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NEST-DISMANTLING BEHAVIOR OF THE HAIR-CRESTED DRONGO IN CENTRAL CHINA: AN ADAPTIVE BEHAVIOR FOR INCREASING FITNESS?

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Abstract. We studied a unique nest-dismantling behavior after fledging by Hair-crested Drongos (*Dicrurus hottentottus*) at the Dongzhai National Nature Reserve, Henan Province, China, during the summer of 2007. Of the 13 nests that fledged young, 12 were dismantled by the adults that built them after the young fledged. Some individuals initiated dismantling behavior on the same day the young birds left the nest and completed dismantling within a few days; others waited for a few days and took longer to finish. The mean rates of visitation and nest-dismantling behavior were 0.10 ± 0.04 and 0.06 ± 0.03 times hr^{-1} (\pm SE), respectively, once nest dismantling was initiated. We propose that the nest dismantling by the Hair-crested Drongo may be an adaptive behavior to increase fitness by reducing risk of future predation and competition for nest sites in the following breeding season.

Key words: *breeding ecology, Dicrurus hottentottus, fitness, Hair-crested Drongo, nest dismantling, post-fledging.*

Comportamiento de Desmantelamiento de los
 Nidos de *Dicrurus hottentottus* en China Central:
 ¿Comportamiento Adaptativo para Aumentar la
 Adecuación Biológica?

Resumen. Estudiamos un comportamiento único de desmantelamiento de los nidos después del emplumamiento de los polluelos por parte de *Dicrurus hottentottus* en la Reserva Natural Nacional Dongzhai, Provincia Henan, China, durante el verano de 2007. De los 13 nidos que emplumaron polluelos, 12 fueron desmantelados por los adultos que construyeron el nido, después de que los polluelos emplumaron. Algunos individuos comenzaron el desmantelamiento el mismo día en que los polluelos dejaron el nido y completaron el desmantelamiento dentro de unos pocos días; otros esperaron unos días y demoraron más en terminar. La tasa media de visita y del comportamiento de desmantelamiento del nido fueron 0.10 ± 0.04 y 0.06 ± 0.03 veces hr^{-1} (\pm EE), respectivamente, una vez que el desmantelamiento del nido fuera iniciado. Proponemos que el desmantelamiento de nido por parte de *D. hottentottus* puede ser un comportamiento adaptativo para aumentar la adecuación biológica mediante la reducción del riesgo de depredación futura y de competencia por los sitios de anidación en la siguiente época reproductiva.

Nest-destroying behavior has been reported widely. For example, some birds destroy nests in their territories to avoid intraspecific and interspecific competition (Picman and Picman 1980, Belles-Isles and Picman 1986). Others dismantle old or abandoned nests and use the materials to build new ones (Weaver and West 1943, Root 1969, Sedgwick and Knopf 1988) or steal other birds' nest materials to build their own (Snow and Snow 1979, VanderWerf 1998, Jones et al. 2007), saving time and energy in searching for

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materials. Additionally, a dominant male Acorn Woodpecker (*Melanerpes formicivorus*) may destroy its group partners' nests because of reduced paternity (Koenig 1990). All of these behaviors occur during the nest destroyers' own nesting period.

Previous studies of avian nesting behavior have usually focused on nest construction, egg incubation, or nestling provisioning (Hansell and Ruxton 2002, Grant et al. 2005, Karubian et al. 2007). Despite extensive studies of dispersal, mortality of adults and fledglings, etc., after fledging (King and Belthoff 2001, Naef-Daenzer et al. 2001, Soutullo 2006), how birds dispose of their nest after fledging has received little attention. In 2002, 2003, and 2006 at Dongzhai, China, we observed an unreported nest-dismantling behavior among Hair-crested Drongos (*Dicrurus hottentotus*) after young birds fledged: adult drongos dismantle their nests. In 2007, we undertook an exploratory study of this behavior. Our research questions: (1) How common is nest dismantling among individuals of this species? (2) When do birds initiate this behavior? (3) How long does it take to dismantle the nest completely? (4) How do (2) and (3) vary from individual to individual?

METHODS

STUDY SITE

We conducted the study at Baiyun Station of Dongzhai National Nature Reserve (Dongzhai, 31.95° N, 114.25° E, altitude 100–446 m) in the Dabieshan Mountains, which lie in the south of Henan Province of central China. The reserve is located in the transition between the subtropical and temperate zones and is characterized by a rich avian diversity. The forests are composed predominantly of oaks (*Quercus* spp.), Masson Pine (*Pinus massoniana*), Dyetree (*Platycarya strobilacea*), Beautiful Sweetgum (*Liquidambar formosana*), and Hupeh Rosewood (*Dalbergia hupeana*). Some tea (*Camellia* spp.) gardens, farmland, and replanted forests of Chinese Fir (*Cunninghamia lanceolata*) are also scattered around the study site. Dominant shrub species are young Oriental Oak (*Q. variabilis*), Sawtooth Oak (*Q. acutissima*), Glaucous Allspice (*Lindera glauca*), and bamboo (*Pleioblastus* spp.). The Baiyun Station (400 ha) is one of the core areas of Dongzhai.

STUDY SPECIES

The Hair-crested Drongo is a summer breeder in central and northern China (Zheng 2005). Both of the parents participate in nest construction, incubation, and nestling provisioning (Zhao 2001). Nests are made mainly of fine grass stems and rootlets, which are common at the study area, and have no inner lining such as feathers or fibers (Du and Zhang 1985, Zhao 2001). The cup-shaped nest, which is attached firmly in a tree crotch, is approximately 16.4 × 18.0 cm in external diameter, 10.9 × 12.3 cm in inner diameter, and 6.4 cm in depth (Du and Zhang 1985). The nest-construction, incubation, and nestling-provisioning periods take 11, 21, and 13 days, respectively (Du and Zhang 1985). Drongos are territorial during the breeding period and aggressive to conspecific intruders and raptors. At Dongzhai drongos raise one brood each year, and most juveniles fledge from late June to early July. In this area they breed in three types of forest: broadleaf, coniferous, and mixed conifer–broadleaf (Gao et al. 2006).

BEHAVIORAL MONITORING

We searched the study area and found 14 Hair-crested Drongo nests between May and June 2007 (Table 1). We intensively monitored three nests by observing them continuously from dawn (04:00–04:45, GMT +8) to dark (19:15–20:00) for 8 to 10 consecutive days after fledging, except during extreme weather conditions such as heavy rain, and then we checked the nests every few days (mostly 1–3 days). We surveyed the remaining 11 nests approximately every 1–3 days. Our visitation of nests was random. These checks were only to see whether the nests were being dismantled, but we observed some nests intensively for at least 40 min to investigate how the dismantling behavior happened. When observers were absent we used a video camera (Sony DCR-PD100AP), placed in a concealed site 8–30 m from the nests. The tapes were exchanged every 40 min. Videotaped data were examined at later dates, and the time taken to change a tape was excluded for the calculation of the frequency at which the birds visited their nests (see below). We recorded the time and details of the drongos' behaviors and scored the behaviors

TABLE 1. Fledging date, monitoring period, number of fledglings, and fate of the nests monitored in 2007 at Dongzhai National Nature Reserve, Henan Province, China.

Nest code	Fledging date	Period of monitoring of nest dismantling	No. of Fledglings	Dismantled?
DYP1	30 June	1 July–20 July	3	Yes
BDY1	1 July	1 July–16 July	1	Yes
NZG1	?	1 July–1 August	?	Yes
CZL1	3 July	3 July–1 August	4	Yes
DYP2	3 July	3 July–2 August	2	Yes
CZL3	3 July	4 July–31 July	?	Yes
DYP3	4 July	4 July–2 August	3	Yes
CZL2	5 July	5 July–1 August	2	No
MZY2 ^a	6 July	6 July–2 August	3	Yes
MZY5	8 July	8 July–18 July	1	Yes
MZY4 ^a	13 July	13 July–2 August	2	Yes
WZG1	16 July	16 July–1 August	4	Yes
MZY3 ^a	23 July	23 July–2 August	3	Yes
MZY1	Failed	1 July–2 August	0	No

^aMonitored intensively and continuously for 8–10 days after fledging; MZY1 was the abandoned nest and produced no fledglings, while all the other nests succeeded in fledging.

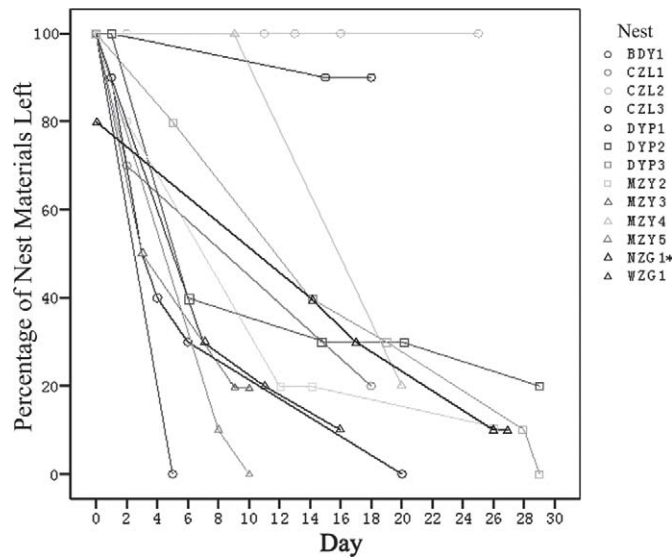


FIGURE 1. Relationships between the percentage of nest materials left and the days after fledging of Hair-crested Drongo at Dongzhai National Nature Reserve, Henan Province, China. Each line indicates one nest. Asterisk (*) indicates nests at which the exact fledging date is unknown and the date on which we found the nest is used as the first day.

as nest dismantling, no dismantling, and uncertain. The sampling period was divided into eight intervals: <06:00, 06:00–08:00, 08:00–10:00, 10:00–12:00, 12:00–14:00, 14:00–16:00, 16:00–18:00, and >18:00. We calculated the frequencies of nest-dismantling and nest-visiting behaviors for each interval, and we report them as mean \pm SE. We used the percentage of the nest materials left at each check to quantify the rate of dismantling a nest (Fig. 1). Percentages of nest materials left were determined according to the pictures taken during our visits to the nests. We did not photograph nests on each visit, so Fig. 1 portrays data only from those days when pictures were taken. As a result, some nests had records for only a few days. The heavy rain during our monitoring might have destroyed the nests to some extent, but its contribution was limited to later in the process, when most of the nests had already been dismantled by drongos and

the nest materials were loosening. We were not able to quantify, however, the effect of weathering on the nest-destroying rate. Even so, and in the lack of records for the percentage of nest materials left at some sites, Fig. 1 displays the general rate of nest dismantling.

Monitoring totaled 740 hours. At each nest monitoring varied from 5 to 33 days and from 2 to 138 hours cumulatively, depending on when the nests were completely dismantled.

RESULTS

At the study site the mean nest height was 8.1 ± 0.6 m (range 6.0–15.5 m, $n = 14$) and the distance between two adjacent nests ranged from 15 to 210 m. For the nests with fledglings the number of fledglings was 2.5 ± 0.3 ($n = 11$). We were not able to estimate the number of fledglings for two successful nests because of insufficient observations (nests NZG1 and CZL3 in Table 1). On the day of fledging, the juveniles stood on the nest branches, jumped away from their nest step by step, then flew to an adjacent tree, the adults sometimes calling nearby. Juveniles spent the first few days near the nest area, then dispersed more widely as they became capable of flying further. We did not detect the return of any young after the day of fledging to the nests that we monitored ($n = 6$).

Adult drongos often visited the nests after the juveniles fledged, and 38% of the visits were associated with nest-dismantling behavior. The average frequencies of visiting and dismantling behavior were 0.10 ± 0.04 and 0.06 ± 0.03 hr^{-1} , respectively ($n = 13$ nests) during the observation periods. Each time they spent from approximately a few seconds to nearly 20 min at the nest. The time that drongos spent at the nests when visiting and dismantling were not exhaustively recorded in our study, however, so we didn't consider its effect on the frequencies of visiting and dismantling behaviors. Of the six nests that we monitored on the day of fledging, five were visited by adult drongos on the same day the juveniles left the nests. Three of the nests were pecked gently by the birds during the visits. We are not sure how such pecking behavior is related to dismantling behavior.

The typical nest-dismantling behavior was initiated when adult birds stood by the side of the nest, or on the nest branch, and began to dismantle the nest by pecking and pulling the nest materials with their beaks. The nest materials were dropped aside to the ground below the nests, and we didn't find any material that was taken away. The central part of the nest was often dismantled first, followed by the outer edges (Fig. 2). Nest visiting and

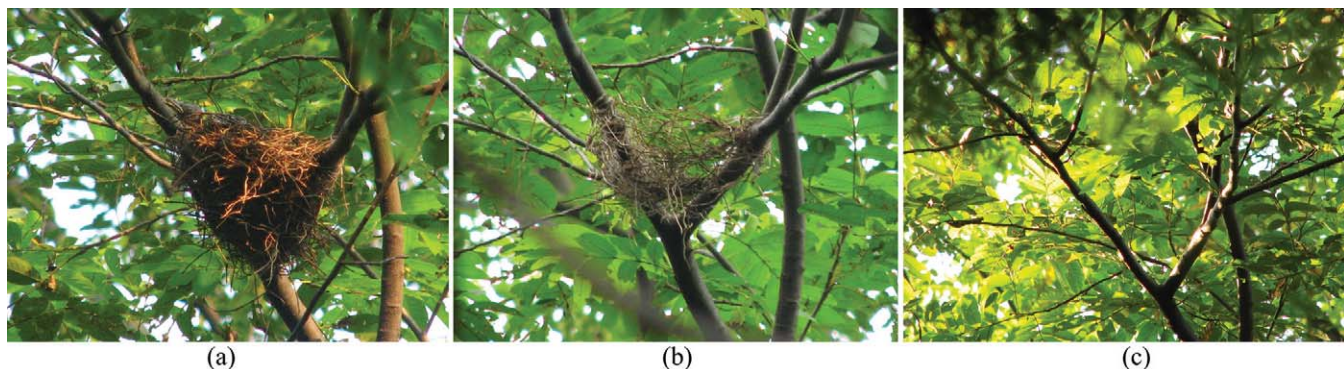


FIGURE 2. An example of a nest being dismantled by Hair-crested Drongos (*Dicrurus hottentottus*) after fledglings left the nest at Dongzhai National Nature Reserve, Henan Province, China. (a) Two days before fledging; (b) three days after fledging; (c) 20 days after fledging.

dismantling were carried out by either member of a pair or both. In one case, two birds flew to a nest, followed by another pair, but the latter pair flew away after a while and the former two pecked the nest a few times before flying away also. The dismantling behaviors were often accompanied by calls, especially when only one bird was at the nest and another was somewhere nearby.

Most nest-visiting and dismantling behaviors occurred between 08:00 and 12:00 and after 18:00. Twelve (92%) of the successful nests were dismantled (Table 1) while being monitored. Some nests were dismantled completely, others only partially (Fig. 1). Two nests, one with successful fledglings (CZL2) and the abandoned nest (MZY1), remained intact during monitoring (Table 1, Fig. 1).

The date of initiating nest dismantling after fledging varied. Most birds appeared to dismantle their nests immediately after the juveniles fledged, while some birds started to dismantle their nests on the second or third day after fledging, on the basis of our observations or remaining nest materials. One nest (MZY4) was left intact during the first 9 days after fledging but found to be dismantled 6 days later (Fig. 1).

The rate of dismantling also varied. Some nests, such as nest DYP2 and MZY2, were dismantled quickly in the first few days, more slowly afterward, while other nests were dismantled at a more constant rate (Fig. 1). We detected no relationship between the fledging date and the rate of dismantling a nest, possibly because of the small sample of monitored nests. Two nests (DYP1 and BDY1) with similar fledging dates (30 June and 1 July, respectively), however, took 5 and 20 days to be completely dismantled, respectively.

We saw no juveniles involved in the nest dismantling. In the Hair-crested Drongo juveniles are easily distinguished from adults by the lack of hairlike crown feathers and less glossy plumage.

DISCUSSION

To our knowledge, this is the first record of nest-dismantling behavior after fledging in the Hair-crested Drongo, even though the species is common and widely distributed. Also, the Hair-crested Drongo's nest-dismantling behavior differed from nest-destruction behaviors reported in other species of birds (e.g., Weaver and West 1943, Root 1969, Snow and Snow 1979, Potts et al. 1980, Sedgwick and Knopf 1988, VanderWerf 1998, Jones et al. 2007) because it was not associated with nest building, occurred after fledging, and no reuse of the nest materials was observed.

We could not determine the exact identity and sex of the individuals that dismantled the nests because we did not mark the birds and were not able to sex them by external appearance. However, our observations suggest that the dismantlers were quite familiar with the nests, as they usually flew to the nests with no hesitation. Because adult drongos are territorial and evict conspecific intruders, we believe that the nest owners, both male and female, dismantled their own nests.

Because 92% of nests with successful fledglings were dismantled, we believe that the occurrence of this behavior in the Hair-crested Drongo at our study site is not random. We propose that this behavior is an adaption of Hair-crested Drongo to maximize individual fitness. Nest dismantling may reduce the risk of predation on fledglings (predation hypothesis). By removing the nests, the drongos may make predators such as the Gray-faced Buzzard (*Buteo indicus*), Besra (*Accipiter virgatus*), and Eurasian Jay (*Garrulus glandarius*), which are common at the study area, less likely detect their fledglings remaining near the nests.

Drongos are well-known for their aggressive behaviors towards larger birds, including raptors (Morcombe 2003, Nijman 2004, Arlott 2007), but fledglings may be more vulnerable to predators. If this hypothesis is valid, drongos should dismantle their nest as soon as the young birds leave the nests. Our field observations, however, indicated that the initiation, duration, and rate of nest dismantling varied greatly from individual to individual. The second explanation could be that the nest dismantling reduces competition for nest sites (nest-site-competition hypothesis). By dismantling the nest, the drongos may conceal their successful nest locations from other individuals when they return for breeding the following year. When the cost of competing for a new territory is greater than that of destroying a nest and protecting an old territory, the drongos may be expected to adopt the latter strategy. We found that four nest trees used in 2006 were reused in 2007, and even the positions of the nests in 2007 were on the same branches used in 2006. This hypothesis can also explain the large variations among individuals in the initiation, duration, and rate of nest dismantling: the drongos may finish dismantling the nests up until they leave the breeding ground for the autumn migration. Suitable nest sites like that in Fig. 2, however, seem not to be in limited supply in the study area, because there may be many such locations (the junction between two tree branches) in a forest. Yet a "good" nest site in a bird's eye may not be obvious to the human eye, or maybe the nest site is also a cue for a good territory, which may be fewer than the possible nest sites in a forest. An alternative explanation is that the dismantling behavior may be an adaptive strategy that benefited drongos in the past. Some factor (e.g., limited nest sites or territory) may have obliged drongos to monopolize a site but the restrictive factor(s) disappeared with environmental change. In this case, if the dismantling behavior has been retained but is no longer adaptive, then its energetic cost to the pair must be negligible. This "once-beneficial hypothesis" may supplement the nest-site-competition hypothesis. All these hypotheses are based on our inference that the nest dismantlers are the nest owners. If the dismantlers are other individuals, then what do they gain from destroying the nests? It is to reduce intraspecific competition? But why then they do not destroy the nest before fledging?

The dismantling behaviors were usually accompanied by calls, but these calls also seemed to be used in other occasions. Further work is needed to explore the vocal communication of the Hair-crested Drongo and how it is related to the dismantling behavior. The only nest abandoned during our monitoring remained intact, while most of the nests with successful fledglings were dismantled. The relationship between breeding success and the decision to dismantle a nest is a question for future work. Furthermore, whether nest density has effect on the rate of nest dismantling rate remains unknown.

Studies have rarely addressed how adult birds dispose of their nests after breeding, most likely because most birds simply leave their nests but also because the fate of an empty nest is usually less interesting or less important than the fate of fledglings or adults. These observations of the Hair-crested Drongo suggest that postbreeding behaviors such as nest dismantling could be important to the life history and fitness of some species. We are planning more intensive observations and a series of experiments to test the alternative hypotheses discussed above.

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