

FROM FIELD AND STUDY

The Energetics of Migrating Hummingbirds.—The energy problems of migrating hummingbirds have been of recurrent interest to students of avian biology. While the consensus among ornithologists seems to be that Ruby-throated Hummingbirds (*Archilochus colubris*) do make the migratory flight across the Gulf of Mexico, a distance of over 500 miles, physiologists have not been able to demonstrate their energetic capability to do so. Pearson (Condor, 52, 1950:145–152) measured the metabolism of Anna and Allen hummingbirds (*Calypte anna* and *Selasphorus sasin*). The metabolism of hovering *S. sasin* averaged 85 cc. O₂/gm./hr., while that of *C. anna* averaged 68 cc. O₂/gm./hr. By assuming that migrating hummingbirds have a flight speed of 50 miles per hour, a metabolic rate of 80 cc. O₂/gm./hr., and that they carry one gram of fat as fuel, he estimated the flight range of *A. colubris* to be 385 miles (1 gm. fat = 9 Cal., 1 liter of oxygen consumed = 4.69 Cal.).

Odum and Connell (Science, 123, 1956:892–894) reported the ability of *A. colubris* to store fat, amounting to over 40 per cent of its body weight (2.1 gms.), in preparation for migration. This factor was offset, in calculations of flight range, by studies on the flight speed of hummingbirds (Greenewalt, Hummingbirds, 1960, Doubleday and Co.; Van Riper, in C. L. Stong, 1960, The Amateur Scientist, Simon and Schuster, p. 178; Pearson, Condor, 63, 1961:506–507), which revealed that hummingbirds fly at speeds nearer to 25 rather than 50 miles per hour. Thus in 1961, Pearson (*op. cit.*) concluded the “earlier estimate of flight range in still air remains unchanged at 385 miles.”

For the past two years, I have been conducting experiments on the energetics of hummingbirds, utilizing over 70 birds of seven species. By duplicating Pearson's techniques, along with the assumptions implicit in these techniques, it was possible to measure the flight metabolism of five species of hummingbirds, *Calypte costae*, *C. anna*, *Selasphorus rufus*, *S. sasin*, and *Stellula calliope*. The values obtained were comparable to those reported by Pearson. Fortunately, an immature male *C. costae* (body weight 3.0 gms.; ambient temperature 24° C.) hovered constantly in the metabolic chamber for 50 minutes, thereby allowing direct measurement of oxygen consumption during flight. The average flight metabolism for 35 minutes of constant flight was 42.4 cc. O₂/gm./hr., with values for one minute varying from 32.7 to 50.9 cc. O₂/gm./hr. This average value of 42 cc. O₂/gm./hr. is undoubtedly more representative of flight metabolism of hummingbirds than the previously reported values.

We shall assume that linear flight is no more strenuous than hovering flight and that the Ruby-throated Hummingbird carries 2 grams of fat, utilizable during flight. Connell, Odum and Kale (Auk, 77, 1960:1–9) have shown that the average fat free weights of male *A. colubris* are less than those of the female (2.50 and 2.76 gms., respectively). If the average body weight in midflight is 3.50 grams for the males and 3.76 grams for the females, we can calculate that, on the average, migrating *A. colubris* utilize fat at the rate of 0.69 and 0.74 Cal./hr. A 2-gram fat supply would sustain a male for 26 hours of flight and a female for 24.3 hours. At an average speed of 25 miles per hour the non-stop flight range of a male *A. colubris* would be 650 miles, whereas that of a female would be 610 miles. These distances are easily enough to span the Gulf of Mexico. Even if one-sixth of the fat were not available for energy metabolism during flight, the hummingbirds could fly over 500 miles.

The problem is much more complex than these calculations would indicate. It is likely that hummingbirds obtain some lift from their forward momentum, and the metabolism of linear flight may possibly be even lower than that of hovering. It is difficult to assess the importance of the changing weight of the birds and little or no information is available on this point. The gravitational effects would be less toward the end of the flight, and this may also influence oxygen consumption.

Through the discovery of a lower metabolic rate for flight than that previously supposed, the capability of *A. colubris* to fly non-stop across the Gulf of Mexico is now energetically demonstrable.—ROBERT C. LASIEWSKI, Department of Zoology, The University of Michigan, Ann Arbor, Michigan, January 6, 1962.

Notes on Some Birds of the State of Michoacán, México.—In the course of field studies of the Strickland Woodpecker (*Dendrocopos stricklandi*) carried out in Michoacán from January 15 to May 30, 1961, I did some general collecting and observing. The following notes present biological information on poorly known species or supplement the distributional information presented in the “Distributional Check-list of the Birds of Mexico,” parts 1 and 2 (Pac. Coast Avif. No. 29, 1950; *ibid.* No. 33, 1957).

Coragyps atratus. Black Vulture. Blake and Hansen (Field Mus. Nat. Hist., Zool. Ser., 22, 1942: 524-525) found that this species was restricted to the tierra caliente (= Arid Tropical Zone) in the Tancitaro region of Michoacán. Black Vultures were seen commonly three miles north of Tzitzio, 6500 feet, in 1951 (Davis, Condor, 55, 1953:90). In 1961, they were seen at numerous localities between Morelia, 6234 feet, and Puerto Garnica, 54 kilometers by road east of Morelia, 9000 feet, where two were seen circling over the pine-fir forest on March 7 and seven were seen on March 25, flying steadily to the west.

Sphyrapicus thyroideus. Williamson Sapsucker. A female was taken 18 miles by road south-southeast of Zinapécuaro, 8000 feet, on March 9. In addition, single birds were seen at Los Trojes, 30 kilometers by road east of Morelia, 7100 feet, on January 20 and 21, and at Puerto Morillos, 52 kilometers by road east of Morelia, 8800 feet, on February 28. In each case, the bird seen was a female. The records for Los Trojes may pertain to the same individual, but a total of at least three birds was involved. Howell (Auk, 70, 1953:118-123) has shown that Yellow-bellied Sapsuckers (*S. varius varius* and *S. v. nuchalis*) in the southern parts of their winter ranges are predominantly females and the same may be true of the Williamson Sapsucker. However, the latter species is rare in México, which is the southern part of its winter range. A survey of 14 museum collections yielded a total of only 32 specimens. Adding my two sight records and single specimen, only 35 records are available. Using the Tropic of Cancer as an arbitrary dividing line, 27 records are for localities north of the line, in the states of Sonora, Sinaloa, Chihuahua, and Durango. These represent 15 males and 12 females. Eight records are from localities south of the line, in the states of Jalisco (3), Michoacán (4), and México (1). These represent two males and six females. Although the samples are too small to support any definite conclusion, the situation appears to be similar to that described by Howell (*op. cit.*:123) for *nuchalis*, in which "there is at least a suggestion that the females are more abundant at the periphery of the winter range and that the proportions are reversed in the northern part, where males are in the majority."

Ridgwayia pinicola. Aztec Thrush. This species was encountered only once, 8 miles north of Ciudad Hidalgo at 8000 feet. On May 3, a female was taken from a tall oak on the steep north wall of a deep barranca. Soon afterward a male flew to the same tree and was collected. The male was in full breeding condition with the left testis 12 mm. long. The female had a brood patch and a large, yolky egg in the greatly expanded oviduct. Near the tree in which the birds were shot were scattered madroños (*Arbutus* sp.) bearing berries, and these were probably the source of attraction for this pair.

Vireolanus melitophrys. Chestnut-sided Shrike-vireo. On March 7, a male and a female were seen in oaks in predominantly pine-fir forest at Puerto Garnica. The two were seen about one mile apart and probably did not represent a mated pair. On April 28, 12 miles southeast of Morelia, 8000 feet, a pair was seen foraging in a small oak. One flew to a nearby pine and the other followed at once. The female was collected as she probed about in a dense tuft of needles at the end of a branch; the male flew out of sight. A few minutes later I heard a bird giving repeated, loud, very harsh calls, sounding like *r-a-a-a-a-k*, becoming louder at the end. This was the male and it was collected. The stomachs of both birds were well filled with insect fragments, including parts of small beetles and an ant head. The left testis of the male measured 8×5 mm. The female had a brood patch, her oviduct contained a large, yolky egg, and her ovary held a very large, yolky follicle apparently about to rupture.

Salvin and Godman (Biología Centrali-Americana, Aves, vol. 1, 1879-1904:209) gave the iris color of this species as greenish-white ("viridescente albo") and this is repeated by Ridgway (Bull. U. S. Nat. Mus., No. 50, part 3, 1904:225). The iris of both of my specimens was yellow.

Passer domesticus. House Sparrow. A juvenile was taken on May 20, 3 miles north of Tzitzio, 6500 feet. This species is now widely distributed in Michoacán. It was seen commonly in Jacona, Zamora, Paracho, Capácuaro, Uruapan, Nuevo Urecho, Ario de Rosales, Tacámbaro, Pátzcuaro, Quiroga, Morelia, Zinapécuaro, San Pedro (5½ miles west-northwest of Ciudad Hidalgo), Ciudad Hidalgo, Maravatio, Tuxpan, and Zitácuaro. These localities virtually blanket the northern half of the state from west to east. At the village of La Pié de la Mesa, 3 miles north of Tzitzio, the species was not recorded in 18 days of collecting in 1951. In 1961, House Sparrows were common there, with two breeding groups located in two large trees in the center of the village. Establishment at this locality within the past ten years suggests that the species has extended its range in Michoacán rather recently.—JOHN DAVIS, *Hastings Reservation, University of California, Carmel Valley, California, December 11, 1961.*