

- UNC at Wilmington Contribution in Marine Science, No. 894:54-56.
- PRICE, H. F. 1946. Food of a Yellow-crowned Night Heron. *Auk* 63:441.
- SPRUNT, A. 1954. Florida birdlife. Coward-McCann, New York.
- STEVENS, J. 1986. Applied multivariate statistics for the social sciences. L. Erlbaum Associates, Hillsdale, NJ.
- SUTTON, G. M. 1967. Oklahoma birds. Univ. Oklahoma Press, Norman.
- WAYNE, A. T. 1906. A contribution to the ornithology of South Carolina, chiefly the coast region. *Auk* 23:56-57.
- WISCHUSEN, E. W. 1979. The nesting success and structure of a Yellow-crowned Night Heron colony in Alabama. *Colonial Waterbirds* 3:85-86.

*The Condor* 91:983-985  
© The Cooper Ornithological Society 1989

## OVERNIGHT MASS LOSS BY WINTERING VERDINS<sup>1</sup>

MARCUS D. WEBSTER<sup>2</sup>

*Department of Avian Sciences, University of California, Davis, CA 95616*

*Key words: Body mass; roosting; energetics; body composition; fat; Remizidae.*

For small birds in extreme environments, the accumulation of sufficient energy reserves for overnight survival is a primary aim of daytime activity (King 1972, Chaplin 1974, Blem 1976). During the winter when thermoregulatory demands are greatest and food resources often scarce, the survival of small passerines may depend on continuous foraging and coincidental lipid storage throughout the day (Blem and Pagels 1984). In birds weighing <40 g, stored energy often provides less than two times the estimated overnight caloric requirements (Blem 1976). This small capacity for storage provides only a very limited reserve for metabolic maintenance during periods when food is not accessible or when the weather prohibits foraging.

Circadian cycles of body mass, recorded primarily from captive birds, have been reported for several avian species (reviewed by Lehikoinen 1987). These weight changes are often correlated with daily rhythms of body fat content (Blem 1976, Blem and Pagels 1984). Estimates of energy utilization may therefore be made from mass loss of fasting birds if appropriate assumptions are made regarding body composition (Helms 1963). Errors associated with assumptions of the caloric content of lost mass may be significant, however, since body components other than fat affect the daily mass cycle (King 1972, Dolnik and Gavrilov 1979). Estimates of caloric reserve utilization from mass changes must therefore be accompanied by "tedious qualifications and uncertainties" (King 1972) such as those

in this paper. Nevertheless, the close correspondence between diurnal cycles of wintertime fat content and body mass in small insectivorous birds (Chaplin 1974, Blem and Pagels 1984) prompted the present study.

To estimate the energy cost of roosting, I measured overnight changes in body mass of free-living Verdins (*Auriparus flaviceps*) wintering in the Colorado Desert of southern California. Verdins are very small (ca. 6.5 g) and highly active insectivores; such a species might represent an extreme for daily cycles of energy storage among passerine birds.

### STUDY AREA AND METHODS

I studied Verdins between December and February 1986-1988 at the Living Desert Reserve, an arboretum and nature preserve near Palm Desert, Riverside County, California. The habitat preferred by Verdins in this area is typical of Colorado Desert alluvial washes, with coarse-grained sandy soil supporting a diverse plant community dominated by palo verde (*Cercidium floridum*), smoketree (*Dalea spinosa*), and cheesebush (*Hydrocotyle salsosa*).

Verdins were captured by hand from their winter roost nests (Buttner et al. 1987) or mist-netted as they left the roost. I caught birds just before the start of their normal active period (mean time = 06:30, range = 06:05-07:05) and about 1 hr after they entered the roost in late afternoon (mean time = 17:14, range = 16:10-18:10). Within 5 min of capture, I weighed the birds to the nearest 0.05 g using a K-Tron DS-10 portable electronic balance. Individual birds were weighed only once during the study; none had previously been disturbed. The birds were released after I banded them with unique color-band combinations to distinguish individuals. I sexed the birds by comparative intensity of the yellow head (males showed brighter, more extensive color) and by observing subsequent behavior (male singing; Taylor 1967). Dissections of Verdins killed in the course of other studies confirmed my sex determinations in 11 of 13 cases.

<sup>1</sup> Received 19 December 1988. Final acceptance 18 May 1989.

<sup>2</sup> Present address: Biology Department, St. John's University, Collegeville, MN 56321.

TABLE 1. Overnight mass loss by Verdins during winter.

	n	Body mass (g) <sup>a</sup>	
		$\bar{x} \pm SE$	Range
<b>Males</b>			
AM <sup>b</sup>	24	6.50 ± 0.05	5.95–7.10
PM	20	6.89 ± 0.07	6.35–7.40
<b>Females</b>			
AM <sup>b</sup>	21	6.43 ± 0.06	5.65–6.85
PM	19	6.93 ± 0.09	6.15–7.55
<b>Pooled</b>			
AM <sup>b</sup>	45	6.46 ± 0.04	5.65–7.10
PM	44	6.92 ± 0.05	6.15–7.55

<sup>a</sup> Birds were weighed to the nearest 0.05 g just before the onset of activity (AM = 06:30 ± 2 min [SE]) and ca. 1 hr after roosting (PM = 17:14 ± 5 min).

<sup>b</sup> Mean AM mass differed from mean PM mass for both sexes and for all birds combined (two-tailed *t*-test, *P* < 0.01). Body mass did not differ between the sexes.

## RESULTS AND DISCUSSION

Body mass of Verdins differed significantly (Student's two-tailed *t*-test; *P* < 0.01) between morning and late afternoon measurements (Table 1). The sexes did not differ in absolute mass or in daily cycles of mass. Overnight, the birds lost an average of 0.46 g, or 6.7% of the mean body weight at roosting.

Verdins spent an average of 14.1 hr/day in their roost nest, although roosting-period duration varied among individuals (± ca. 0.25 hr) and with date (ca. 1 hr longer active period in late February vs. December). The average rate of overnight weight loss from 1 hr postroosting to just before the onset of activity was 0.035 g/hr. This is 29% less than the weight loss rate predicted for a 6.5-g bird at 0°C by Lehtikainen's equation (1987, fig. 2a). Overnight temperatures at the Living Desert Reserve rarely dropped below 5°C during the study, suggesting that temperature effects on mass loss might account for the discrepancy. Also, Verdins may have lower overnight energy requirements than other birds in comparable climatic conditions. Verdins roost individually in enclosed, well-insulated nests; the protection afforded by the nest may allow Verdins to use a smaller proportion of their caloric reserves for overnight maintenance (Buttemer et al. 1987).

The loss of body mass results from the catabolism of energy reserves, urinary and fecal losses, and pulmonary evaporation of water. The latter avenues will comprise a significant proportion of weight changes in species with low diet assimilation efficiencies, high water intake, or when air temperature is high. When evaporative water losses are low, and when birds eat highly digestible food as in the present study, energy-containing components make up a higher proportion of the daily cycle of body mass (Dolnik and Gavrillov 1979).

Caloric body components (primarily lipids) accounted for <30% of overnight mass losses in captive White-throated Sparrows (*Zonotrichia albicollis*; ca. 25 g) at -5°C (Kontogiannis 1967). In contrast, Helms (1963) estimated from data on free-ranging birds that the de-

position and utilization of lipid reserves accounted for 54% of the daily mass cycle in five sparrow species (body weights: 20–40 g). These studies may underestimate the overnight loss of mass attributable to fat utilization in very small birds during winter: In free-living Black-capped Chickadees (*Parus atricapillus*; 12.0 g) in February, mass lost overnight was 86% fat (Chaplin 1974). During other seasons of the year, daily variation in chickadee lipid reserves was a smaller proportion of the body mass cycle (mean annual value = 46%; Chaplin 1974). Carey et al. (1978) found that freshly captured American Goldfinches (*Carduelis tristis*; 13.0 g) housed overnight at -10°C lost 9% of their initial body mass and that >90% of the lost mass was lipid, primarily from fat depots. Daily fat deposition (and presumably use) by wintering Golden-crowned Kinglets (*Regulus satrapa*; 5.8 g) amounted to 0.3 g (Blem and Pagels 1984). This is 50–83% of the mass loss predicted for kinglets resting overnight for 13 hr at 0°C (Lehtikainen 1987).

From the results of the investigations of very small birds cited above (e.g., overnight mass loss = 46–90% lipid), I estimate that the body mass lost overnight by Verdins in this study was 60–80% fat. The caloric value of lost mass is thus 0.6–0.8 times 37.7 kJ/g (the caloric content of a typical avian triglyceride; Blem 1976), or 22.6 to 30.2 kJ/g. These values compare favorably with previous estimates of the caloric value of overnight mass loss in small birds, 24.1–29.5 kJ/g (Blem 1976, Dolnik and Gavrillov 1979).

The energy content of mass lost overnight by wintering Verdins, given the assumption above, is 10.4–13.9 kJ. This compares well with extrapolations of roosting metabolism measurements by Buttemer et al. (1987), who estimated that 12 kJ were required for winter roosting by free-living Verdins from the same population. Doubly-labeled water measurements of active period (*n* = 34;  $\bar{x}$  = 20.2 ± 0.5 kJ [SE]) and 24-hr field metabolic rate (*n* = 14;  $\bar{x}$  = 33.6 ± 1.0 kJ) provide, by difference, a third independent measure of roosting energy costs: 13.4 kJ (Webster and Weathers, unpubl. data).

The close agreement (±15%) between three independent methods of assessing energy requirements of roosting Verdins supports my assumption regarding the composition of lost mass. Mass change/body composition techniques for estimating energy utilization by animals in nature are valid alternatives to isotopic and time-budget methods, but probably are less precise.

Thanks to Karen Sausman, Terrie Correll, and personnel of the Living Desert Reserve for their cooperation and assistance. Al Muth, director, and the staff of the Phillip L. Boyd Deep Canyon Desert Research Center provided logistical support. For helpful discussions and constructive criticism, I am grateful to C. R. Blem, Erick Greene, Michael Kern, James R. King, Donald R. Powers, and Wes Weathers. This study was supported by a grant from the National Science Foundation (BSR 8505490) to W. W. Weathers.

## LITERATURE CITED

BLEM, C. R. 1976. Patterns of lipid storage and utilization in birds. *Am. Zool.* 16:671–684.

- BLEM, C. R., AND J. F. PAGELS. 1984. Mid-winter lipid reserves of the Golden-crowned Kinglet. *Condor* 86:491-492.
- BUTTEMER, W. A., L. B. ASTHEIMER, W. W. WEATHERS, AND A. M. HAYWORTH. 1987. Energy savings attending winter-nest use by Verdins (*Auriparus flaviceps*). *Auk* 104:531-535.
- CAREY, C., W. R. DAWSON, L. C. MAXWELL, AND J. A. FAULKNER. 1978. Seasonal acclimatization to temperature in cardueline finches. II. Changes in body composition and mass in relation to season and cold stress. *J. Comp. Physiol.* 125:101-113.
- CHAPLIN, S. B. 1974. Daily energetics of the Black-capped Chickadee, *Parus atricapillus*, in winter. *J. Comp. Physiol.* 89:321-330.
- DOLNIK, V. R., AND V. M. GAVRILOV. 1979. Bioenergetics of molt in the Chaffinch (*Fringilla coelebs*). *Auk* 96:253-264.
- HELMS, C. W. 1963. Tentative field estimates of metabolism in buntings. *Auk* 80:318-334.
- KING, J. R. 1972. Adaptive periodic fat storage by birds. *Proc. XV Int. Ornithol. Congr.* (1970):200-217.
- KONTOGIANIS, J. E. 1967. Day and night changes in body weight of the White-throated Sparrow, *Zonotrichia albicollis*. *Auk* 84:390-395.
- LEHIKONEN, E. 1987. Seasonality of the daily weight cycle in wintering passerines and its consequences. *Ornis. Scand.* 18:216-226.
- TAYLOR, W. K. 1967. Breeding biology and ecology of the Verdin, *Auriparus flaviceps* (Sundevall). Ph.D.diss. Arizona State Univ., Tempe.

*The Condor* 91:985-986  
© The Cooper Ornithological Society 1989

## FIRST REPORTED NESTS OF THE BLACK-BREASTED WOOD-QUAIL (*ODONTOPHORUS LEUCOLAEMUS*)<sup>1</sup>

DAVID McDONALD

*Department of Zoology, University of Florida, Gainesville, FL 32611*

KATHY WINNETT-MURRAY

*Department of Biology, Hope College, Holland, MI 49423-3698*

*Key words:* *Odontophorus leucolaemus*; nest; eggs; Costa Rica; Phasianidae.

The Black-breasted Wood-Quail (*Odontophorus leucolaemus*) occurs at middle elevations from northern Costa Rica to western Panama (AOU 1983, Stiles and Skutch 1989). We report here the discovery of two nests in Monteverde, Puntarenas Province, Costa Rica (10°18'N, 84°48'W); this is apparently the first published nest record for the species. In Costa Rica, *O. leucolaemus* occurs mainly on the Caribbean slope, but reaches the Pacific slope in the northern mountain ranges (Stiles and Skutch 1989). It is a common resident at Monteverde, where loud morning choruses are heard more often than the birds are seen. Skutch (1947) described the nest, eggs, and incubation behavior of the Marbled Wood-Quail (*Odontophorus gujanensis*).

Both nests were on steep stream banks in secondary forest (lower montane moist forest life zone, Holdridge 1966) on a dairy farm that lies between 1,300 and 1,400 m. Both nest sites were heavily shaded. The nests were ellipsoid hollows fashioned in deep leaf litter. Leaf litter in the vicinity contained twigs (Fig. 1), such that the nest appeared to have been fashioned without addi-

tional materials simply by burrowing into the litter. The entrance was tunnel-like. The first nest was approximately 5 m above the bed of a permanent stream, while the second was 3 m from a dry stream bed that runs intermittently during the rainy season. The hollow of the second nest measured approximately 24 × 13 cm; the entrance faced the stream bed (Fig. 1).

The first nest contained five eggs when it was discovered on 9 June 1985. It also contained five eggs on 10 June and 14 June. The fate of this nest was not known.

The second nest was discovered on 10 June 1988, when an adult quail flushed from the bank near an empty nest. We checked the nest periodically between 12:00 and 17:20 for the next 11 days with the following results: 11 June (one egg), 13 and 15 June (two eggs), 16 and 17 June (three eggs), 18 and 20 June (four eggs), 21 June through 6 July (five eggs). The eggs were white when fresh, but soon became partly discolored with brown mud or leaf stains. As eggs appeared on successive nest checks, they were numbered, measured with a vernier dial caliper, and weighed with a 50-g Pesola® spring scale to the nearest 0.5 g. The mean length was 44.5 mm (range = 43.1-48.5, SD = 2.3, n = 5). Mean width was 28.7 mm (range = 28.5-28.8, SD = 0.1, n = 5). Mean fresh egg weight was 18.6 g (range = 18.0-19.5, SD = 0.7 g, n = 5).

On 8 July the nest contained an unhatched egg and

<sup>1</sup> Received 6 January 1989. Final acceptance 24 May 1989.