Philadelphia. The male was not actually seen attending the nest of either female, but was seen with two females who shared his territory during the same period.

In 1974, while studying insectivorous birds in Kawuneeche Valley, Rocky Mountain National Park, Colorado, Ken Rosenberg and I observed a case of polygyny in the Western Wood Pewee (*Contopus sordidulus*). That year we mapped the territories of three male pewees which had settled along the floodplain of the headwaters of the Colorado River. One male who was polygynous occupied a territory of about 1.6 ha. This is nearly the same as the average pewee territory size for that year—1.7 ha—but somewhat larger than the combined 1973–1974 average of 1.2 ha.

Two pewee females shared the territory of the polygynous male. They both constructed nests but in two different, isolated, small stands of trees separated by nearly 50 m of willow scrub. Both females had completed incubation of the eggs and were feeding well-developed nestlings when, on 24 July, the second of the two nests in the territory was discovered. On the following day, and on 27 and 29 July, the male was observed without interruption feeding at one nest, foraging from lodgepole pines, and then feeding at the other nest. By 30 July the young in one nest had fledged and moved into the dense vegetation, precluding any further observations of the male feeding two broods.

The prevalence of polygynous behavior in tyrannids is still an open question. As far as I am aware, this is only the fourth flycatcher reported to exhibit polygyny. Is the rarity of such reports simply indicative of the frequency of occurrence in nature, or is it merely a product of the small number of substantive studies on tyrannids? My experience with the behavior and ecology of certain flycatchers in the Rocky Mountains, and the observations of W. J. Smith (pers. comm.) suggest that polygyny may be more common in this family than we suspect.

Department of Zoology, Murray Hall, University of Maine, Orono, Maine 04473. Accepted for publication 2 March 1976.

CANNIBALISM IN THE PIÑON JAY

RUSSELL P. BALDA
AND
GARY C. BATEMAN

Cannibalism has been observed in an array of vertebrates spanning the gamut from fishes through humans. In cases involving highly predaceous species which normally feed on life forms similar to their own, one might expect to find cannibalism occurring rather regularly since what constitutes normal prey is not markedly different from the prey selected during the cannibalistic act. As an example, Largemouth bass (*Micropterus salmoides*) may eat their young or even other conspecifics of approximately their own size (Minckley 1973:224). One suspects that evolution would favor mechanisms tending to prevent this behavior from becoming rampant.

Reports of cannibalism among raptorial birds are not especially uncommon. Ingram (1959) listed 21 species of hawks and owls having "convincing records" as cannibals. In most cases such cannibalism has been directed towards nestlings (but see Clevenger and Roest 1974) and has been observed post facto (e.g. Heintzelman 1966). The actual factors responsible for the demise and/or disappearance of missing (presumably eaten) individuals are controversial. Armstrong's (1959) caveat is especially pertinent here; he noted that some cases of presumed cannibalism of nestlings may represent instances in which the supposed victims left the area under their own power. It is also possible that such victims may have been eaten by a predator other than the parent.

Kuhk (1969) noted that most described cases of cannibalism among birds involved young being eaten by their siblings or parents; whether they were generally also killed by them is unknown. For this special type of cannibalism he proposed the term "syngenophagy" (relative-eating).

Reports of cannibalism among passerines are extremely scanty in the literature available to us. The only report encountered (Richter 1965) described an incident wherein an adult Gray Jay (*Perisoreus canadensis*) was observed to tear at the body of a road-killed juvenile conspecific and fly away with parts of it. The author speculated that the adult was feeding these remains to the remaining brood members. Actually he gave no evidence that this was a case of syngenophagy.

The event described below occurred on the morning of 1 April 1970, on the colonial breeding grounds of the Piñon Jay (*Gymnorhinus cyanocephalus*) described by Balda and Bateman (1971, 1972). In 1970, the jays began building nests in late February and the mean date of laying the first egg was 9 March (n = 22 nests; Balda and Bateman 1972). During 5 years of study, this was the earliest attempt at nesting, and followed the production of a huge crop of piñon pine (*Pinus edulis*) cones and seeds the preceding autumn.

On 31 March temperatures recorded on a Bendix hygrothermograph in a white weather shelter adjacent to the nesting area ranged from a low of –14°C to a high of 1°C ($\bar{x}$ = –7°C). During the morning of 1 April the temperatures were as follows: –17°C at 06:00; –11°C at 08:00; and –5°C at 10:00. Snowfall was measured at Flagstaff Pulliam Airport, 21 km southwest of the study site. Snow began falling in the afternoon of 29 March, continued for all of 30 March and subsided in the afternoon of 31 March. The total accumulation for this 3-day period was 36 cm. The breeding grounds were covered with a continuous layer of snow except for small patches of open ground at the base of some of the trees. The litter, duff, and soil were tightly frozen.

At 09:00 on 1 April, nest number 21, situated 3.2 m off the ground in a ponderosa pine (*Pinus ponderosa*), was visited and found to contain three pink, featherless nestlings no older than 1 day of age. At this age, nestlings usually weigh between 5.3 and 9.4 g (Bateman and Balda 1973). The age was determined by the fact that the length of incubation is 17 days (Bateman and Balda 1973), and the third egg was known to have been laid on 14 March. In an attempt to determine the amount and type of food brought to these young, they were fitted with collars made of short pipe cleaners. The female left the nest at our approach but returned to brood within

3 min after we departed. Observations were made from a hillside about 60 m from the nest with 8 × 40 binoculars.

At 09:10, the brooding female began begging loudly and frantically as the male approached. The female performed these activities while sitting on the nest, which is somewhat unusual. Most often females leave the nest before begging from their mates. On this particular day, however, many females were heard and seen begging from the nest, probably because of the inhospitable weather and/or their poor energy balance. The male came to the nest and apparently fed the female while she stood on the nest cup. After this transfer of food both adults peered deeply into the nest cup and appeared to be manipulating the young with their bills. Our impression was that the young were being fed. After about 2 min the male flew off with nothing in its bill and the female resumed brooding. At 09:30 we scared the female from the nest to see the contents. The female remained within 25 m of us during the next 5 min. The nest contained only two collared young, who gaped at us as we examined them. Neither of them had been fed since 09:00. A careful examination of the nest, surrounding branches and the snow below did not turn up the missing young or its collar. Also, we did not observe the removal of a young by either parent and conclude that one or both parents ate it. At 09:35 we returned to our observation site and the female brooded continuously. She did not call or shift positions during this time. At 10:25 she began begging softly as other birds could be heard calling in the distance. This soft begging shortly changed to loud, vigorous begging but no male approached to feed her even though some males were observed feeding other females at nearby nests. At about 10:30 the female stood on the nest cup and appeared to be manipulating or feeding the young as slight throat movements were evident. The young were not visible to us during this activity. After 2–3 min the female flew off in the general direction of the calling birds and we proceeded to check the nest. It contained but one living young with its collar intact. A 15-min search of the nest, limbs, twigs and surface of the snow below the nest turned up nothing. Based on this evidence we conclude that the brooding female devoured the second nestling. Before our search ended two birds, presumably the parents, returned to the nest tree and scolded us at length. We removed the third young and hand-reared it for four days before it died.

The parents may have consumed the two young (and presumably their collars) after they died from either starvation or the effects of the collar but this seems unlikely in view of the fact that the third young survived the experience and we observed no dead young in the nest.

Our data regarding the fate of 11 other nests which contained eggs or young during this late March storm suggest other incidences of cannibalism (table 1). Two nests which contained very young birds (0–1 days of age) were both empty by the end of the storm. On the other hand one nest containing larger young (8–10 days old) which died still held the deserted young. In five other cases the young survived the storm. Three nests which contained eggs during this period were deserted and in two cases the eggs were punctured as though by the bill of a bird. This very circumstantial evidence suggests the possibility that the parent(s) may have cracked the eggs and eaten the contents.

TABLE 1. Fate of 11 nests during late March storm.

Nest Contents	Number of Nests	Fate of Nest
Eggs	1	Eggs intact, deserted
Eggs	2	Eggs punctured, deserted
0–1 day old young	2	Nestlings gone
3–5 day old young	2	Nestlings survived, female attentive
8–10 day old young	1	Nestlings frozen, deserted
8–10 day old young	3	Nestlings survived, female attentive

The Piñon Jay is known to prey on vertebrates. Bateman and Balda (1973) reported an incident of two birds killing an adult short-horned lizard (*Phrynosoma douglassi*) and of an Eastern fence lizard (*Sceloporus undulatus*) being fed to nestlings (also see Ligon 1971). One of us (RPB) has also observed jays hunting on rocky outcrops in spring where they appeared efficient at capturing and killing lizards.

Ricklefs (1965) pointed out two strategies of adjusting brood size to correspond to food availability. He indicated that the evaluation mode is most useful when food availability for young has high predictability prior to oviposition, whereas brood reduction is advantageous when the food supply is highly fluctuating and unpredictable at the time of egg laying. Mean clutch size for Piñon Jays over a three-year period shows variation of less than 0.5 egg between years (Balda and Bateman 1972). This indicates that in spite of the relatively gross fluctuations in one important component of the diet of the young (i.e. piñon pine seeds; Bateman and Balda 1973) there must be vastly overriding factors which prevent the assessment or evaluation mode from becoming "fixed" in these birds. For example, even in nesting seasons following a bumper crop of pine seeds, these seeds, which might ordinarily be an important part of the diet of the young, could easily become unavailable following a heavy snow. Likewise we have shown (Bateman and Balda 1973) that the most important foods for nestlings are various arthropods obtained by terrestrial foraging. Such foods are essentially unavailable following storms such as that which occurred on the study area in late March, 1970.

We offer the hypothesis that the parents ate the young because the cold temperatures placed a severe energy drain on the adults and snow cover prevented efficient foraging. Thus, conditions may have threatened the very existence of some nesting adults. In this case the birds may have recognized their young as a source of energy needed for their own survival. Thus, the young were viewed as "expendable" and aided the survival of the parents to increase the probability that they might breed at another time.

We have occasionally witnessed intruding birds being driven from a nest by the owners. This suggests that some birds may attempt to cannibalize nestlings other than their own. We have no data, however, to support this hypothesis.

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Department of Biological Sciences, Box 5640, Northern Arizona University, Flagstaff, Arizona 86001.
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EFFECTS OF NASAL TUFTS AND NASAL RESPIRATION ON THERMOREGULATION AND EVAPORATIVE WATER LOSS IN THE COMMON CROW

BRUCE A. WUNDER
AND
JOSEPH J. TREBELLA

One feature of the family Corvidae is the presence of thick, conspicuous tufts of feathers which extend over the proximal one-third of the beak covering the external nares. Schmidt-Nielsen et al. (1970) suggested that some birds may use a temporal countercurrent air flow through the nares to reduce respiratory evaporation, but no one has investigated the possible role of nasal feather tufts in water or heat exchange in corvids or other passerine birds. Common Crows (*Corvus brachyrhynchos*) frequently winter in areas from which many passerines migrate. We have investigated the thermoregulatory ability of the Common Crow—a large passerine—and the possibility that its nasal tufts are important in thermal or water balance.

METHODS AND MATERIALS

Nine Common Crows were captured during January 1974, in Fort Collins, Larimer County, Colorado. Judging by the aging technique of Emlen (1937), all were first-year birds. The birds were kept in individual cages at 23–25°C on a 12L:12D photoperiod during the study. All birds were kept in the lab for at least two weeks before being tested. Canned dog food, dry dog meal and water were available *ad libitum.*

Oxygen consumption ($\dot{V}O_2$) was measured in an open flow system using a Beckman paramagnetic oxygen analyzer (Model F3). A metal ammunition case (23 × 30.5 × 45.7 mm) served as an air-tight respirometer. Temperature was monitored inside the respirometer with a thermocouple. Air flow through the system was maintained at 2000 cc/min with Brooks E/C flow meters calibrated with a Brooks Vol-U-Meter flow calibrator. The flow system used corresponds to condition B of Hill (1972). The birds were in a hardware cloth cage with a perch. The bottom of the respirometer had a layer of mineral oil to cover and prevent evaporation of water from cloacal discharges. The birds were maintained at a given ambient temperature (T_A) for at least one hour (although most tests necessitated two or more hours), after which oxygen consumption was calculated (corrected to STP) from the lowest values maintained for at least 15 min. Ambient temperature was maintained to within ± 0.5°C by a temperature-controlled growth chamber. All data were gathered between the hours of 17:00 and 24:00. Cloacal temperature (T_B) was measured at the beginning and end of each run by inserting a YSI thermistor probe 2.5 cm into the cloaca.

Measurements of evaporative water loss (EWL) were made simultaneously with oxygen consumption. The gravimetric technique used was the same as that described in Wunder (1970).

Following measurements of $\dot{V}O_2$, T_B and EWL at a variety of T_A's in normal birds, the nasal tufts were cut off. Then $\dot{V}O_2$, T_B, and EWL were measured in birds at both 5° and 37.5°C. Following those measurements, the nares were plugged with modelling clay and painted with layers of colloidin, and $\dot{V}O_2$, T_B, and EWL were again measured at 5° and 37.5°C for comparison.

Statistical comparisons of treatments were made using analysis of variance and paired t-test computer programs developed by the CSU Statistical Services Laboratory. Values expressed in this paper are means ± one standard deviation with sample size given in parentheses.

RESULTS

The pattern of oxygen consumption as a function of T_A in Common Crows weighing an average of 384.8 g is shown in figure 1. The animals demonstrated a thermoneutral zone extending from at least 37.5°C to 15°C. Below 15°, $\dot{V}O_2$ increased slowly with decreasing T_A. The mean of 24 $\dot{V}O_2$ measurements in thermoneutrality give an SMR of 1.53 ± 0.18 cc O_2/(g·hr).

Body temperature (40.2 ± 0.6°C, n = 31) was regulated fairly well at intermediate ambient temperature exposures. However, at 30–33°C, T_B started to rise and at 37.5°C the crows showed a definite ($P < 0.05$) regulated hyperthermia of 41.4 ± 0.8°C (9). At low T_A exposures the crows showed a much greater T_B lability (fig. 2).

Evaporative water loss was stable between T_A exposures of 5 to 20°C. At T_A's above 20°C, EWL increased exponentially (fig. 3). With water loss expressed as amount of heat lost by evaporation (EHL) relative to heat production (HP) (assuming consumption of 1 cc O_2 liberates 4.8 calories and