

Short Communications

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Notes on the Breeding Behavior of a Philippine Eagle Pair at Mount Sinaka, Central Mindanao

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ABSTRACT.—We documented the breeding behavior and diet of a Philippine Eagle (*Pithecophaga jefferyi*) pair from July 1999 to January 2000 in an isolated forest in Central Mindanao. We observed eight distinct courtship displays and several activity patterns on the nest. Copulation started two months prior to egg laying and continued until the first month of incubation, with a mean of 1.5 copulations per day. Seventy-four percent of the time devoted to incubation was by the female. The incubation period lasted 58 days. Throughout the incubation and early brooding phases the male provided food for the female and the young. Diet consisted of 17 prey items of four vertebrate taxa, mostly mammals, with civet cats (Family Viverridae) and flying lemur (*Cynocephalus volans*) representing the bulk of the diet. Received 30 November 2001, accepted 15 August 2003.

The Philippine Eagle (*Pithecophaga jefferyi*) is one of the most critically endangered birds of prey (Bildstein et al. 1998). It is endemic to the islands of Luzon, Leyte, Samar, and Mindanao of the Philippines. On Mindanao, eagles begin nesting from September to December in habitats ranging from primary lowland forests to highly disturbed woodlands. Recently, efforts were renewed to study the ecology and biology of this highly endangered raptor in an effort to devise management strategies for the long term conservation of the remaining population. An analysis of

the eagles' nesting density suggest that there are about 200 pairs in Mindanao, with each breeding pair occupying about 133 km² (Bueser et al. 2003).

A complete breeding cycle in this species lasts two years, and successful pairs produce a single offspring (Gonzales 1968, Kennedy 1985). Since the detailed work by Kennedy (1977, 1985) on Philippine Eagle nesting biology, there have been few studies on the behavior and ecology of this species. Recently, new information on the eagles' breeding success (Miranda et al. 2000) and nesting density and population estimates for Mindanao Island (Bueser et al. 2003) have been published. This study describes the prey as well as the behavior of a pair of Philippine Eagles nesting in a relict forest in Central Mindanao, Philippines. This initial attempt to quantify activity patterns of a pair in an isolated forest habitat is relevant in the light of continued forest fragmentation in the Philippines, where the behavioral responses of Philippine Eagles to a shrinking habitat remain unknown.

METHODS

We gathered 703 h of behavioral data between July 1999 and January 2000 in Mount Sinaka, Cotabato Province, Philippines. Mount Sinaka (07° 20' N, 125° 12' E) is located in an isolated mountain range (peak at 1,448 m) with 19 km² of relict tropical forest. A nest was found in 1995, and was used during two successful nesting attempts. On 15 June 1999, the female was caught by a farmer and brought to the Philippine Eagle Foundation for rehabilitation. After one week the eagle's right wing was marked by clipping following Young and Kochert (1987), a radio transmitter was installed, and the bird was released the following week. The following month we located the female building a nest

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in a tree 200 m away from the old nest. The new nest was in a 29-m White Lauan (*Shorea contorta*, Dipterocarpaceae) tree at 750 m elevation, in an agroforest located on the mountain's western slope. We documented aerial displays and nesting behavior from several blinds located 40–150 m from the nest using 8 × 40 binoculars and a 20–56× spotting scope. We distinguished the female by her wing and by radio tracking. We directly observed and identified prey items delivered to the nest. The egg was laid on 16 November 1999 and hatched after 58 days of incubation. However, the chick died nine days later after three days of stormy weather.

RESULTS AND DISCUSSION

We recorded 118 h of notes on aerial displays, 293 h during nest building and before egg laying, and 292 h during incubation and brooding. We documented courtship behaviors during flight and on the nest. We distinguished four behaviors associated with aerial displays: mutual soaring, dive chase, talon presentation, and territorial flights. Mutual soaring was a circular gliding flight by both birds on thermals with the male usually soaring higher. Dive chases involved a diagonal drop in flight altitude, wings half folded toward the body, with the male trailing in pursuit. A dive chase sometimes was followed by a male talon presentation, which is characterized by a quick extension of the tarsi toward the back of the gliding female. On two occasions the female flipped over and quickly presented her talons. Such mutual talon presentation is known in many species of raptors (Brown and Amadon 1969). Mutual territorial flight behaviors were gliding flights with the male slightly above the leading female. Male courtship acts on the nest included vigorous calling toward the female in a low, horizontal posture (precopulation display), and delivery of prey for the female to consume (courtship feeding; Hatchwell et al. 1999). Food solicitation by the female, a pattern similar to the sexual solicitation display, also was observed. We also noted reciprocal pecking and preening actions directed toward the bill, wings, and other parts of the body of the other bird (allopreening).

We first observed delivery of nest materials on 17 September 1999, and deliveries contin-

ued throughout the study. The male brought more nest materials ($n = 29$ deliveries) than the female ($n = 22$ deliveries) prior to egg laying; the female made more deliveries ($n = 33$) than the male ($n = 7$) during brooding and incubation stages. Nest materials were delivered by both birds 1.7 times/day prior to egg laying, 1.2 times/day during incubation, and 3.0 times/day during brooding. The behavior sequence for nest building was as follows: the bird acquired leafy twigs (fresh or not) or a dried branch, deposited the material around the nest, pressed the materials with the breast, followed slowly by brooding. The mean duration of nest building behavior at the nest (excluding acquisition of materials) prior to egg laying was $5.7 \text{ min/day} \pm 4.2 \text{ SD}$ ($n = 43$).

Copulation occurred on the nest and nearby perches, with or without prior courtship feeding. When prey was delivered to the unattended nest, the male issued loud and prolonged calls that changed into short, high-pitched whines when the female alighted on the nest. Calls became vigorous and gained speed while the male mounted, but gradually waned after copulation. When the male displayed precopulatory behavior without food, he did so in an apparently more submissive and wary manner, walking in a low horizontal posture toward the female and mounting her if she did not exhibit any rejecting behavior (e.g., an erect or threat posture). We observed 27 copulation attempts (25 during courtship, 2 during incubation), for a mean of 1.7 copulations/day between September and December 1999. The duration of copulation from mounting until dismounting lasted a mean of $19 \text{ s} \pm 3 \text{ SD}$ ($n = 6$). In three instances, copulation occurred twice within a period of 30 min, and the maximum number of copulations observed in one day was three. Such copulation rates, which appear more than necessary for fertilization, has been reported in many raptor species (Newton 1979, Pandolfi et al. 1998, Arroyo 1999). Aside from ensuring successful fertilization, frequent copulation also is interpreted as a mechanism to strengthen the pair bond (Newton 1979).

The female performed 74% of the incubation duty (data from 963 instantaneous samples collected at 10-min intervals), but male incubation bouts were longer (the total time

that an adult spent on the nest bowl, sitting or not; male: mean = 3.1 h \pm 1.7 SD, n = 11 bouts; female: mean = 1.4 h \pm 0.8 SD, n = 70 bouts). Preening, defecation, or nest building by an attending adult commonly ended a bout of incubation. Unlike defecation, which was done only from a different tree, preening was performed also on the nest. When inside the nest bowl, an adult approached the egg with a distinctive gait: flexed toes with claws directed inward and feet leaning sideways. Before the adult sat, the egg was turned by reaching down 2–5 cm ahead of the egg then gently arching its bill toward the belly. While incubating, the adult tugged intermittently at the substrate in front of the egg. The mean time spent away from the nest was 21.0 h \pm 3.8 SD (n = 5) for the male and 4.6 h \pm 1.7 SD (n = 8) for the female. Turnover of incubation was signaled by calling or by alighting on the nest. The longest period that the egg was left unattended was 102 min. The male performed nighttime incubation on only three occasions, while the female incubated the egg during the rest of the nights throughout the duration of the incubation period.

We did not directly observe hatching, but surmised its occurrence from the behavior of the brooding female. On the morning of 13 January 1999, the female increased her tugging behavior and appeared to be sitting less tightly on the egg. The female turned the egg several times and nibbled frequently at the nesting materials. A few minutes after the chick hatched, the female moved the shell and ate a few pieces. No vocalizations were heard during hatching, but the adults exchanged calls about 3 h after hatching. The first parent-chick interaction consisted of light pecks and brushes by the female soon after the chick was able to raise its head.

Only the female brooded the chick and she spent less time brooding (62% of instantaneous samples, n = 321) than incubating (74% of 963 samples). Mean duration of female brooding bouts was 80 min \pm 46 SD (n = 14). Although the male did not brood, he attended the nest for a mean duration of 6.7 min \pm 9.7 SD (n = 9) when the female was away. The male was absent during the last three days of observation. The chick was left unattended for a maximum period of 232 min on 20 January 2000, eight days into the nest-

ling stage (mean duration = 55.2 min \pm 64.6 SD, n = 13). The female alone fed the chick; mean duration of feeding bouts was 13.0 min \pm 6.6 SD (n = 11). The first meal was delivered on 15 January 2000, two days after hatching, and consisted of 36 pea-sized bits of rat meat. The chick was fed three times on the third day, three times on the seventh day, and twice on the ninth day.

The male eagle delivered 17 vertebrate prey items to the nest from October 1999 to January 2000: 11 during the courtship period (mean = 0.34 prey/day), 2 during incubation (mean = 0.10 prey/day), and 3 during brooding (mean = 0.50 prey/day). Of the 17 prey items, 16 (94%) were mammals. Prey items included flying lemurs (*Cynocephalus volans*, n = 7), civet cats (Family Viverridae, n = 7), rice field rats (*Rattus* spp., n = 2), and Philippine cobra (*Naja naja*, n = 1). Some of the prey items observed in this study also were reported by Kennedy (1985). Contrary to persistent reports by local people, no domestic animals were recorded.

Except for the Philippine cobra, all prey items were mostly gutted and decapitated, with portions of the fur already plucked off. Only the hindquarters of the civet cats were delivered to the nest. All prey appeared fresh, and probably came from new kills. Most of the delivered carcass was consumed, including the tail, bones, nails, and a few internal organs (e.g., kidney, intestine). Portions of prey not eaten immediately were left on the sides of the nest and in most cases were consumed later. On three occasions old prey remains that had not been consumed were removed from the nest. Unlike observations of Harpy Eagles (*Harpia harpyja*) in South and Central America (Alvarez-Cordero 1996, Galletti and de Carvalho 2000), we rarely observed discarded skeletal bones of prey. Although the sample size of prey was small, our observations suggest that studies of the diet of tropical birds of prey such as the Philippine Eagle based solely on prey remains rather than direct observations could underestimate prey species diversity.

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