

and slightly more than half as long in *Melanerpes (Tripsurus) pucherani*. It would be interesting to know, in conclusion, whether any of those other species have two types of holes and back into the narrow ones in the manner of *M. rubricapillus*.

(Since the above was written, Dr. Short (pers. comm.) has called attention to other woodpeckers

having tails 45–50% of wing lengths, such as *Picoides (Dendrocopos) maculatus*, *P. absoletus*, and *P. dorae*, various species of *Dendrocopos* and *Celeus (Microp-termus) brachyurus* that might be observed for unusual types of roost holes and manner of entering them.)

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## CHANGE OF WINTER FEEDING SITES BY INDIVIDUAL BROWN-HEADED COWBIRDS

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It seems logical to expect individual birds to return day after day to winter feeding sites containing abundant supplies of suitable food, and, as every bird-banding station operator knows, this often occurs among birds visiting standard winter feeding stations. However, as shown by the low rate of recapture of birds at a trapping station 2 miles from the roost and the recapture of several 10 miles beyond the first trapping station, it is indicated that Brown-headed Cowbirds (*Molothrus ater*) wander or range widely on their wintering ground even when food is abundant near their roosting site.

During the period 10 November 1960 to 13 January 1961, I operated banding traps 28 different days at the cattle-feeding area on the Kilby State Prison Farm about 2 mi. W from a large roost, chiefly of Brown-headed Cowbirds, near Montgomery, Alabama. I also operated traps on the Smith-McQueen Farm 10 mi. W from the Kilby site, near Prattville, Alabama, for 8 days during the period 15 November 1960 to 21 January 1961. Abundant supplies of food

were easily available to the many birds visiting both sites, even without their entering the traps. A total of 7239 Brown-headed Cowbirds were banded at the Kilby site and 1316 at the Prattville site.

Thirty-one recaptures were made during the period of trap operation, and nine of these were of birds recaptured the same day they were banded. Of the remaining 22 recaptures, 16 were made at the banding sites within the first 6 days after banding, and one each was made on the 13th, 16th, and 20th days. The low and declining recapture rate at the banding sites suggested that many birds were feeding elsewhere. That some of these cowbirds changed their feeding sites was also indicated by recapture at Prattville of three birds 13, 14, and 16 days after banding at Kilby. Thus, individual Brown-headed Cowbirds sometimes returned to the same feeding sites, chiefly during successive days. They also used other sites, one of which was more distant from their roost, although food availability was essentially the same and continuously good at both sites.

Among Brown-headed Cowbirds which were foraging in flocks, food-searching was thus somewhat of a daily endeavor, although good feeding sites were involved in recent earlier experiences of the birds. The sites where individual birds fed on successive days may have depended more on movement of flocks than on earlier experiences of individual birds.

Data used in this note were collected when I was an employee of the U.S. Fish and Wildlife Service.

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## TESTOSTERONE-INDUCED SINGING IN FEMALE WHITE-CROWNED SPARROWS

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During studies of reproduction in White-crowned Sparrows, *Zonotrichia leucophrys gambelii*, we made ancillary observations of steroid induction of song that are pertinent to an interpretation of the breeding behavior of females of this species under natural conditions. We were not able to study the induced songs systematically because of the conflicting requirements of the main objectives of the experiments; but because it is unlikely that we will be able to augment the data in the near future, we now report

them briefly, together with a summary of the pertinent literature. Female *Z. l. gambelii* can be added to the growing list of female passerines for which sonagrams of androgen-induced songs have been published (*Fringilla coelebs*: Thorpe 1958; see also, Hooker 1968:322; *Turdus merula*: Thielcke-Poltz and Thielcke 1960; *Junco oreganus* and *J. phaeonotus*: Konishi 1964; *Turdus migratorius*: Konishi 1965a; *Zonotrichia leucophrys nuttalli*: Konishi 1965b).

## MATERIALS AND METHODS

The experimental birds were migrant female *Z. l. gambelii* captured near Pullman, Washington. In each experiment, 30 females with regressed ovaries (November–February; condition of the ovary ascertained by laparotomy) were caged in pairs indoors at 21–25°C and exposed to a daily photoperiod of LD 8:16 (lights on 09:30–17:30 PST). After 1 or 2 weeks, the birds were segregated randomly into five groups of six each. Birds of each group were treated with a single dose level of steroid or with its carrier. In one experiment, the birds received intramuscular (thigh) injections of depo-testosterone cypionate (50, 100, 200, or 400 µg/day); in a second, depo-estradiol cypionate (8.3, 50, 100, or 200 µg/day); and in the third, progesterone (42, 84, 160, or 336 µg/day)

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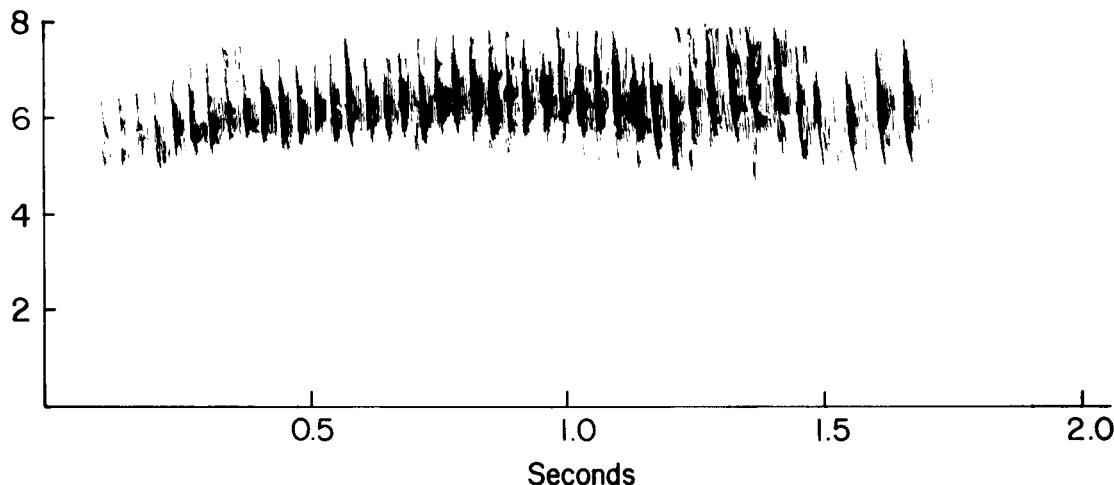


FIGURE 1. The trill of a female White-crowned Sparrow. Females treated with testosterone or estrogen trill and engage in the solicitation display. Values along the ordinate are in kilohertz (kHz).

(Upjohn), every 3 days for 15 days between 10:00 and 11:30. All controls received refined cottonseed oil. The birds were observed daily between 10:00 and 11:30 and occasionally between 13:00 and 15:00. Their song patterns were noted by ear and also were recorded (Sony model 660 tape recorder and Sony Dynamic Microphone F-96). The treble and bass tone controls of the recorder were set on "flat." Tape speed was 7.5 in/sec. The recordings were later converted to sound spectrograms by means of a Kay Sona-Graph 6061A (high-shape and wide-band settings). We taped about 60 individual songs for analysis of pattern.

## RESULTS AND DISCUSSION

The control sparrows in all experiments and those given progesterone were silent before and during the 15-day experimental period. Estradiol-treated birds also did not sing, but those given 200  $\mu\text{g}$  daily trilled (fig. 1) and postured like courting wild females (during courtship, female White-crowned Sparrows typically posture by squatting before the male with bill and tail raised, wings extended and quivering). Trilling and posturing also followed testosterone treatment. They were observed after 12–15 days on estradiol (200- $\mu\text{g}$  daily dose only), but as early as day 9 with testosterone (400- $\mu\text{g}$  daily dose only).

At least half of the females treated with testosterone, in contrast to those receiving other steroids, also developed *advertising* (*territorial*) songs similar to those of males netted near Pullman (fig. 2). However, the second element of the female song had three or four abrupt changes in frequency range, whereas only two changes of this kind occurred in the same note of the male song. The fifth element of the female song also had a wider frequency range than the corresponding note in the male song, but wider ranges have been described elsewhere for this note of the male song (Peyton and DeWolfe 1968). A sixth note sometimes terminated the induced songs (fig. 2B). A whistle note of this kind also frequently ends the song of *Z. l. nuttalli* (Marler and Tamura 1962).

We can present only semi-quantitative information on the temporal frequency of these induced songs as they relate to dose of testosterone because our exper-

iments were designed with other purposes in mind. Females began to sing within 3 days after the initial testosterone treatment, softly at first (whisper songs) and apparently only at the 400- $\mu\text{g}$  dose level. Within 6 days, however, they were singing loudly, even in the dark, and at all doses. Each female used one, or at most two, unchanging song patterns throughout the experiment. Males of this race and *Z. l. nuttalli* also have a single song pattern (Kessel and Schaller, *in* Banks 1964:17; Marler and Tamura 1964). Once a female began to sing, she continued to sing for the remaining days of the experiment. Birds treated with the lower doses of androgen (50 and 100  $\mu\text{g}/\text{day}$ ) sang most frequently and had songs of nearly normal characteristics when compared with male song patterns (fig. 2B–D). Birds treated with daily doses of 200–400  $\mu\text{g}$  of testosterone produced normal songs and abortive ones like those shown in figures 3 and 4. The vocal activity of one bird stimulated her neighbors so that songs generally occurred in choruses rather than singly.

The patterns shown in figures 3 and 4 may represent early stages of song development which would have given way to full advertising forms had the experiment continued longer. Compare the pattern in figure 3 with the male song in figure 2A. It appears that the first and fourth notes are missing from this female's chant, and that the whistle portion of her second note has increased in length. The warbling pattern in figure 4, if pitch is neglected, resembles a song composed of the first and second notes of the male song repeated over and over. Mulligan and Erickson (1968) found that androgen-induced songs of female canaries (*Serinus*) were also like those of the male, but more simply phrased. According to Nice (1943), the song of *Melospiza* gradually crystallizes into its adult form from initial warbling notes.

Our testosterone-induced songs are also similar to an unusual song recorded in southern Alaska from White-crowned Sparrows (*Z. l. gambelii*) of unknown sex (Peyton and DeWolfe 1968). In this song, the second element, which resembles that of the male in figure 2A, is repeated twice and the fourth element is absent. The second note of our recordings in figure 2, with its three or four sudden changes in frequency

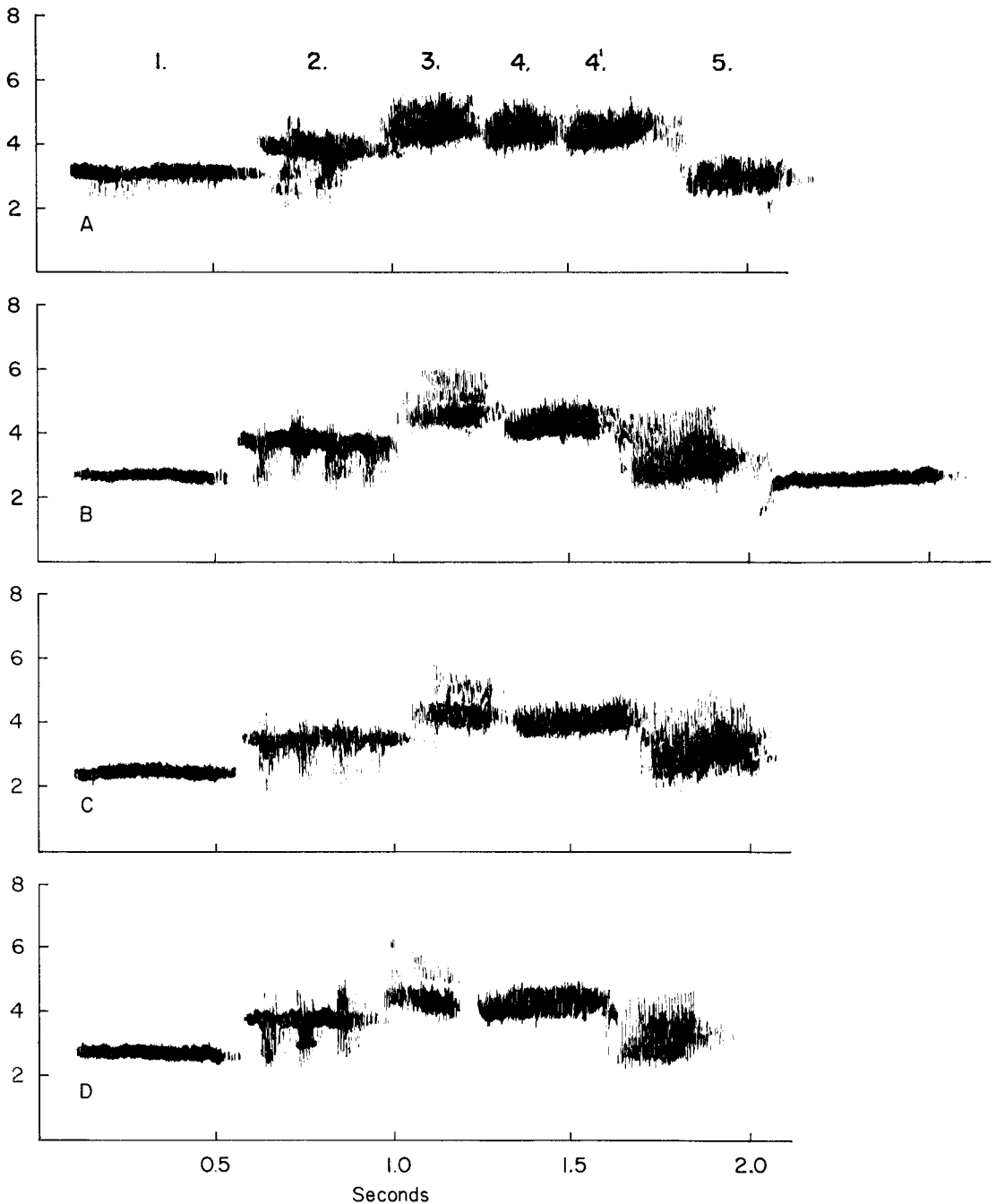


FIGURE 2. Songs of the White-crowned Sparrow, with the elements (notes) of the pattern numbered consecutively along the top. A, the advertising (territorial) song of a captive male. The doubled fourth element of this male's song is unusual. A single fourth note is more common. B-D, songs produced by females treated with testosterone. Note the differences in the number of abrupt frequency changes in the second element of male and female songs, the doubling of the fourth element in the male song, and the sixth whistle note of the female recorded in B. Values along the ordinate are in kilohertz.

range, resembles the repeated second note of this new song. The fourth note is also apparently missing in the songs of figures 3 and 4.

We have established that female White-crowned Sparrows will sing if given testosterone. But, is this a normal activity of free-living females? There are, in fact, scattered reports of singing female *Zonotrichia*

(Bent 1968). *Z. albicollis* sings "early in the breeding season before nest building begins" (p. 1381-1382). *Z. querula* and *Z. l. nuttalli* vocalize during the nesting period. Breeding females also commonly trill. On rare occasions, we have also observed captive female *Z. l. gambelii* that sing, although the vast majority does not. The scarcity of song among our captive females

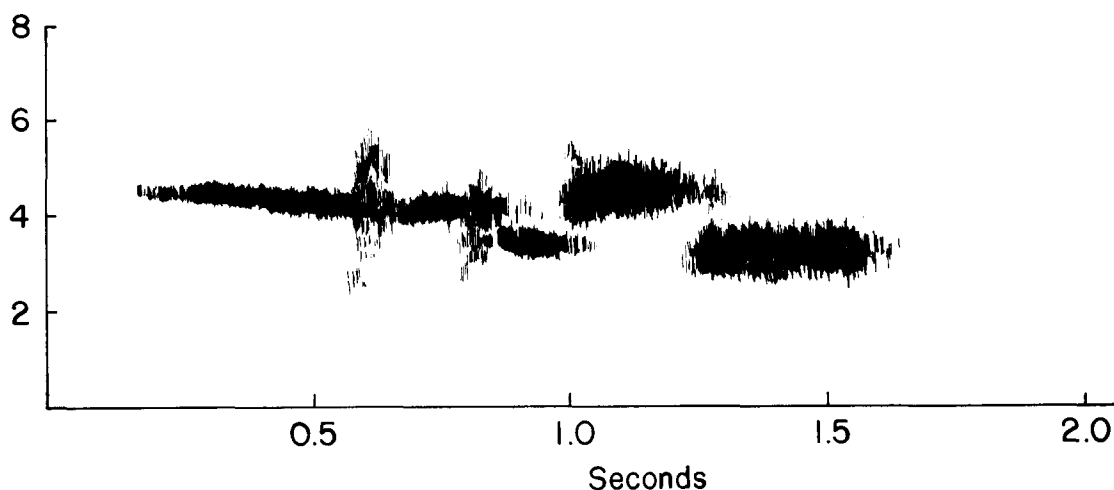


FIGURE 3. A bizarre song of a female White-crowned Sparrow treated with testosterone. Values along the ordinate are in kilohertz.

may be related to the fact that they do not breed in captivity (Farner et al. 1966), and field reports specify that females sing during the *breeding* period. If song in female crowned sparrows signifies androgen production, as changes in the secondary sexual characteristics (bill and leg color; developed vasa deferentia in breeding females) do in related female birds (Witschi and Miller 1938; Pfeiffer and Kirschbaum 1941; Schildmacher and Steubing 1952), then it seems likely that females of this race produce androgens when the ovary is mature and steroidal-genetic.

One can visualize several possible functions for a female song at this time. It may solidify the pair-bond or stimulate the breeding activities of the male. It may also ensure reproductive isolation between regional populations if the female recognizes the males of her own group by their song patterns (Nottebohm 1970), and vice versa. A classical example of a songbird with regional dialects is in fact the White-crowned Sparrow, *Z. l. nuttalli* (Marler and Tamura 1962).

Thorpe (1964) suggests, to the contrary, that female song is exceptional and indicative of hormone imbalance in species with a normal breeding organization (male dominant). This statement is not fully supported by the facts. Reports of singing females are surprisingly numerous, and many have been compiled by Nice (1943), Robinson (1949), Gerber (1955), Van Tyne and Burger (1959), Armstrong (1963), and Thorpe himself (1961, 1964). It seems equally plausible to us that female song is a *normal* physiological activity, at least in certain species, associated with ovarian androgen synthesis during the breeding period. For one thing, ovarian estrogens are synthesized from androgens (Turner 1966:470-472). Second, sexual characteristics (e.g., bill color) and behavior (e.g., aggressiveness) caused by androgens normally occur in many female songbirds during the breeding season or at times of year (autumn) when the reproductive system shows a brief resurgence of activity. Third, testosterone has been identified both

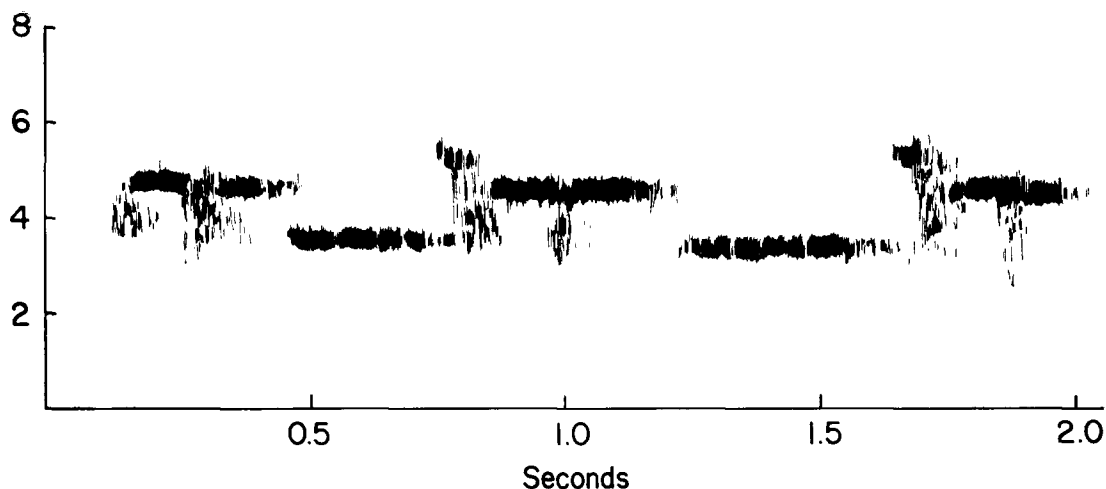


FIGURE 4. The unusual warbling song of a female White-crowned Sparrow treated with testosterone. Values along the ordinate are in kilohertz.

chemically (Höhn and Cheng 1967) and histochemically (Woods and Domm 1966) in the avian ovary, and also in the female's blood (O'Malley et al. 1967). Fourth, androgens normally participate in the development of the avian oviduct (Ringoen 1943; Brant and Nalbandov 1956; Breneman 1956; Oades and Brown 1965; Oka and Schimke 1969). Fifth, those few females that have been studied experimentally sing when treated with androgens (Leonard 1939; Shoemaker 1939; Baldwin et al. 1940; Noble and Wurm 1940a,b; Voss 1940; Vaugien 1948; Poulsen 1951; Herrick and Harris 1957; Thorpe 1958; Thielcke-Poltz and Thielcke 1960; Konishi 1965a,b; Mulligan and Erickson 1968; Brockway 1969). In short, it appears that androgens are a normal, if secondary, part of the endocrine regulation of reproduction in females of many avian species, and that androgenic effects may be externalized as song in at least a few of these species. Although estrogens are responsible for inducing certain female vocalizations (Brockway 1969; Wood-Gush and Gilbert 1969), it is noteworthy that administration of estradiol in female *Z. l. gambelii* did not induce song, but only the trill accompanying the copulation display.

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## SOME TEMPERATURES OF PANAMANIAN BIRDS

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McNab (1966), summarizing records of body temperatures of birds, notes that large birds have lower body temperatures than do medium-sized ones (20-50 g), but their temperatures are above those of mammals of the same weights. Small birds have low body temperatures, like those of the relatively few mammals of the same weights. He, King and Farner (1961), and Wetmore (1921) list temperatures mainly of nontropical birds. Temperatures of a few tropical hummingbirds (Lasiewski 1964; Morrison 1962) and oceanic birds (Howell and Bartholomew 1961) have been measured in special metabolic studies. The present paper reports temperatures of other tropical birds and discusses possible reasons for differing temperatures of tropical and nontropical birds.

The birds were captured in mist nets set at three localities in Panamá: Barro Colorado Island (9° 09' N, 79° 51' W), Panama Canal Zone, July-September 1970 and December 1970-January 1971; Limbo Hunt Camp (9° 9' 35" N, 79° 44' 36" W), Navy Pipeline Area, Panama Canal Zone, on 16 January 1971; and the Florida Audubon Society cabin (8° 50' 33" N, 82° 35' 33" W) below Cerro Punta, Chiriquí, Panamá, 27-29 January 1971. The Canal Zone localities were near sea level, the Chiriquí locality was at about 1650 m (5400 ft).

Temperatures in degrees Celsius were taken with a Schultheis quick-recording thermometer inserted into the cloaca. To be certain that the mercury reached cloacal temperatures, the reading was taken only after the thermometer had stabilized, after 30-60 sec in the cloaca. The bird was then weighed and molt condition recorded. Birds released from nets after rain were sometimes wet and chilled, so that their temperatures were often very low. They are not recorded in the list given here. Nomenclature and order of arrangement of birds followed here are those of Meyer de Schauensee (1966) or those of Eisenmann (1955) for birds not in Meyer de Schauensee's list.

## BARRO COLORADO ISLAND, PANAMA CANAL ZONE

In table 1, 38 species of birds from Barro Colorado Island are represented. Most birds were netted at the laboratory clearing or in the forest undergrowth. The Yellow-rumped Cacique (*Cacicus cela*), a tame fledgling, and the Clay-colored Thrushes (*Turdus grayi*), hyperactive caged birds, were kindly provided by Eugene S. Morton; the tame Orange-chinned Parakeet (*Brotogeris jugularis*) was provided by Robin Foster. The Great Tinamou (*Tinamus major*) and Chestnut-winged Chachalaca (*Orientalis garrula cinereiceps*) were captive birds. Temperatures range from 38.2° in the Orange-chinned Parakeet to 43.2° in an Ocellated Antbird (*Phaenostictus mcleannani*), Wood Thrushes (*Hylocichla mustelina*), and a Plain-colored Tanager (*Tangara inornata*).

Martins (1858:19), Simpson and Galbraith (1905:237), and Wetmore (1921:10) found that, in birds, temperatures of females are often slightly higher than those of males. In Spotted Antbirds (*Hylophylax naeviodies*), both sexes incubate and brood during the nesting period. Sixteen males with an average weight of 18.0 g (range, 16.8-19.3) had an average cloacal temperature of 41.8°C (range, 38.6-43.8), while 17 females with an average weight of 17.5 g (range, 15.8-20.0) had an average cloacal temperature of 42.1°C (range, 40.8-43.1).

On Barro Colorado Island, I captured 124 birds in mist nets, or 0.22 birds/12-m net/hr.

## LIMBO HUNT CAMP, NAVY PIPELINE AREA, PANAMA CANAL ZONE

Table 2 shows average cloacal temperatures of 11 species of birds from one day's capture in forest, forest-edge, and second-growth vegetation. All birds were brought to the clearing for measurement of body and ambient temperatures and of weight. The only unusual temperature was a low one for one Long-tailed Hermit (*Phaethornis superciliosus*).

McNab (in litt.) found a body temperature of 41.0° C for a male Black-throated Trogon (55.0 g) at Pedra do Gavião, Amazonas, Brazil. This temperature is similar to the one I record.

At the Limbo Hunt Camp, I captured 20 birds in mist nets, or 0.17 birds/12-m net/hr.

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