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: $cm^3\ O_2/g\text{-}hr = 4.71 - 0.1128T$ ($S_{yx} = 0.07889$, $S_B = 0.00694$, $n = 47$) and $cm^3\ O_2/g\text{-}hr = 4.80 - 0.1021T$ ($S_{yx} = 0.14968$, $S_B = 0.01521$, $n = 28$). 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 $cm^3\ O_2/g\text{-}hr$ ($n = 27$, mean body weight = 27.3 g), and that of *Z. l. gambelii* was 2.65 ± 0.378 $cm^3\ O_2/g\text{-}hr$ ($n = 10$, 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 ($cm^3/g\text{-}hr = 5.27 - 0.0125T$), 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

TABLE 1. Body weight and levels of hormones for five thrice-captured male White-crowned Sparrows on Camano Island.

	First capture April/May	Second capture May/June	Third capture June/July
Body weight (g)	27.40 ± 0.85[a]	27.50 ± 0.67[a]	24.10 ± 0.98[a]
irLH[b] ng/ml	4.05 ± 0.52	4.88 ± 1.40	4.40 ± 0.81
Total androgen[c] ng/ml	6.71 ± 2.96	3.30 ± 1.63	2.89 ± 0.86
Corticosterone μg/100 ml	1.44 ± 0.51	1.00 ± 0.30	1.52 ± 0.45

[a] Means ± Standard error.
[b] Immunoreactive luteinizing hormone; [c] 5α-dihydrotesterone plus testosterone.

destructive to their territory. Subsequently, birds were attracted to the nets by playing tape-recorded White-crowned Sparrow songs. Territorial males almost invariably responded and in many cases females also. Using this combination of tape-recorded songs and carefully placed mist nets it was found that repeated captures of the same individuals could be made throughout the breeding season.

Blood sampling in the field. Blood is taken from a wing vein in heparinized micro-hematocrit tubes after puncture of the vessel with a 26-gauge needle. We have found that up to 12 tubes (approximately 0.6–0.7 ml of whole blood) can be withdrawn from a single bird (weight 22–36 g). Each tube is hermetically sealed at one end with the flame of a propane torch and centrifuged at about 2000 rpm for 5 minutes in an International Clinical Centrifuge fitted with a micro-hematocrit tube head. A 12-volt automobile battery is used as a power source and direct current converted to alternating current with an inverter. After centrifugation hematocrit is estimated by measuring the ratio of the length of tube occupied by red blood cells and the total length of tube occupied by blood. Plasma is then aspirated off with a 50-μl syringe and stored frozen on dry ice. On return to the laboratory all samples are stored in a deep-freeze chamber until analyzed.

As far as possible blood samples are taken within 10 minutes of capture (mostly within 5 minutes). This is to minimize any effects of capture stress on hormone levels.

Other procedures. After withdrawal of blood sample, each bird was banded with an aluminum band (U.S. Department of the Interior, Fish and Wildlife Service) in combination with one or two plastic color bands for subsequent individual identification in the field. After banding, each bird was weighed to the nearest 0.1 g on a triple-beam balance.

Unilateral laparotomy was also performed on each bird in order to determine sex and reproductive state. Our procedure was similar to that described by Bailey (1953) except that it was performed without anesthesia. For males we visually estimated testis size by comparison with testes of known weight preserved in ethanol. For females we visually estimated the sizes of follicles and oviduct, and noted the presence or absence of brood patch. Such data were admittedly rough estimates but were comparable to those of Lewis (1971) on actual gonad weights taken earlier from the same breeding population.

Notes on the state of molt were recorded when applicable. After all data and samples had been collected the bird was released for subsequent recapture.

Assay methods. Hormones in the plasma samples were measured by saturation-analysis techniques. A double-antibody radioimmunoassay, developed by Follett et al. (1972), and adapted for use on plasma of White-crowned Sparrows by Follett et al. (1974) was used to measure the levels of luteinizing hormone (LH). The steroids, 5α-dihydrotestosterone, testosterone, estrone and estradiol-17β were measured by a single-antibody assay. The methods, as adapted for avian plasma, have been described in detail by Wingfield and Farner (1975). Hormone levels of some serially sampled birds are presented in table 1.

RESULTS AND DISCUSSION

In 1974 between April and late August, 60 breeding adults were banded on Camano Island. Of these, 31 (52%) returned to the same territories or within 100 meters of those territories in 1975, despite having been captured and processed at least once during the previous year. This is similar to the findings at individual banding stations on wintering grounds in which 30–50% of banded adult White-crowned Sparrows was found to return each winter (Mewaldt 1964, Cortopassi and Mewaldt 1965). It has also been shown that *Z. l. gambelii* tend to return to the same breeding area (Cortopassi and Mewaldt 1965).

Birds were trapped in both summers of 1974 and 1975 (in some cases up to five times per season), weighed, and blood samples taken. Laparotomy was also performed in most cases. In all instances birds remained on their territory indicating that our operations were not sufficiently stressful to cause desertion. Throughout the study it was not unusual for males to recommence singing and females to return to the nest (incubating or feeding young) within 30–60 minutes of release. Further, these birds fledged young and began a second brood synchronously with unbanded birds suggesting that these techniques did not unduly disturb or delay the cycle. In general, at least one week was allowed to pass before attempts at recapture were made. In addition, our observations on nesting success, in comparison with the data of Lewis (1971), show that our field operations did not reduce the number of young fledged.

Fledgling White-crowned Sparrows were also sampled on Camano Island in 1974 and 1975. It was found that up to 5 micro-hematocrit tubes of blood (approximately 0.2 ml) could be taken from "stub-tail" fledglings just out of the nest without ill effect. Laparotomy was not performed at this time as this was a very stressful procedure in birds so young. In addition, the gonad could not be discerned with certainty as an ovary or testis in the field situation. At about 30 days of age the fledglings became independent of their parents (Lewis 1971). At this time 12 tubes of blood could be taken and laparotomy was also performed.

Color-banding allowed us to observe individuals of known identity in the field. This is important since samples taken from an unmarked population would not accurately distinguish first and second broods or renesting birds. Also, this allowed the obvious advantage of individual histories of hormone levels. Data can be analyzed without the problem of individual variation. In 1974, 45 blood samples were collected from a nucleus of 19 banded birds and in 1975, 67 samples were taken from 28 banded birds (including 12 birds banded in 1974). These were supplemented by samples from birds that were caught only once but for which observation indicated the reproductive state of the individual. Further samples were taken from transients (during migration in April and September) and molting birds (July–September). Thus the total number of samples taken from birds that could be assigned to a specific phase of the annual cycle was 124 in 1974 and 306 in 1975.

The data presented in table 1 are for serially sampled birds during the period late April to early July. This is the period of most intense nesting activity and presumably the highest titers of reproductive hormones. These data suggest that the level of androgens (5α-dihydrotestosterone + testosterone) may decrease from the time of the first clutch when territorial defense is maximum to the time of the second clutch ($P < 0.15$). Also they suggest that this decrease occurs in the presence of continued high levels of LH, a phenomenon that has been noted also by Lam and Farner in captive male *gambelii.* There is a significant decrease ($P < 0.05$) in body weight through the course of the breeding season.

The plasma level of corticosterone (1.08 ± 0.39 μg/100 ml, n = 5) in birds sampled immediately after being shot in the field, was not significantly different from that of birds sampled within 10 minutes of capture (0.98 ± 0.16 μg/ml, n = 10). The situation is similar for the plasma level of LH (4.19 ± 0.85 ng/ml, n = 5 and 4.22 ± 0.50 ng/100 ml, n = 10, respectively). These data indicate that samples collected within 10 minutes after capture have hormone levels very similar to precapture levels.

The scheme described herein offers significant advantages in the investigation of the endocrine basis of such phenomena as reproduction, establishment and defense of territory, and molt under natural conditions. Especially important is the capability for comparison of levels of hormones in the plasma of individual birds through the course of different phases of the annual cycle. To varying degrees, individual birds have their own characteristic general plasma levels of at least some hormones. When this occurs the scheme described here permits the detection of significant changes that are unlikely to be found in data based on a single sample from each bird of a time series. Another advantage is that temporal patterns of hormone levels of individual birds can be compared under the differing conditions of consecutive years. The scheme also eliminates possible effects of removal of territorial birds from a breeding population.

SUMMARY

Techniques for the collection and transport of blood samples for analysis of hormones from a feral population of White-crowned Sparrows, (*Zonotrichia leucophrys pugetensis*) are described. Birds are captured in Potter traps or mist nets, banded, blood samples taken and then released for subsequent recapture. Laparotomy is performed in most cases. Blood samples are centrifuged in the field and plasma stored and transported frozen on dry ice. The data and observations presented suggest that the capture and processing procedures are not sufficiently stressful to delay or otherwise disrupt the breeding cycle. Field operations of the type described herein are now essential in the validation of the results and conclusions based on laboratory experiments on the endocrine control of the annual cycle.

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NEWS AND NOTES

HICKEY RECEIVES ALLEN AWARD

Joseph J. Hickey, professor of wildlife ecology emeritus at the University of Wisconsin, received the 1976 Arthur A. Allen Award from the Cornell University Laboratory of Ornithology at a dinner in his honor on September 25. The Allen Award, named for the Laboratory's founder, is presented annually to a person who has made outstanding contributions to ornithology.

Hickey's "A guide to bird watching," published in 1943 and recently reprinted, has helped birders enjoy their hobby and conduct useful scientific studies. Through his research on pesticides, Hickey gave early warnings of the harmful effects some pesticides have on wildlife, and worked to inform the public of his findings through writings and speaking engagements. The Peregrine Falcon has been one of Hickey's special interests, and he is the editor of the recent book "Peregrine Falcon populations."

COLOR-BANDED CURLEWS

Adult and juvenile Long-billed Curlews in the Columbia Basin of southeastern Washington have been banded with red, yellow, green, or blue plastic leg bands as well as U.S. Fish and Wildlife Service bands. The plastic bands are the same size as the U.S.F.W.S. bands and are put on the opposite leg. Each bears a black number and is visible on standing or perching birds.

Should you see any of these birds, please write: Bird Banding Laboratory, Office of Migratory Bird Management, Laurel, Maryland 20811. Report date, time of day, and location of the observation; plus name of observer(s), color of the band, and if possible, the number on the band. Also include the activity of the bird when it was seen, the type of habitat (e.g., grassland, mudflats along a lake, etc.), and the number of other curlews associated with the marked individual(s). Julia N. Fitzner, Battelle-Northwest Laboratories, P.O. Box 999, Richland, WA 99352.

CORNELL SUMMER FIELD COURSES

Cornell University announces summer field courses in general ecology, herpetology, ichthyology, mammalogy, ornithology, and plant ecology, June 29–August 12, 1977. For information write to Simon A. Levin, Section of Ecology and Systematics, 235 Langmuir Laboratory, Cornell University, Ithaca, NY 14853.

TRAINING IN ZOO ANIMAL MEDICINE

The College of Veterinary Medicine, University of Missouri—Columbia, in cooperation with the St. Louis Zoological Park, is offering a residency program designed to produce specialists in the field of Zoo Animal Medicine.

The resident will assist the Senior Staff Veterinarian in the zoo's animal health care, including the maintenance and treatment of some 2500 zoo animals. Nutrition, behavior, parasitology, bacteriology, and pathology will be stressed in the training program. The resident will use the Zoo's hospital facilities, the resources of the University of Missouri, and the services of the Schools of Medicine of St. Louis and Washington universities when needed.

This is a two-year program. Reappointment for the second year is contingent upon successful completion of the first year. Residency certificate will be awarded by the College of Veterinary Medicine, University of Missouri—Columbia.

Prerequisites: D.V.M. degree or equivalent, and one year internship or its equivalent experience in clinical veterinary medicine.

The annual salary is $11,000. The program will begin April 1, 1977. Requests for information and application forms should be directed to: William J. Boever, D.V.M., Senior Staff Veterinarian, St. Louis Zoological Park, St. Louis, MO 63110. The University of Missouri and the St. Louis Zoological Park are equal opportunity employers.

FRANK M. CHAPMAN FUND

The Frank M. Chapman Memorial Fund gives grants in aid for ornithological research and also post-doctoral fellowships. While there is no restriction on who may apply, the Committee particularly welcomes and favors applications from graduate students; projects in game management and medical sciences are seldom funded. Applications are due on 15 September and 15 February. Information on form and content of applications may be obtained from the Frank M. Chapman Memorial Fund Committee, The American Museum of Natural History, Central Park West at 79th Street, New York, N. Y. 10024.

THE CONDOR

The Condor is again carrying display advertising. C.O.S. members can help by calling this to the attention of institutional publishers and businesses whose products or services would appeal to ornithol-