as an example, out of 22 juveniles, 12 were males and all 12 occurred in the top 14 birds.

On March 7, 1973, seven territorial males and five females were removed from an experimental part of the study area (Knapton and Krebs 1974). Ten males subsequently established territories in this experimental area. Five hierarchies had been determined during the winter in this area, and of these 10 new territorial males, 7 had figured in the hierarchies. Table 1 gives the position in the hierarchies of these 7 males, and the number of juveniles in each hierarchy. The top juvenile males from 4 of the 5 hierarchies established territories, as did 2 males who held second position in 2 of the hierarchies, and finally one male who was fifth in the largest hierarchy (the B-C Hierarchy). The third bird in the B-C Hierarchy obtained a territory in early May on the control (undisturbed) area, shortly after a control male disappeared from his territory. Thus, if we analyze the B-C Hierarchy, out of 12 juvenile males, 4 from the top 5 obtained territories, which is highly unlikely to have occurred by chance ($P = 0.01$, Wilcoxon two-sample rank test). Interestingly, of the 7 females who paired with the new territorial males after the removals, only one had been a prominent member in the hierarchies.

Our results strongly support the hypothesis that, given the opportunity, the juveniles who obtain territories are the dominant individuals in dominance hierarchies established during the pre-breeding season.

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THE OXYGEN CONSUMPTION OF THE MOUNTAIN WHITE-CROWNED SPARROW (*ZONOTRICHIA LEUCOPHRYS ORIANTHA*) IN RELATION TO AIR TEMPERATURE

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The Mountain White-crowned Sparrow (*Zonotrichia leucophrys oriantha*) is the least well-known member of its species, although its reproductive biology has recently begun to receive substantial attention (e.g., Morton, Horstman, and Osborn, Condor 74:152–163, 1972). It is a migrant that winters from the extreme southwestern United States into central Mexico and breeds in the Rocky Mountains, Sierra Nevada, and isolated ranges of the Great Basin (Banks, Univ. Calif. Publ. Zool. 70:1–123, 1964) above an altitude of about 2000 m. Although predominantly a nesting bird of alpine and subalpine meadows, it also inhabits shrubsteppe vegetation dominated by sagebrush (*Artemisia* sp.) at lower altitudes, and the krummholz of the tundra zone at the highest altitudes. As an adjunct of investigations of the ecological energetics of this species we measured its oxygen consumption in relation to air temperature. Inasmuch as these results will not reappear in an explicit form in subsequent publications, we report them here briefly as a contribution to the data archives of crowned sparrows in particular and comparative avian energetics in general.

Six adult *Z. l. oriantha* captured at the end of the breeding season near Niwot Ridge, Boulder Co., Colorado (40.1°N, 105.3°W, ca. 3500 m in altitude) were brought to the laboratory at Pullman, Washington, and initially housed in an outdoor aviary. Together with six adult *Z. l. gambelii* that had been captured during the autumn migration in southeastern Washington, the Colorado birds were placed in individual cages in a constant-condition room (air temperature 8 ± 1°C, photoperiod LD 10:14, lights off at 0700) on 5 February 1975. Oxygen consumption was measured between 1 March and 15 April. The conditions of husbandry and methods of measuring oxygen consumption were as previously described (King, Comp. Biochem. Physiol. 12:13–24, 1964). Measurements were made during the period from 1100 to 1800 within the birds' subjective night, at least three hours after their last meal. Each series of measurements included two *oriantha* and one *gambelii*, the latter included for purposes of interracial comparison. Air-temperature adjustments during the measurement of oxygen consumption were in upward steps, as in previous experiments, with at least an hour allowed for adjustment to steady-state conditions at each step. The air temperature range was from −10°C to 37°C, with known test temperatures distributed at irregular intervals (cf. King, 1964). The birds were in essentially black-body and free-convection conditions in the metabolism chambers. Air and chamber-wall temperatures were nearly identical.

Oxygen consumption in both subspecies was a linear function of ambient temperature between −10 and 23°C, and was independent of ambient temperature between about 23 and 34°C. The least-squares regressions of oxygen consumption (STPD) on ambient temperature for *oriantha* and *gambelii*, respectively, were: $\text{cm}^3\ O_2/\text{g-hr} = 4.71 - 0.1128T$ ($S_{yx} = 0.07889$, $S_B = 0.00694$, $n = 47$) and $\text{cm}^3\ O_2/\text{g-hr} = 4.80 - 0.1021T$ ($S_{yx} = 0.14968$, $S_B = 0.01521$, $n = 28$). These regressions do not differ statistically ($P > 0.05$) in either slope or elevation. Regression lines fitted to the points between 23 and 34°C (the thermoneutral zone) had slopes not differing from zero. The mean BMR (± SD) of *Z. l. oriantha* was 2.23 ± 0.436 $\text{cm}^3\ O_2/\text{g-hr}$ ($n = 27$, mean body weight = 27.3 g), and that of *Z. l. gambelii* was 2.65 ± 0.378 $\text{cm}^3\ O_2/\text{g-hr}$ ($n = 10$, mean body weight = 26.0 g). The means differ significantly ($P < 0.01$). The regression lines for the two segments of the temperature-metabolism curve intersect at 23.3°C for *oriantha* and 22.2°C for *gambelii*, arbitrarily defining the essentially identical lower critical temperatures in these two taxa.

In sum, *oriantha* and *gambelii* acclimated to 8°C and LD 10:14 are alike with respect to the temperature dependence of oxygen consumption below the lower critical temperature, but the BMR of *gambelii* is about 19 per cent above that of *oriantha*. Since neither *oriantha* nor *gambelii* function within the thermoneutral range for substantial periods of their annual cycle the ecological significance of this is questionable.

The results for *gambelii* can be compared with those of the earlier investigation of this species (King, 1964) by identical procedures but different conditions of acclimation (photoperiod also LD 10:14, but air temperature $= 20 \pm 2$°C). The *gambelii* of the earlier measurements had a slightly but significantly lower (11 per cent, $P < 0.01$) BMR, an identical lower critical temperature, and a steeper dependence of oxygen consumption on air temperature ($\text{cm}^3/\text{g-hr} = 5.27 - 0.0125T$), but not differing statistically ($P > 0.75$) from the current data. These differences are in the direction found in other species upon thermal acclimation on short daylengths (Pohl, Ibis 113:185–193, 1971; West, Comp. Biochem. Physiol. 43A:293–310, 1972).

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AVIAN ENDOCRINOLOGY—FIELD INVESTIGATIONS AND METHODS

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The advent of saturation-analysis techniques (radioimmunoassays and competitive-protein binding assays) for the estimation of avian gonadotropins and steroids in small volumes of plasma (Follett, Scanes and Cunningham 1972, Peterson, Henneberry and Common 1973, Kerlan and Jaffe 1974, Schrocksnadel, Bator and Frick 1973, Senior 1974, Wingfield and Farner 1975) has made possible a number of studies of these hormones in relation to reproductive function (Follett and Nicholls 1973, Follett, Farner and Mattocks 1975, Kerlan and Jaffe 1974, Senior 1974, Lam and Farner 1976). All of these investigations have involved captive birds with the exception of that of Temple (1974) in which Starlings (*Sturnus vulgaris*) were captured from the wild and sacrificed. A study of the hormonal changes through a reproductive season of a feral population with individual birds repeatedly sampled in the field has not as yet been reported.

During the past two years we have developed a system for collecting and estimating the plasma levels of several hormones in serial samples from repeatedly-captured wild birds. We have tested it on populations of the White-crowned Sparrow (*Zonotrichia leucophrys*). Our experience indicates that the system can obtain reliable information on plasma levels of hormones without interrupting reproductive activity. This paper describes our methods and procedures and illustrates the kind of endocrinological information that can be obtained with this system.

MATERIALS AND METHODS

Sites and methods of capture. We have developed and tested our procedures on a breeding population of the northern Pacific-coast race of White-crowned Sparrow (*Zonotrichia leucophrys pugetensis*), which breeds west of the Cascade-Sierra divide from northern California (Blanchard 1941, Banks 1964, Cortopassi and Mewaldt 1965) to the Puget Sound region. Birds were caught with mist nets or Potter traps on breeding territories on Camano Island, Island County, Washington, and in a wintering area at San Jose, California. Traps were used exclusively at garden feeders where birds came regularly to feed. It was found preferable to use mist nets (2 × 12 meters) mounted on telescopic tent poles with two guy-ropes per pole. Such nets were found to be simple and rapid to erect or strike. A further advantage of this system was that a single investigator could easily handle the nets and thus reduce disturbance of birds on breeding territories.

From late summer through spring migration, White-crowned Sparrows can be found in flocks of up to several hundred individuals from which they can easily be captured with mist nets. However, during the latter stages of the breeding season, and especially during incubation, they become secretive in addition to being widely spread in territories. In the initial stages of the investigation we attempted to flush the birds from dense cover and to drive them toward previously set nets. It soon became obvious that this method was both stressful to the birds and