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. O_2/gm./hr., while that of *C. anna* averaged 68 cc. O_2/gm./hr. By assuming that migrating hummingbirds have a flight speed of 50 miles per hour, a metabolic rate of 80 cc. O_2/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. O_2/gm./hr., with values for one minute varying from 32.7 to 50.9 cc. O_2/gm./hr. This average value of 42 cc. O_2/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).