

MID-WINTER LIPID RESERVES OF THE GOLDEN-CROWNED KINGLET

CHARLES R. BLEM

AND

JOHN F. PAGELS

Passerine birds have relatively high weight-specific metabolic rates that increase sharply in progressively smaller species (Lasiewski and Dawson 1967). Kendeigh (1970) pointed out that small birds generally are poorly insulated and might be expected to be stressed by low ambient temperature. He suggested, therefore, that energy expenditure may be influential in determining the lower limits of body size of passerines (Kendeigh 1972, but see Kendeigh et al. 1977). High costs of endothermic temperature regulation may be avoided through overnight decreases in body temperature; it appears that nocturnal hypothermia may naturally occur in several species of small passerines (Haftorn 1972, Chaplin 1976, Bucher and Worthington 1982, Lustick et al. 1982). Direct proof is difficult to obtain; hypothermia may occur in small birds in the laboratory because of stress from caging or handling, and may not be a natural part of the daily cycle.

Kinglets (*Regulus* spp.) might be expected to show hypothermia because they are among the smallest Temperate-Zone passerines in the world (see Kendeigh 1972, Chaplin 1982). Two species occur in North America, the Golden-crowned Kinglet (*R. satrapa*; body weight 5.7 g) and the Ruby-crowned Kinglet (*R. calendula*; 6.3 g; Kendeigh 1972). These species appear to tolerate cold and may winter as far north as southern Canada and Alaska.

To our knowledge, little has been published about the utilization or storage of energy by kinglets (see Gavrilov 1972). Therefore, we undertook to measure the size of lipid depots and the amplitude of daily energy cycles in the Golden-crowned Kinglet. We hypothesized that such a bird might not be able to carry sufficient energy stores to maintain high body temperatures over long, cold, winter nights. If daily cycles of energy storage are not sufficient to fuel overnight survival, this indicates that nocturnal hypothermia must occur if the species is to survive.

METHODS

Golden-crowned Kinglets were collected by shotgun between 22 January and 8 February 1983, in Amelia County, Virginia. The collection locality (37°15'N, 78°W) is near the latitudinal center of the winter range of the species. Extreme low temperatures in mid-winter may reach -18°C at this site and lowest average January temperatures recorded in three decades of monitoring were approximately 3.3°C (NOAA 1982). Times of collection (08:00-16:25) were recorded and carcasses were analyzed as described by Blem (1981).

RESULTS AND DISCUSSION

Sixteen kinglets (6 females, 10 males) were obtained throughout the daylight period. Body weights ranged from 5.2 to 6.4 g (mean = 5.8 g, SE = 0.1), and sexes were not significantly different in fresh weight ($t = 1.67$). We found a distinct but small diurnal cycle in lipid reserve, but not in body weight or lean dry weight (Fig. 1). Using total lipid measurements, diurnal winter lipid cycles in Golden-crowned Kinglets may be described accurately ($r = 0.95$) by the following equation:

$$\text{Lipid} = 0.035 \text{ Time} + 0.014$$

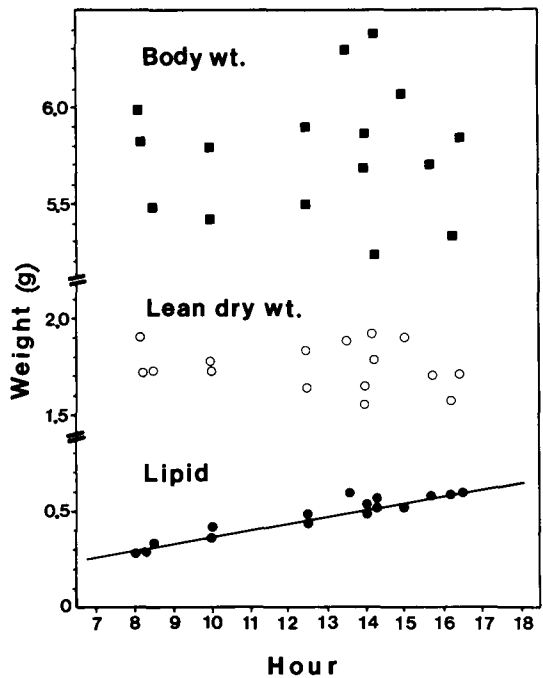


FIGURE 1. Body composition of 16 Golden-crowned Kinglets collected throughout the daylight period in mid-winter.

where lipid is in grams and time is given in hours to the nearest decimal fraction (e.g., 13:30 = 13.5). Maximum lipid reserves (0.6 g) were equal to about 22.6 kJ (assuming lipid = 37.7 kJ/g or 9.0 Kcal; see Blem 1976). In mid-winter in central Virginia, mean overnight low temperatures of at least 0°C last for about 15 h. Using the equation for existence metabolism of birds exposed to 0°C as given by Kendeigh (1970), we predict that a 5.8-g kinglet would use 46.1 kJ during this period, slightly more than twice the caloric content of maximum lipid depots. Other potential energy sources are glycogen reserves in the liver and food stored in the digestive tract, but since there is no apparent diurnal cycle in lean dry weight (see Fig. 1), glycogen stores probably are of little importance. Mean dry weight of food in the esophagus and stomach of kinglets collected late in the afternoon was 36 mg and maximum amounts were only 44 mg (=0.9 kJ, assuming a caloric equivalent of 20.9 kJ/g).

In general, measurement of total extractable lipid overestimates energy reserves. Lipid associated with nervous tissue and cell membranes is extractable but not available for use as an energy source. In the present instance, use of the regression equation for lipid as a function of time to predict reserves at dusk (17:00) and dawn (07:00) provides estimates for maximum (0.6 g = 22.6 kJ) and minimum (0.3 g = 11.3 kJ) depots. The difference between these values provides a more realistic estimate for overnight energy utilization (11.3 kJ). This is only about 24.5% of the predicted overnight energy demand at 0°C.

One cannot assess minimum size in endothermic homeotherms without considering the thermal environment (Tracy 1977). The low energy reserves of Golden-crowned Kinglets might be explained by the birds' judicious choice of roost sites. Much energy might be conserved by roosting in tree cavities or the like and one of us (C.R.B.) has observed Golden-crowned Kinglets going into leafy squirrel nests at twilight in winter (unpubl.). However, available estimates of the energy savings in such roosting sites are estimated to be less than 15% of the daily requirement at

best (Kendeigh 1961). Conversely, Lustick et al. (1982) and Mayer et al. (1982) showed that American Goldfinches (*Carduelis tristis*) may save 50% of their overnight energy requirement by roosting in suitable sites and by partial hypothermia. Roosting, alone, is not likely to account for the difference between energy reserves and expenditures.

Huddling is another potential means of conserving energy. Chaplin (1982) found that roosting pairs of Bushtits (*Psaltriparus minimus*; 5.5 g) used 21% less energy than individuals and that the saving was due to reduced activity and nocturnal huddling. Studying Goldcrests (*Regulus regulus*), Gavrilov (1972) found that individuals housed in pairs at 0°C reduced heat loss by 23% and trios reduced heat loss by 37%. These amounts are not sufficient to offset differences between reserves and energy demands, since reserves are less than 25% of the energy needed at normothermic body temperatures at relatively moderate mid-winter ambient temperatures. Hence, even with such large savings, it is unlikely that hypothermia could be avoided.

In summary, our data indicate a small fluctuation of daily lipid cycles in wintering Golden-crowned Kinglets. Reserves are inadequate for overnight energy demands at normothermic body temperatures.

We thank Ronald Adleman for permission to collect kinglets on his property. Jennifer Stewart and Leann Blem provided useful reviews of this note.

LITERATURE CITED

- BLEM, C.R. 1976. Patterns of lipid storage and utilization in birds. *Am. Zool.* 16:671-684.
- BLEM, C. R. 1981. Geographic variation in mid-winter body composition of Starlings. *Condor* 83:370-376.
- BUCHER, T. L., AND A. WORTHINGTON. 1982. Nocturnal hypothermia and oxygen consumption in manakins. *Condor* 84:327-331.
- CHAPLIN, S. B. 1976. The physiology of hypothermia in the Black-capped Chickadee, *Parus atricapillus*. *J. Comp. Physiol.* 112B:335-344.
- CHAPLIN, S. B. 1982. The energetic significance of huddling behavior in Common Bushtits (*Psaltriparus minimus*). *Auk* 99:424-430.
- GAVRILOV, V. 1972. How birds reduce heat loss. *Piroda* 1972(10):110.
- HAFTORN, S. 1972. Hypothermia of tits in the arctic winter. *Ornis Scand.* 3:153-166.
- KENDEIGH, S. C. 1961. Energy of birds conserved by roosting in cavities. *Wilson Bull.* 73:140-147.
- KENDEIGH, S. C. 1970. Energy requirements for existence in relation to size of bird. *Condor* 72:60-65.
- KENDEIGH, S. C. 1972. Energy control of size limits in birds. *Am. Nat.* 106:79-88.
- KENDEIGH, S. C., V. R. DOL'NIK, AND V. M. GAVRILOV. 1977. Avian energetics, p. 127-204. *In* J. Pinowski and S. C. Kendeigh [eds.], *Granivorous birds in ecosystems*. Cambridge Univ. Press, London.
- LASIEWSKI, R. C., AND W. R. DAWSON. 1967. A reexamination of the relation between standard metabolic rate and body weight in birds. *Condor* 69:13-23.
- LUSTICK, S., B. BATTERSBY, AND L. MAYER. 1982. Energy exchange in the winter acclimatized American Goldfinch, *Carduelis (spinus) tristis*. *Comp. Biochem. Physiol.* 72A:715-719.
- MAYER, L., S. LUSTICK, AND B. BATTERSBY. 1982. The importance of cavity roosting and hypothermia to the energy balance of the winter acclimatized Carolina Chickadee (*Parus carolinensis*). *Int. J. Biometeorol.* 26:231-238.
- NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION. 1982. Local climatological data. Annual survey with comparative data. NOAA, Asheville, NC.
- TRACY, C. R. 1977. Minimum size of mammalian homeotherms: role of the environment. *Science* 198:1034-1035.

Department of Biology, Virginia Commonwealth University, Academic Division, Richmond, Virginia 23284. Received 19 November 1983. Final acceptance 19 May 1984.

The Condor 86:492-493
© The Cooper Ornithological Society 1984

WHITE-FACED IBIS NESTING IN THE SOUTHERN SAN JOAQUIN VALLEY OF CALIFORNIA

GARY L. IVEY

AND

DANIEL J. SEVERSON

White-faced Ibis (*Plegadis chihi*) were last reported nesting in the southern San Joaquin Valley at Buena Vista Lake, Kern County, California, in 1922 (Lamb 1922). Grinnell et al. (1918) reported ibis as "a common summer visitant and breeder in the San Joaquin Valley." Booser and Sprunt (1980) reviewed the literature for the species and summarized its historical breeding distribution. The most recent published nesting record within the Central Valley was cited from a personal communication by Ryder (1967) that White-faced Ibis had "not nested in the Central Valley since 1954 or 1955." Voeks and English (1981) surveyed

White-faced Ibis distribution in the western states during 1979 and 1980. They did not mention the four pairs that nested in a small cattail (*Typha* sp.) marsh at Mendota Wildlife Management Area, Fresno County (northern San Joaquin Valley) in 1979. By 1983, that nesting population had increased to 24 pairs (Beam, pers. comm.).

On 8 June 1983, we visited South Wilbur Flood Area in southern Kings County to inventory colonial nesting waterbirds. This approximately 3,300-ha marsh is owned and managed by the J. G. Boswell Company for storage of excess irrigation and flood waters, and is located within the historic Tulare Lake bed. Dominant vegetation in the marsh included Baltic rush (*Juncus balticus*), summer tamarisk (*Tamarix pentandra*), cattail and hardstem bulrush (*Scirpus acutus*). We canoed through mixed colonies of Great Blue Herons (*Ardea herodias*), Double-crested Cormorants (*Phalacrocorax auritus*), Great Egrets (*Casmerodius albus*), Snowy Egrets (*Egretta thula*), Cattle Egrets (*Bubulcus ibis*), and Black-crowned Night-Herons (*Nycticorax nycticorax*) which were nesting in a flooded grove of summer tamarisk and Baltic rush. During the survey we found five White-faced Ibis nests which contained from one to four eggs, one nest with two half-grown young, and six nearly-fledged young at various locations in the colony. The nests were in Baltic rush and summer tamarisk about 20 to 50 cm above water, which was 65 cm deep. The ibis