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BODY TEMPERATURE OF A NESTLING GOLDEN EAGLE

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Body temperatures of nestling hawks and eagles are not well known. Such data are desirable because death from overheating has been reported for young Red-tailed Hawks (*Buteo jamaicensis*; Fitch et al. 1946), Golden Eagles (*Aquila chrysaetos*; Nelson 1969), and other raptors (Brown 1971). Beecham and Kochert (1975) reported that 41% of the mortality of nestling Golden Eagles in southwestern Idaho was probably caused by heat prostration.

During June 1976 we measured daily ambient temperatures and body temperature fluctuations of a single Golden Eagle nestling at an eyrie on the west face of Walter's Butte, nearly 24 km S of Nampa (Canyon

Co.), Idaho. We monitored it from a camouflaged blind approximately 50 m below the nest.

Body temperature data were collected by a miniature temperature-sensitive radio-transmitter (Model L; Mini-mitter Co., Indianapolis, Indiana), force-fed to the nestling. We found that by placing the device within the partial carcass of a freshly killed mouse, the eaglet would not soon regurgitate it. The transmitter was usually recovered inside regurgitated pellets in the nest.

We used walkie-talkie receivers modified by the Mini-mitter Company for receiving the emitted frequency signal, and found it necessary to use a 32-gauge copper antenna wire in order to increase their reception range. The number of emissions per 10 s were recorded at 15-min intervals and later converted to calibrated temperature values. These calibrations were determined initially from individual transmitter rates in water baths in the laboratory. Ambient temperature, recorded at a constant point on the cliff's edge beside the nest, was always measured with the same mini-mitter. Except at one session (14 June),

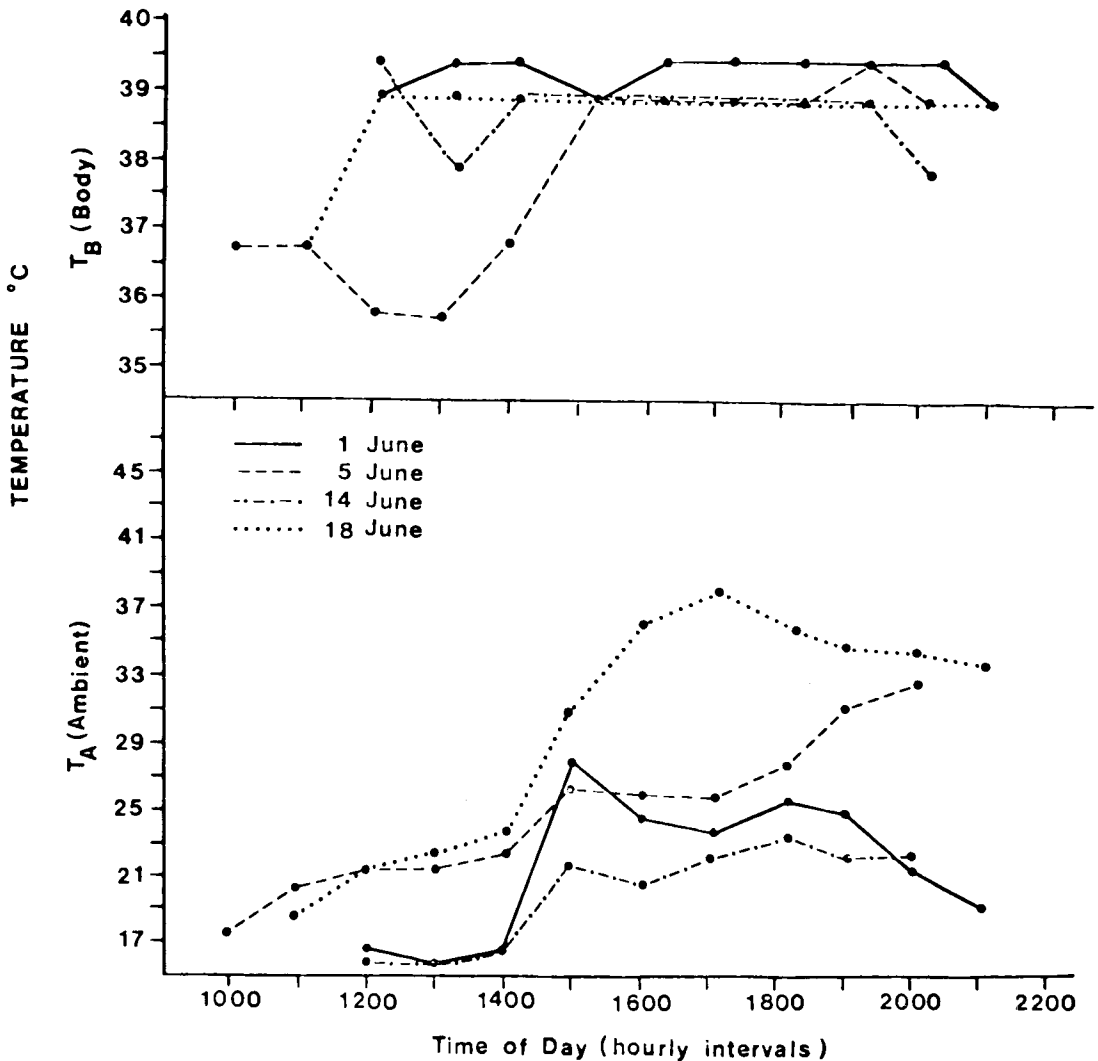


FIGURE 1. Daytime ambient temperature and body temperature of a nestling Golden Eagle.

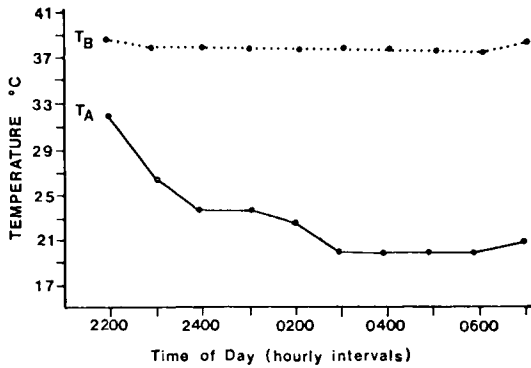


FIGURE 2. Nocturnal ambient temperature and body temperature of a nestling Golden Eagle.

nestling body temperature was measured by a separate mini-mitter. On 14 June a third mini-mitter was used for body temperature.

We recorded fluctuations in the nestling's body temperature on 1 June (approximately 35 days of age), 5 June, 14 June, and 18 June (approximately 53 days of age). On 18 June monitoring was continued throughout the night until 07:00 the next morning when the mini-mitter was regurgitated by the nestling. In all, we spent 55 h monitoring body temperature of the eaglet, which successfully fledged shortly after 19 June.

Body temperature generally fluctuated daily as follows: (1) after the mini-mitter had been inserted, the temperature rose slightly above the overall mean body temperature of 38.6°C, (2) within one to two hours, the temperature dropped two degrees, then (3) stabilized between 38 and 39°C during the day.

Ambient temperatures at the nest gradually rose until 14:00 to 15:00 (Fig. 1), when the sun first shone into the nest, resulting in a rapid warming, ranging from 5.5°C (14 June) to 11.1°C (1 June). The mean rise in temperature during that time over the four monitoring days was 7.5°C.

A single nocturnal recording (Fig. 2) found that the nestling's body temperature dropped to approximately 37.8°C within an hour after sunset, remaining near that until about sunrise. Slight nocturnal depression in body temperature of diurnal raptors, in accordance with diel metabolic fluctuations, has been found in small owls and American Kestrels (*Falco sparverius*; Gatehouse and Markham 1970) and Turkey Vultures (*Cathartes aura*; Hatch 1970).

The body temperature of nestling Golden Eagles has not previously been measured. Hence, we do not know if the true core body temperature differs significantly from that which we recorded from the region of the crop and proventriculus. The cloacal temperatures of two nestling Broad-winged Hawks (*Buteo platypterus*) were 38 to 39°C when 4 to 9 days old and 41 to 42°C when 20 to 22 days old (Fitch 1974). Simultaneously recorded cloacal and intraperitoneal temperatures differed by 0.4°C in Burrowing Owls (*Athene cunicularia*; Coulombe 1970) and 0.97°C in White-crowned Sparrows (*Zonotrichia leucophrys*; Southwick 1973). Differences in cloacal and proventricular temperatures were found to be insignificant in petrels (Warham 1971) and 0.6°C in Ferruginous Hawks (*Buteo regalis*; Powers and Trost, unpubl. data). It is likely that true core

TABLE 1. Mean ambient temperature (T_A) and body temperature (T_B) of a nestling Golden Eagle.

Date	T_A (°C)	T_B (°C)
1 June, day	21.7	39.1
5 June, day	25.2	37.9
14 June, day	20.1	38.7
18 June, day	30.3	38.8
18-19 June, night	21.5	38.1

body temperature is close to body temperature recorded by a mini-mitter and that this means of telemetry will remain useful in measuring body temperature of nestlings.

Despite the dramatic development in nestling Golden Eagles between weeks 5 to 8, we found a rather uniform daily body temperature during that period. The slight rise in temperature at the beginning of each session may have been due, in part, to the activity of being captured and restrained for force-feeding or to the specific dynamic action associated with digesting food. Southwick (1973) found that a disturbance of a telemetered White-crowned Sparrow caused a transient 2-3°C rise in temperature. There is little indication that ambient temperatures approaching or exceeding body temperature stimulated hyperthermia in the young bird. On 18 June at 16:45 ambient temperature reached 40°C with little change in the eaglet's body temperature. The low body temperature on 5 June was apparently influenced, perhaps stabilized, by sunlight striking the nest at the regular 14:00 to 15:00 time period. However, our sample size is too small to fully explore the possible thermoregulatory reactions to high ambient temperatures, particularly since daytime temperatures during our study were relatively mild, seldom approaching the critical 32°C temperatures indicated by Kochert (1972).

The body temperature changes observed on 5 June were unusual. After ingestion of the mini-mitter, the usual rise and fall of 2°C in body temperature occurred except that the entire sequence was shifted down 2 to 3°C (see Fig. 1 and Table 1). We cannot account for this deviation, unless, perhaps, the eaglet had been underfed. It was attended in part by a three-year-old male (A. Bammann, pers. comm.) who may have been unable to provide enough food.

It would have been ideal if we could have correlated body temperatures with the nestling's activity. We could not see the bird in the nest from the blind, however, so we could not tell if it used any thermoregulatory behavior.

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PREDATION ON VERTEBRATES BY CLARK'S NUTCRACKERS

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Bent (1946) and Goodwin (1976) have suggested that various species in the family Corvidae are "opportunistic" feeders and that predatory behavior is not unusual among crows. Of 29 species in eight genera of North American corvids for which Bent gave data on diet, 25 (86%) sometimes kill their own prey; of these 25, 13 (52%) occasionally kill small mammals. Here we report 13 observations of Clark's Nutcrackers (*Nucifraga columbiana*) attacking vertebrates in the central Sierra Nevada. We also saw the birds feeding on road kills 16 times.

Although conifer seeds are the main food of these birds (Vander Wall and Balda 1977, Tomback 1977), they frequently eat meat. For example, the stomachs of 426 nutcrackers from Montana contained, by volume, 83% conifer seeds, 13% arthropods, and 3% mammal remains; 98% of them contained seeds, 59% contained arthropods, and 12% contained mammal remains (Giuntoli and Mewaldt 1978). Cottam (1945) reported similar stomach contents from ten birds. Sometimes the meat is carrion (Bradbury 1917, Munro 1919, Cottam 1945, Bent 1946), but often nutcrackers kill their own prey: molluscs (Decker and Bowles 1931), insects (Skinner 1916, Decker and Bowles 1931, Bent 1946), birds' eggs (Munro 1919, Bent 1946, French 1955), nestlings (Rowley 1939, French 1955), adult birds (MacCracken 1949), and small mammals (Bainbridge 1956, Dixon 1956).

We observed predation by Clark's Nutcrackers while studying Belding's Ground Squirrels (*Spermophilus beldingi*) on a subalpine meadow at Tioga Pass, Mono County, California (elevation about 3,000 m). The study area was described by Morton (1975) and Sherman (1977). During May-August of 1974-1977, 16 observers spent 3,817 hours watching squirrels and as many non-observation hours at the study area. We saw nutcrackers attack vertebrates 13

times (Table 1). At least six attacks were successful; on the other occasions, the prey escaped by entering a burrow or bush.

Belding's Ground Squirrels were attacked most frequently (54%), but because our observations were concentrated on that species the nutcrackers' apparent preference for them may be exaggerated. Predation attempts on the squirrels were most successful in 1977 (Table 1), perhaps due to unusual weather. From 30 April until 26 May 1977 it stormed daily, with intermittent snowfalls, subfreezing temperatures, and high winds (Morton and Sherman 1978). More than 60% of Tioga Pass *S. beldingi* perished during the storm. Most either starved or were preyed on by conspecific ground squirrels or nutcrackers. Usually when nutcrackers landed near adult ground squirrels the latter did not flee, give aerial predator alarm calls (Turner 1973), or otherwise alter their behavior. These observations suggest that Clark's Nutcrackers infrequently prey on the squirrels, for they were not regarded as predators. Probably nutcrackers are especially likely to attack ground squirrels successfully when the latter are weak, ill, or behaving abnormally, as they were during the 1977 spring snowstorm (Table 1).

A typical nutcracker attack on a squirrel occurred on 15 May 1977, at the height of the storm. The ground squirrel, an emaciated adult female (Morton and Sherman 1978) was foraging near her burrow when a nutcracker landed about a meter away. When the bird swooped down, the mammal ceased foraging, looked up, then continued to feed. The nutcracker pecked at the ground and moved closer to the squirrel, alternately facing away from and sideways to it. Suddenly the bird flew to the ground squirrel's side and jabbed the animal's head with its bill. In contrast to Dixon's (1956) account of a "battle" between a nutcracker and a (healthy?) ground squirrel, there was no struggle in this instance. The weakened animal apparently was killed instantly by the nutcracker's blow near its eye. After repeatedly pecking its victim's skull, the bird ate most of the side of the squirrel's face and brain before we chased it off to recover the carcass. The speed and accuracy of the bird's attack suggests that Clark's Nutcrackers are familiar with preying on at least some small vertebrates. Gill (1974) made a similar suggestion about Gray Jays (*Perisoreus canadensis*) after observing the