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SHORT COMMUNICATIONS

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DOCUMENTATION OF INFANTICIDE AND CANNIBALISM IN BALD EAGLES

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KEY WORDS: *Bald Eagle*; Haliaeetus leucocephalus; *cannibalism*; *infanticide*; *mate loss*.

Non-kin infanticide, the killing of dependent young by unrelated conspecifics, occurs in a wide array of taxonomic groups including mammals, insects, fish, and birds (Hrdy 1979, Hrdy and Hausfater 1984). Several hypotheses have been proposed to explain this behavior including the removal of potential competitors to gain access to limited resources such as nesting territories and food (Hrdy 1979).

In many social contexts, the adaptive advantages of cannibalism, the consumption of conspecifics, are closely linked with infanticide (Mock 1984). For example, cannibalism may provide nourishment, lower the reproductive success of competitors, and decrease intraspecific competition for resources by lowering population density (Stanback and Koenig 1992). As the fitness benefits of infanticide and cannibalism are not mutually exclusive, Stanback and Koenig (1992) note that it is ''difficult to distinguish between the following scenarios: (a) selection that favors cannibalism, for which infanticide is often a necessary prerequisite, and (b) selection that favors infanticide, for which cannibalism is a subsequent option.''

Among birds, infanticide encompasses a variety of species and social contexts (Mock 1984). Several studies have reported infanticide by adult males (e.g., Crook and Shields 1985, Freed 1986), which often has been interpreted as a means of obtaining breeding opportunities under conditions of high competition for mates or nest sites. Some accounts document cannibalism following the killing of young by unrelated adults (e.g., Balda and Bateman 1976, Village 1983). However, among raptors, direct observations of infanticide are relatively rare (but see Wiemeyer 1981, Bortolotti et al. 1991, Webster et al. 1999) and we found no reports of cannibalism linked with infanticide for Bald Eagles (*Haliaeetus leucocephalus*). This scarcity of confirmed occurrences may be due, at least in part, to the combined relative infrequency of such events and the difficulty in continuously monitoring nest activities. Here we describe a case of infanticide and cannibalism in the Bald Eagle.

STUDY AREA AND METHODS

We video-monitored a Bald Eagle nest on a tributary of the James River in Virginia in 2002 as part of a larger study on the diet and provisioning patterns of nesting Bald Eagles in the lower Chesapeake Bay. A small, bullet security camera (Speco Technologies, CVC-320WP, Amityville, NY U.S.A.) was mounted directly above the nest and wired to power (a deep-cycle 12-V marine battery) and recording (a time-lapse videocassette recorder, HS-9596U, Mitsubishi Digital Electronics America, Inc., Irvine, CA U.S.A.) equipment positioned 250 m from the base of the nest tree. Additional details of the camera system components are provided in Markham (2004).

We installed the camera system in January, prior to egg laying, and regularly monitored nest activities from 20 February–11 April 2002. We recorded nest activity during the incubation phase (26 d) and nestling phase before (1 d) and after (13 d) mate loss. We positioned the camera so that the entire surface of the nest was in view and made no attempts at additional observations other than those recorded on videotape. Recordings of nest activity typically included all daylight hours (sunrise to sunset).

Because the nest had multiple young, we used the date of first egg laying and first chick hatching to classify nesting phase. During tape review, we identified individual adult birds by unique plumage characteristics and differences in body size consistent with sexual dimorphism in the species (Bortolotti 1984). We also used relative body size to identify nestlings. Bald Eagle chicks hatch asynchronously (Gerrard and Bortolotti 1988); thus, nestlings shortly after hatch date are often easy to distinguish on the basis of relative size.

RESULTS

At the start of video-monitoring, we observed both breeding adults contributing to nest maintenance. Recordings on 20 February marked our initial observation of the first egg and the laying of the second egg. By 24 February, the three-egg clutch was complete. The first chick hatched on 26 March after a minimum 34 d incubation. The second and third chicks hatched 3 and 4 d later, respectively.

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Throughout this period, we consistently observed both adults sharing incubation and brooding responsibilities.

Beginning 30 March (nestling ages 1–4 d), the resident adult male was no longer observed on the nest. We believe this mate died; an adult male was treated and released by a state biologist within 1 km of the nest site earlier in the nesting season (exact date not recorded by wildlife officials). The bird had suffered injuries after a fishhook became imbedded in its wing. Though the damage was assessed as minor and the bird was released immediately, concurrence of this event with the disappearance of the resident male suggests that the injuries may have been fatal.

On 3 April, the youngest of three chicks (4 d) was lethargic and did not exhibit food begging behavior, while its siblings were active and readily begged for and received food. The youngest chick was brooded by the female overnight, but was motionless and presumed dead when first visible the following morning. The adult attempted to preferentially brood the dead chick on two occasions, leaving both older siblings exposed. On 4 April at 1317 H, the first instance of cannibalism was observed when the adult picked up the dead chick's body and began feeding it to the other nestlings.

Two additional incidences of cannibalism occurred at this nest, this time in conjunction with infanticide, over a 2-d period during which another Bald Eagle was repeatedly observed on the nest. Based on size dimorphism in Bald Eagles (Bortolotti 1984), we identified this bird as male, and age-specific plumage patterns (McCollough 1989) indicated it was 4 yr old. On the first day, 9 April, we observed the female delivering prey items to the nest, brooding, and provisioning the chicks. At 1552 H, following a feeding bout, the female left the nest and the 4-yr-old male arrived within 1 min. The male approached the chicks and grasped the larger (older; 11 d) of the two in its talons, moved it to the nest edge, and pinned it down while killing and eating it. At 1610 H, the male left the larger chick's carcass and repeated the same behavior of grasping and pinning the second (sole remaining) chick (10 d), although not killing it. The adult female arrived on the nest at 1611 H and immediately flushed the 4-yr-old male from the camera view.

On the second day, 10 April, we witnessed a similar pattern of intrusion followed by infanticide and cannibalism. The 4-yr-old male entered the nest twice when the female was absent from view. The female returned to the nest within 1 min on both occasions, immediately flushing the male. Intermittently, the female attempted to brood and feed the remaining live chick. At 1224 H, after the absence of the female for over 90 min, the male landed on the nest and began picking at prey remains. After alternating between a prey item and the last living nestling, the adult pinned the struggling chick down with its talons and began ripping the nestling apart with its beak. At 1249 H, 1 min after the 4-yr-old male finished consuming the nestling, the female joined the 4-yr-old male on the nest. After calling at the 4-yr-old male for 40 sec, the female stepped toward him and flushed him from view. Later in the day, the female delivered and consumed one prey item on the nest surface. The 4-yr-old male returned to the nest periodically, occasionally bringing nesting material (sticks) and arranging the nest lining. On two subsequent occasions, the female chased the 4-yr-old male off the nest.

The following day, 11 April, both the resident female and the 4-yr-old male were observed on the nest again. The female again chased the 4-yr-old male off the nest, but it appeared that both eagles had been roosting near the nest (the 4-yr-old male landed on the nest surface at 0604 H, before sunrise, followed by the female within 20 sec). Following this encounter, the 4-yr-old male was not observed on the nest again in the remaining hours of observation. The female delivered and consumed one prey item on the nest surface later that day.

DISCUSSION

Agonistic interactions among adult and subadult Bald Eagles are well-documented, yet observations of direct conflict between immatures and nestlings are considerably less common. While video-monitoring other Bald Eagle nests in the Chesapeake Bay region during the 2002–03 breeding seasons, we observed several instances in which immature eagles (between the ages of 2 yr and 4 yr old) landed on occupied nests while the breeding pair was out of sight (away from the nest surface). In none of these instances did the immature eagle directly interact with the nestlings. However, P. Nye (pers. comm.) documented a case in New York in which a dead 4-wk-old eaglet was found below a nest several days after a 2-yr-old Bald Eagle was seen repeatedly landing on the occupied nest (in each observed instance, the subadult was driven off by the resident breeders); necropsy results revealed talon punctures on the nestling. Such evidence, along with relatively more common findings of intraspecific predation of chicks by adults in other raptor species (e.g., Rosenfield and Papp 1988, Bortolotti et al. 1991), suggests the events described here may have been a simple case of nest predation by the 4-yr-old male. We found no previous accounts of direct observations describing this behavior in Bald Eagles in the literature available to us.

Given the loss of the original adult male and subsequent appearance of a 4-yr-old male, another potential explanation for the observed account of infanticide is that these events occurred in the context of mate replacement, following the original male's disappearance from the nest site. Mate replacement has been previously documented in Bald Eagles both within (Kozie 1986, Grubb et al. 1988, Jenkins and Jackman 1993, Anthony et al. 1994, Kennedy and McTaggart-Cowan 1998) and between (Herrick 1932) breeding seasons. Though we know of no direct accounts of infanticide following mate replacement in Bald Eagles, some observations strongly suggest this occurs. P. Nye (pers. comm.) observed a case in which a breeding female was driven from her nest containing

a single 1-wk-old chick by an intruder female. The original female was repeatedly harassed by the intruder and eventually moved to a new nest site, while the intruder remained on the territory with the original male; the single chick of the original breeding pair was not seen following the replacement and observers presumed it was killed by the intruder female (P. Nye pers. comm.).

Among avian species, the act of unrelated adults killing young has typically been interpreted as a means through which the adult can secure mating opportunities sooner than would be possible if the offspring continued to be reared (Crook and Shields 1985, Moller 1988). However, of the theoretical models described by Rohwer (1986) for mate replacement during a nesting season, the natural history characteristics of the Bald Eagle (i.e., unlikely renesting within the same season and increased breeding success with experience) suggest that adoption of existing clutches may be more adaptive to securing a position as a replacement adult than infanticide. In observations of mate replacement during the breeding season, Grubb et al. (1988) observed the replacement male assisting the female in parental duties. Adoption of nestlings has also been observed in fostering experiments, suggesting that Bald Eagles will accept and raise offspring other than their own. For example, Postupalsky (1975) reports on the successful introduction of 9-wk-old nestlings into eagle nests where the breeding pair was intact. Similarly, over a 5-yr study period, 8 nestlings between the ages of 2.5 wk and 4 wk were successfully fostered to mated pairs in exchange for either eggs or chicks (P. Nye pers. comm.). However, in observations made by Jenkins and Jackman (1993), a replacement female remained indifferent to eggs already present on the nest despite the attempt of the male parent to continue incubation.

Why different behavioral strategies were followed in each of these situations is not clear. The case of indifference may be explained as a gender distinction in adaptive strategies, perhaps varying with the adult's age and mating experience, as sexually-selected replacement behavior has been shown to occur in other avian species (e.g., Crook and Shields 1985, Freed 1986, Robertson and Stutchbury 1988). Among the accounts involving male replacement, the variable responses may have been due to differences in nesting stage at the time of replacement. The account by Grubb et al. (1988) occurred on the threshold of hatching, whereas the young in our observations were both killed when less than 2 wk old. Finally, the age of the replacement adult may also be a contributing factor. Anthony et al. (1994) reported that Bald Eagle nests where one member of the breeding pair had near-adult plumage, defined as having a partially white tail and horizontal line of dark feathers in the eye region, were rarely successful. Further, they concluded that nest failure in an observed instance of mate replacement was specifically attributed to the youth and inexperience of the replacement. Whether or not the age of the nestlings or the replacement adult were a significant factor in the actions we observed is not clear.

Unfortunately, no conclusive evidence is available on whether or not the 4-yr-old male later formed a pair bond with the resident female. A breeding attempt was documented at the nest the following year during aerial surveys (B. Watts and M. Byrd pers. comm.). However, identification of individuals in the breeding pair was not possible because the unique plumage characteristics used to distinguish the birds in 2002 would have been lost with annual feather molt. Thus, caution is needed in interpreting these accounts in the context of mate replacement as opposed to simple conspecific predation by a subadult.

DOCUMENTACIÓN DE INFANTICIDIO Y CANIBALISMO EN *HALIAEETUS LEUCOCEPHALUS*

RESUMEN.—Aunque el infanticidio de individuos no emparentados y el canibalismo están bien documentados para varias especies de aves, las observaciones directas de este comportamiento en las aves rapaces son relativamente escasas. Describimos un caso de infanticidio y canibalismo en *Haliaeetus leucocephalus*. En este caso, el macho residente adulto desapareció poco después de que el pichón eclosionó, y la hembra asumió las responsibilidades de la crianza sin ayuda hasta que el nido fracasó. La primera instancia de canibalismo tuvo lugar cuando el más joven de los tres pichones murió y fue entregado como alimento a sus hermanos por la madre. Otros actos de canibalismo se presentaron luego de la occurrencia de infanticidio, cuando un macho de cuatro años de edad entró al nido matando y consumiendo a los dos pichones restantes. Sugerimos que estos eventos de infanticidio y canibalismo estuvieron estrechamente ligados a la desaparición del macho residente, y potencialmente relacionados con el reemplazo de dicho macho por parte del individuo de cuatro años.

[Traducción del equipo editorial]

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