel undoubtedly would remain well above freezing.

Temperatures of five *Oreotrochilus* captured in caves or tunnels at night are shown in table 1. The one bird listed with a body temperature almost as low as the surrounding temperature was completely torpid and was hanging on a vertical rock surface of the

Table 1
Temperatures of Estella Hummingbirds Captured in Tunnels at Night

Date	Time	Remarks	Tunnel temperature	Bird temperature
Dec. 9,	12:30 a.m.	Torpid, 25 feet from entrance.	14°C.	14½°C. (esophagus)
Dec. 9,	12:40 a.m.	Awake.	14°	36° (esophagus)
Jan. 1,	10 p.m.	Awake, on nest with young.	39½° (cloaca)
Jan. 1,	10 p.m.	Awake, young of above almost fledged.	38° (cloaca)
Jan. 3,	1 a.m.	Awake, on nest with fledged young.	14°	36° (esophagus)
Jan. 3,	9 a.m.	Awake, same bird kept captive.	37° (esophagus)

rough ceiling 25 feet from the entrance of a mine tunnel. She was hanging by the feet and using the tail flicker-fashion for support. Her return to an active condition was similar to that described for Anna and Allen hummingbirds (Pearson, *op. cit.*). Her ovaries were relatively inactive, containing follicles only ½ mm. in diameter. The ovaries of the non-torpid birds at this time likewise contained follicles about ½ mm. in diameter, except in one instance they were 1½ mm.

Nesting.—The nests of *Oreotrochilus estella* occur in large caves, small caves only 4 or 5 feet high and as deep, in mine tunnels, large crevices in cliffs, or, in one instance, in an unoccupied stone hut. One nest in a mine tunnel (fig. 1) was 18 feet from the entrance and was fastened to the ceiling 5½ feet above the floor. The tunnel was so dark at this point that I could not even see the nest until my eyes had become accustomed to the darkness. In another tunnel the nest was 20 feet from the entrance. Along Lake Titicaca in a "sea" cave 4 feet wide, 15 feet high, and 20 feet deep a nest was attached 12 feet above the floor and about 15 feet from the opening. I have not found more than one nest in each tunnel or cave, but in early December, when nests were without eggs or young, each of two tunnels contained three hummingbirds.

Between December 7 and 9, 1951, on the Rio Torata, 11,200 feet, I found four abandoned mine tunnels. A hummingbird occupied a nest in one of them, and the other three contained currently unused nests. On January 1, 1952, near Juli, 12,500 feet, I found four "sea" caves that are a few feet above the present level of Lake Titicaca. Each of these contained a hummingbird nest. In other locations as well, a high propor-

tion of the available caves were utilized by hummingbirds. Such frequent utilization suggests that the number of hummingbirds living in this region may be limited by the number and distribution of suitable caves.

Nests of *Oreotrochilus estella* were composed primarily of a large handful of wool (sheep, llama, alpaca), moss, lichens, leaves, grass, and feathers (many of them not hummingbird feathers). Their texture was similar to that of nests of North American



Fig. 1. Nest of Estella Hummingbird on the ceiling of a mine tunnel.
A 6-inch ruler is inserted in the nest cup.

hummingbirds, but they were much bulkier (fig. 1) despite the fact that this species is not large (six specimens weighed between $6\frac{1}{2}$ and $8\frac{1}{2}$ grams). Nests were almost always glued to the ceiling of the cave or tunnel, but in a few cases were glued to overhanging walls near the ceiling. Goodall, Johnson, and Philippi (Las Aves de Chile, vol. 1, 1946) state that the nests are similar to those of *Oreotrochilus leucopleurus* and that in both of these species the nests are cemented to rock outcrops. I know of no other hummingbirds that fasten their nests with mucilage, although the habit is common among swifts.

Two observations suggest that the same nest is used for several clutches. The mummified remains of a hummingbird were found clinging to the side of a nest that was in use, and in no cave or tunnel was more than one nest found. In such sheltered locations

old nests should last for years unless they are scavenged for subsequent nests. It seems more likely that they are reconditioned and used over again.

Nesting occurrences were as follows:

December 7-9, Rio Torata, 11,200 feet. Three unoccupied nests and one nest occupied but without eggs.

January 1, 3 miles east of Juli, 12,500 feet. One nest with 2 eggs in early stages of incubation; one nest with 2 young almost fledged; 2 nests without eggs or young.

January 2, 55 miles ENE of Arequipa, 15,400 feet. A female with incubation patch, 2 mm. follicle, carrying nest material; collected by Carl B. Koford.

January 3, Pomata, 12,500 feet. Two nests, each with 2 young capable of flying.

January 5, 10 miles south of Ilave, 12,600 feet. One nest with parent incubating. Nest contents not seen.

February 6, Rio Huanque, 30 miles south of Ilave, 13,000 feet. One nest with a single young ready to fly; another nest with one or more naked young.

OTHER BIRDS

Several other kinds of birds were found roosting at night in the same caves and tunnels as the hummingbirds: three Sparrow Hawks (*Falco sparverius*) in one cave, one in another; Horned Owl (*Bubo virginianus*); in different caves, two immature female Streaked Spinetails (*Leptasthenura andicola*); and two kinds of ground tyrants (a female *Agriornis montana* and a male *Muscisaxicola rufivertex*). In addition the following species were found in caves and tunnels not occupied by hummingbirds at the time: Bolivian Goose (*Chloephaga melanoptera*), a male Cinereus Ground Tyrant (*Muscisaxicola cinerea*) feeding nestlings in a cave on February 7, a male Black-fronted Ground Tyrant (*Muscisaxicola frontalis*), and a Gray-headed Finch (*Phrygilus gayi*). None of these was torpid or had a low body temperature.

If to the above are added common genera that make use of small holes and crevices, such as Flickers (*Colaptes*), Miners (*Geositta*), Creepers (*Upucerthia*), Cinclodes (*Cinclodes*), Cliff Swallows (*Petrochelidon*), and Ground Finches (*Sicalis*), it will be seen that a considerable proportion of the small birds living in these mountains resort to retreats of equable temperature.

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