

temperature so that additional energy is not required. Ultimately, however, a net increase in existence energy requirements will necessitate increased energy intake and/or metabolism of stored energy reserves. No significant weight change occurred for the birds evaluated in this study, indicating minimal net metabolism of stored energy during the 30-day study period and primary reliance on increased energy intake.

Maximum daily temperature (Fig. 1) had a markedly better correlation with food consumption than did minimum or mean daily temperatures. This discovery is significant in view of previous studies that have dealt only with constant or mean daily temperatures. As a possible explanation, we suggest that during the night, when daily minimum temperatures normally occurred, the Chukars were mostly inactive and may have lessened physiological temperature stress, as do many other avian species, by seeking shelter, fluffing feathers, slightly lowering body temperatures, and/or huddling in groups (Welty 1962). Also, they may have filled their crops during the day to provide an energy source for utilization during the night as has been reported for Willow Ptarmigan (Irving et al. 1967). During the daylight hours, however, when maximum daily temperatures generally occurred, the Chukars spent a considerable amount of time engaged in foraging and other activities, and were less able to utilize most low-temperature behavioral adaptations. Although the heat increment generated by locomotory activity may have partially substituted for the daytime thermoregulatory requirement (Paladino and King 1984), temperature-related energy expenditures were probably greater during the daytime than at night; hence, the greater correlation of maximum daily temperature with food intake. Under exceptional circumstances where minimum temperature extremes occur during daylight hours (e.g., daytime storm front) the correlation may not hold. In addition, the relationship may lose significance as temperatures approach levels which are non-stressful to the animals.

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## INFANTICIDE IN THE PALESTINE SUNBIRD<sup>1</sup>

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*Key words:* Infanticide; Palestine sunbird; *Nectarinia osea*.

Infanticide has been reported for many mammal (Hrdy 1979) and some bird (Mock 1984) species. Several hypotheses have been suggested to explain its possible adaptive value. Killing of young by unrelated adult males was

interpreted by Wilson (1975) as enabling the performer to secure mating opportunities sooner than would be possible if the female's offspring (unrelated to the infanticidal male) continued to be reared ("sexually selected infanticide," Hrdy 1974). In his review on the incidence of infanticide in birds, Mock (1984) predicted that sexually selected infanticide in birds is much less likely than in mammals, because most birds are monogamous. Here we report similar infanticidal behavior in the Palestine Sunbird (*Nectarinia osea*), a 7-g, monogamous passerine common in Israel.

In spring and summer, females lay 1 to 3 eggs in a well-

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woven nest that hangs from bushes and tree branches. Incubation and nestling periods last 14 and 14 to 20 days, respectively. The young are fed mostly by the female, while the male guards the territory. After fledging, the parents feed the young outside the nest for several days, but the young and the female stay in the nest for several nights after fledging. Females whose brood fails, normally stay in their territories and start building a new nest within 2 to 7 days.

In Tel-Aviv, Israel, during the breeding seasons of 1984 and 1985, we observed four cases of infanticide or attempted infanticide. The first occurred in a three-chick nest that was observed from mid-May 1984. The resident male at this nest was color-banded. At 06:30 on 3 June 1984, the male was not seen in the territory. One fledgling was found dead below the nest, another perched about 10 m from it and a third was still in the nest. The female was feeding the perched fledgling mostly. At 08:00 an unmarked male appeared. It flew to several observation points near the nest which were formerly used by the territorial male. When the female tried to feed the fledgling outside the nest, the invading male interfered by pulling at the female's tail feathers. When she flew off, the male pecked at the fledgling's head while at times standing on the fledgling's back. When the male came close to the fledgling, the latter reacted by making begging calls. However, after being pecked by the male, it made distress calls and fell to the ground. This scenario was repeated throughout the day. At 18:15, the fledgling entered the nest and fed there until 18:30 (a few minutes before darkness), at which time the female also entered the nest. At 06:30 on 4 June, one fledgling was found dead in the nest without noticeable wounds, and the other fledgling was perched outside the nest. For 10 observation-hours, the scenario of the previous day continued—the female tried to feed the fledgling while the strange male (presumably the same individual) attacked the fledgling and interfered with feeding. At 06:30 on 5 June, the fledgling was found dead in the nest, with peck marks on its head and body. Pulled feathers were also visible. The adults were absent.

The second observation occurred in a nest that was observed from the start of incubation. The adults were not marked. On 29 May, as all three young left the nest, a strange adult male appeared and attacked one of the young, which eventually fell to the ground. During the attack, another male, presumably the father of the chicks, appeared and drove away the invader.

The third observation occurred in a nest that was observed from the start of laying on 12 June 1984. Two young hatched and grew normally, but on 10 July the resident male disappeared. On that day a strange young male was observed in the territory standing on the traditional observation spots of the territorial male. The young male was observed attacking the female twice while she tried to feed one of the young outside the nest. On 15 July, one fledgling was found dead below the nest. We suspect that the cause of the death was the attacks of the invading male.

After these three observations, an experiment was attempted to induce infanticidal behavior. We chose a nest where two, almost fledged young were present. At 13:15 on 29 May 1985, we trapped the territorial male. The female continued to feed the young in the nest. At 15:50, a strange male appeared and was seen near the nest several times until dusk. At 06:30 the next day, the female was feeding her young and an adult male was observed near the nest. At 09:30, it began interfering with feeding by pulling the female's tail feathers as she fed her chicks. At 14:15, one of the young came out of the nest and was immediately attacked by the invading male, which pushed the fledgling to the ground. At 15:30, both young were out of the nest, huddled together on a branch. The invading male attacked both young continuously and interfered with

feeding. At 17:15, we released the territorial male which was now color-banded. As soon as it noticed the invading male, the territorial male attacked it. An intensive pursuit ensued, where mostly the territorial male followed the invading one, interrupted at times by active fighting. It continued until dusk (19:20) at which time the female and the fledglings were in the nest and the territorial male was perched on a nearby branch. A day later, we observed another pursuit of the territorial male by the invading one (which was now recognized by the lack of tail feathers due to the fighting).

Only territorial males are guaranteed mates in the Palestine Sunbird. Unmated males are not uncommon in this species and it seems that whenever a territorial male disappears, another male replaces him within a few hours (Goldstein, unpubl.). We suggest that infanticide by invading males is a mechanism to vacate a territory of the progeny of a former male owner in order to obtain the territory. In this species, females that lose their brood normally remain in their territories and start building new nests. Hence, infanticide might enhance mate procurement. If this is true, infanticide in this species is similar in form and function to infanticide in mammals, mainly in primates and rodents (Hrdy 1977, 1979; Labov et al. 1985) and birds such as Barn Swallows (Crook and Shields 1985), the Purple Martin (Loftin and Roberson 1983), the Mexican Jay (Trail et al. 1981), the Long-billed Marsh Wren (Picman 1977), and the Northern Jacana (Stephens 1982). Both the above and Crook and Shields's (1985) observations show that, contrary to Mock's (1984) prediction, sexually-selected infanticide may also occur in monogamous birds.

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