——— AND A. R. PHILLIPS. 1981. Annotated checklist of the birds of Arizona. Univ. Arizona Press, Tucson.

PHILLIPS, A., J. MARSHALL, AND G. MONSON. 1964. The birds of Arizona. Univ. Arizona Press, Tucson.

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**Seasonal and diurnal mass variation in Black-capped Chickadees and White-throated Sparrows.**—During the winters of 1989–90 and 1990–91, we recorded mass of free-ranging Black-capped Chickadees (*Parus atricapillus*) and White-throated Sparrows (*Zonotrichia albicollis*) in northern New Jersey. The data presented here are the first records of seasonal and diurnal mass variation for untrapped passerines in North America. Previous studies have shown that captivity and handling can significantly bias results of studies of avian mass (King and Farner 1966, Castro et al. 1991, Refsnider 1993).

*Study area and methods.*—We recorded mass of Black-capped Chickadees in Mendham, New Jersey (40°46′N, 74°32′W) from November 1990 through March 1991. We weighed White-throated Sparrows from January through March in 1990 and 1991. The study site was in a residential suburban neighborhood containing several feeders. Local weather conditions during the two winters of observation were milder than usual with less than normal precipitation (National Climatic Data Center 1989–91).

We initially captured birds in mist nets or wire traps and marked them with USF&W bands and a unique combination of colored plastic leg bands. The birds were released within 30 min at the site of capture. Periodically throughout the winter season, we recorded body mass as birds alighted on the platform of a baited electronic digital balance that had an accuracy of 0.1 g and an operating temperature range of −5°C to +35°C. We recorded mass during three periods of the day (1)"AM" (sunrise minus 30 min to sunrise plus 2 h), (2) "Midday" (11:00–13:00 EST) and (3) "PM" (sunset minus 2 h to sunset plus 30 min). The balance was connected by cable to a personal computer inside the building. During a bird's visit, 20 consecutive readings at 0.4-sec intervals were recorded. We included only those weight measurements judged to be stable or those that met the following criteria (1) if, within the list of weights recorded during a single visit, there was a minimum of three consecutive weights that differed by no more than 0.1 g, the mean of the consecutive weights was accepted as the body mass during that visit, or (2) if no such group of three existed, the mean of four or more consecutive weights was accepted, so long as none of the values differed by more than 0.2 g (twice the sensitivity of the balance) from the mean. For the AM period the earliest mass recorded was selected for analysis, for the midday period the mass recorded nearest 12:00 was chosen, and for the PM period the latest recorded mass was selected.

We analyzed the data using SAS (1985) procedures in order to generate descriptive statistics. We tested for the reduction in variance explained when comparisons were made between linear and quadratic regression analyses (Steel and Torrie 1960). We used correlation coefficients to test significance of linear regression models. We used goodness of fit,

$R$, and $F$-comparison tests as measures of significance for reduction of variance due to the $X^2$-term of the quadratic.

*Results.*—The two species in the study differed in their pattern of seasonal mass variation (Fig. 1). Black-capped Chickadee maintained a relatively stable mass over the winter. Data for White-throated Sparrow demonstrate a significant ($P < 0.01$) linear decrease in mass from midwinter to spring. As chickadees did not visit the experimental platform during most of January 1991, we distinguished between data collected during the early period, November through December 1990, and the later period, February through March 1991. A test for unequal observations and unequal variances indicated that midday data for these two calendar periods were not homogeneously distributed; however, mean mass was not significantly different: 1990 = 11.4 g vs 1991 = 11.5 g; $F_{78,26} = 1.40$; $P > 0.05$. We analyzed chickadee data for the two periods separately prior to pooling, and found that coefficients of variation were 4.1% and 4.8% respectively, suggesting a stable seasonal pattern in this species.

Black-capped Chickadees and White-throated Sparrows differed with respect to their patterns of diurnal variation (Table 1, Fig. 2). For Black-capped Chickadee, pooled data for the entire winter of 1990–91, based on equal variances for all individuals, indicate significant ($P < 0.05$) mass gain between each diurnal period, followed by overnight mass loss. For White-throated Sparrow, pooled data indicate a significant ($P < 0.05$) gain in mass only between the AM and the midday periods.

*Discussion.*—Pooled data for the Black-capped Chickadees show minimal mass variation over the winter. These results differ from those of Haftorn (1989) who showed mass variation of several species of free-ranging Paridae in Norway conformed to a pattern of winter fattening in which daily mass amplitude varies seasonally and morning mass tends to increase in winter. Our data are similar to those of Lawrence (1958) who showed over five winters that seasonal mass for repeatedly trapped resident Black-capped Chickadees in Ontario varied relatively little. Lawrence quantified seasonal mass variation for Black-capped Chickadee by computing the average of the differences between the lowest and highest mass over the winter expressed as percent of the lowest weight. Using this procedure for our midday data, we computed a seasonal variation for Black-capped Chickadee of 6.7% (range: 5.3–9.2%; N = 6). Lawrence's data, which do not specify time of weighing, show a seasonal mass variation of 7.3% (range: 5–12%; N = 28). Lawrence's data for migrant Black-capped Chickadees show greater mass variation over the season (11.1%; range 8–17%; N = 17).

We note that the robustness of our data suffers from the paucity of records in January due to the infrequency of feeding activity by Black-capped Chickadees at the weighing apparatus during that month. Without a good record for January, the possibility of a departure from the stable seasonal mass pattern for chickadee during that period cannot be ruled out. However, if a seasonal peak in mass were to occur in January, it would have to be of relatively rapid onset and decline. Haftorn's (1989) findings that the mass of most of the birds he studied increased gradually toward a midwinter peak would argue against the probability of a sudden sharp peak occurring in January for Black-capped Chickadee.

Our data are consistent with Rogers and Smith's (1993) conclusion that species of an avian tree-foraging guild employ a winter survival strategy that minimizes variation in body mass, while species of a ground-foraging guild exhibit an increase of mass in midwinter in harsh climates. The tree-foraging Black-capped Chickadee showed relatively little mass variation over the season compared with that shown by the ground-foraging White-throated Sparrow.

Diurnal mass variation data for Black-capped Chickadee in this study are similar to those published by Haftorn (1989) for Paridae in Norway and Howitz (1981) for Black-capped Chickadee in Minnesota. The birds in all three studies gained mass gradually over the day. The pattern of diurnal mass increase shown for White-throated Sparrow in the present study

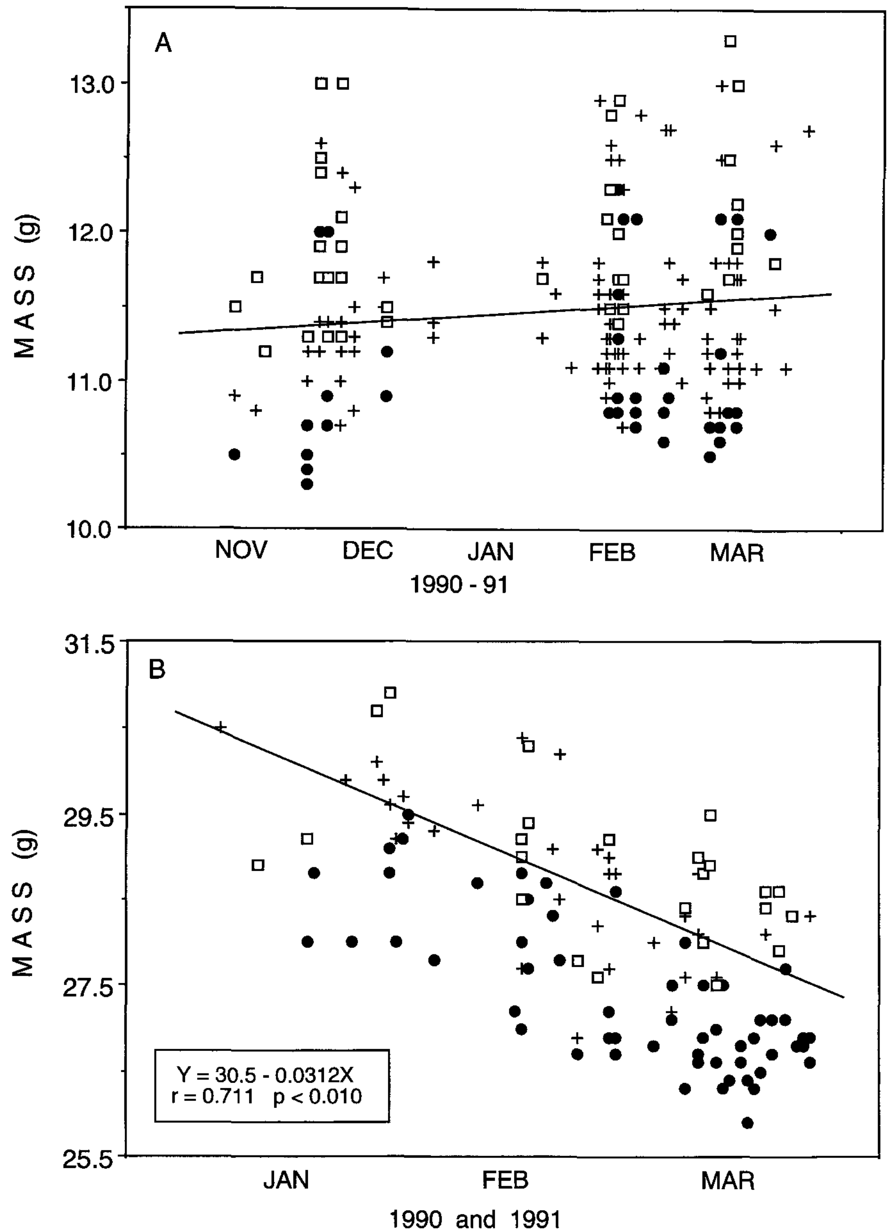


FIG. 1. Mean mass (g ± SE) for Black-capped Chickadee (A) and White-throated Sparrow (B). Best fit lines are for midday data; regression for chickadee was not statistically significant. AM mass (solid circle), midday mass (crossbar), PM mass (open square).

TABLE 1

DIURNAL MASS CHANGE FOR BLACK-CAPPED CHICKADEE AND WHITE-THROATED SPARROW OVER THREE PERIODS OF THE DAY

| | AM | | Midday | | PM | | Percent change in mass[a] | | |
|---|---|---|---|---|---|---|---|---|---|
| | N | Mass g (SE) | N | Mass g (SE) | N | Mass g (SE) | AM-MID | MID-PM | PM-AM |
| Black-capped Chickadee (pooled data for 6 individuals) | | | | | | | | | |
| Early[b] | 11 | 10.9 (0.2) | 27 | 11.4 (0.1) | 19 | 11.8 (0.1) | 4.3% | 3.7% | −8.2% |
| Late[c] | 28 | 11.1 (0.1) | 79 | 11.5 (0.1) | 22 | 12.0 (0.1) | 3.6% | 4.6% | −8.4% |
| Season | 39 | 11.1 (0.1) | 106 | 11.5 (0.1) | 41 | 11.9 (0.1)[e] | 3.8% | 3.9% | −7.9% |
| White-throated Sparrow (pooled data for 3 individuals) | | | | | | | | | |
| Season[d] | 58 | 27.4 (0.1) | 33 | 28.8 (0.2) | 24 | 28.9 (0.2)[e] | 5.2% | 0.1% | −5.4% |

[a] Percent change in mean mass for each period based on the earlier mass.
[b] 13 Nov.–30 Dec. 1990.
[c] 25 Jan.–24 Mar. 1991.
[d] 01 Jan.–30 Mar. 1990 and 01 Jan.–30 Mar. 1991.
[e] Separate underlined data are significantly different at $P < 0.05$, multiple comparison test.

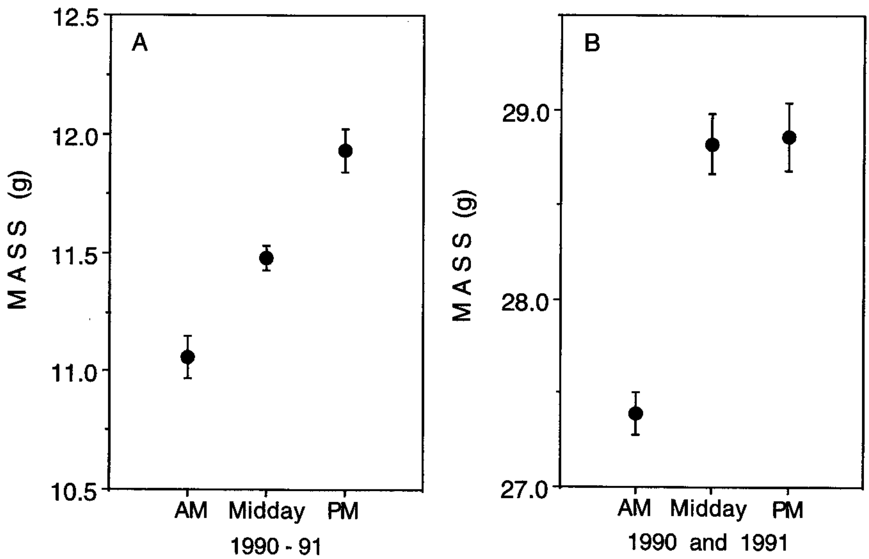


FIG. 2. Mean mass (g ± SE) for Black-capped Chickadee (A) and White-throated Sparrow (B) for three periods of the day.

is consistent with Kontogiannis' (1967) finding that captive birds of this species showed maximum rate of increase in mass during the first 2.5 hours of the day.

Black-capped Chickadee-RWR, the dominant female, gained, on average, nearly twice as much mass over the course of the day in comparison to the dominant male RBR (1.08g vs 0.62 g, representing an average daily change of 9.6% vs 5.6%). RBR exhibited the smallest daily amplitude of mass variation, suggesting that being the dominant male may facilitate energy conservation in roosting.

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## LITERATURE CITED

CASTRO, G., B. A. WUNDER, AND F. L. KNOPF. 1991. Temperature-dependent loss of mass by shorebirds following capture. J. Field Ornith. 62:314–318.

HAFTORN, S. 1989. Seasonal and diurnal body weight variation in Titmice, based on analyses of individual birds. Wilson Bull. 101:217–235.

HOWITZ, J. L. 1981. A population study of the Black-capped Chickadee. Ph.D. diss., Univ. of Minnesota, Minneapolis, Minnesota.

KING, J. R. AND S. FARNER. 1966. The adaptive role of winter fattening in the White-crowned Sparrow with comments on its regulation. Am. Nat. 100:403–418.

KONTOGIANNIS, J. E. 1967. Day and night changes in body weight of the White-throated Sparrow, *Zonotrichia albicollis.* Auk 84:390–395.

LAWRENCE, L. DEK. 1958. On regional movements and body weight of Black-capped Chickadees in winter. Auk 75:415–443.

NATIONAL CLIMATIC DATA CENTER. 1989–91. Climatological Data New Jersey Vols. 94–96, passim. NOAA, Ashville, North Carolina.

REFSNIDER, J. M. 1993. Weight loss by birds when held for banding. N. Am. Bird Bander 18:90–97.

ROGERS, C. M. AND J. N. M. SMITH. 1993. Life-history theory in the nonbreeding period: trade-offs in avian fat reserves? Ecology 74:419–426.

SAS. 1985. SAS Institute Inc., Box 8000, Cary North Carolina.

STEEL, R. G. D. AND J. H. TORRIE. 1960. Pp. 338f *in* Principles and procedures of statistics, with special reference to the biological sciences. McGraw-Hill, New York, New York.

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**Detectability and population density of Scaly-naped Pigeons before and after Hurricane Hugo in Puerto Rico and Vieques Island.**—Detectability and density of Scaly-naped Pigeons before and after Hurricane Hugo hit northeastern Puerto Rico with sustained winds of 30–40 m/s (gusting from 50–60 m/s) on 18 September 1989 (see Boose et al.