Video Evidence Confirms Cannibalism in Eleonora's Falcon

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LETTER

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VIDEO EVIDENCE CONFIRMS CANNIBALISM IN ELEONORA'S FALCON

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Cannibalism is a widespread phenomenon in the animal kingdom (Polis 1981), but has been thought to occur infrequently in birds (Mock 1984). Such behavior has been linked primarily with predatory species (Polis 1981), but it has also been observed in non-predatory passerines such as House Sparrows (*Passer domesticus*; Ben-Dov et al. 2006). Several studies on raptors have documented within-nest siblicide and infanticide, as well as cannibalism on dead nestlings by parents and siblings (Bortolotti et al. 1991, Boal and Bacorn 1994, Sheffield 1994, Margalida et al. 2004, Solaro and Sarasola 2012). Other studies have provided additional evidence of cannibalism in raptors. For example, Jones and Manez (1990) attributed the occurrence of a ring of a conspecific nestling under a Black Kite (*Milvus migrans*) nest to between-nest predation, but the exact circumstances remained unclear. Arroyo (1997) described between-nest cannibalism in Montagu's Harriers (*Circus pygargus*), but the cause of death could not be determined. Although this behavior may be less common in falcons that defend their nests, such as American Kestrels (*Falco sparverius*; Bortolotti et al. 1991), cannibalism might be more frequent in colonial nesting birds, including falcons, due to the higher breeding densities. Negro et al. (1992) observed three cases of intraspecific, between-nest predation among Lesser Kestrels (*Falco naumanni*): (1) an adult unsuccessfully attempted to steal a nestling, (2) an adult successfully stole a nestling and then consumed it, and (3) a conspecific nestling carcass was found in a different nest but there was no information regarding its origin and which individuals, if any, fed on it. Breeding density (Polis 1981) and food availability (Gangoso et al. 2015) might play a role in differences in behavior among falcons, with opportunities to depredate nestlings potentially larger in colonially nesting species.

Eleonora's Falcon (*Falco eleonorae*) is a colonial breeder, nesting on sea cliffs and islets in the Mediterranean and Canary islands (Walter 1979), and some studies have suggested cannibalism occurs in this species. In 1971, one researcher (D. Ristow pers. comm.) found a ringed leg of an Eleonora's Falcon nestling in one nest that had been ringed in another nest 10 m away on the island of Crete, but the circumstances surrounding this event remained unclear. More recently, Steen et al. (2016) recorded an adult Eleonora's Falcon stealing a nestling from a conspecific nest using camera traps in Greece in 2014. Furthermore, Gangoso et al. (2015) found 21 rings in several Eleonora's Falcon nests on the Canary Islands, which they attributed to intraspecific predation from nearby nests. In spite of the information so far available, to our knowledge, no study has recorded an Eleonora's Falcon performing non-parental infanticide, followed by cannibalistic feeding of the carcass to its nestlings. Herein, we document such behavior for the first time in Eleonora's Falcons. We recorded on video the killing of a conspecific nestling by a female Eleonora's Falcon and the subsequent feeding of the nestling to its own offspring.

We studied the breeding population of Eleonora's Falcon on Cyprus from 2012–2014, by means of boat, ground and aerial surveys. We estimated the breeding population size on the island at about 130 pairs, including the intensively studied Akrotiri Peninsula colony (hereafter "Akrotiri"), which included approximately 30 breeding pairs (T. Hadjikyriakou unpubl. data). During the 2013 breeding season, we mapped all the nests at Akrotiri; all data were analyzed in ArcGIS 10.1 (ESRI 2014). In addition, during the same breeding season, we installed four camera traps at four of the nests to monitor parental care and sibling behavior. The camera that recorded the cannibalism incident (Bushnell Nature View HD, Bushnell, Overland Park, KS U.S.A.) was installed on 23 June 2013 and recovered on 16 November 2013, after both the parents and their fledglings departed to their wintering grounds. For this particular nest (hereafter, "focal nest"), we obtained video footage covering the entire breeding season. Video activation was triggered by motion, and the system recorded 10 sec of video footage per trigger activation. The camera was programmed to turn off for a minimum of 6 min before motion could trigger a further recording, thus conserving battery life and memory card space.

In the focal nest three eggs were laid, and all three hatched successfully between 25 and 27 August 2013. On 17 September 2013, when the nestlings were 21–23 d old, at 1130 H, the female parent was in the nest, holding in its talons a live 7–9 d old conspecific nestling, which was fighting to escape (Fig. 1a). By 1137 H, the female parent had killed the nestling (Fig. 1b), and started feeding it to its own offspring (Fig. 1c). The incident lasted approximately 30 min, with the last relevant recording at 1155 H (Fig. 1d), during which the dead nestling had been almost completely fed to the nestlings.

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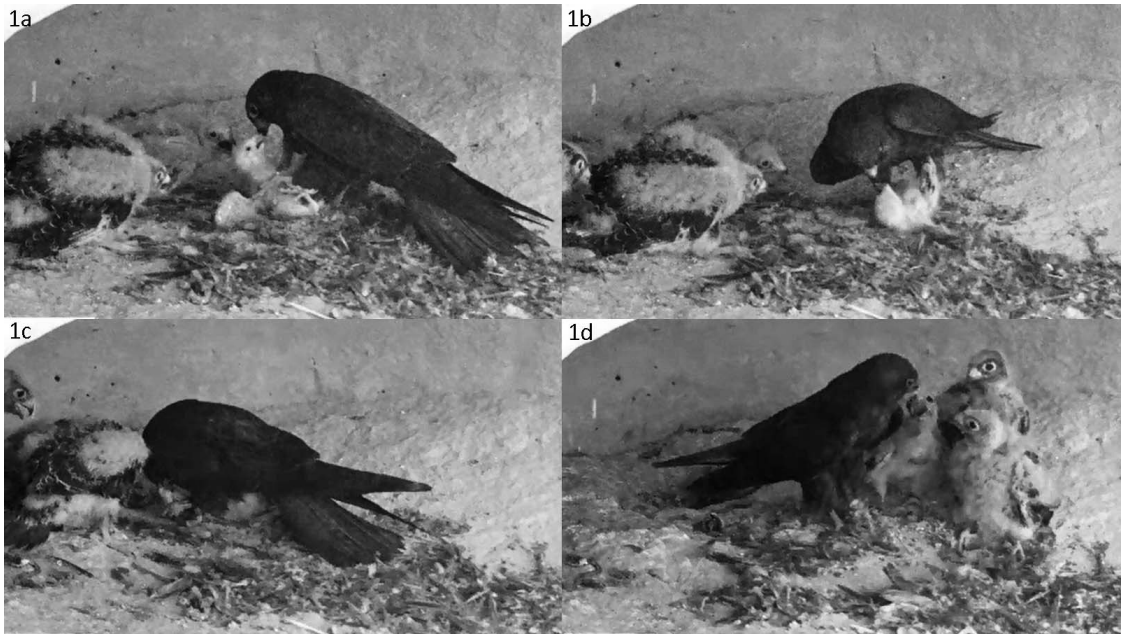

Figure 1. Frames from the video of the Eleonora's Falcon nest, showing a nestling from another nest brought in alive, then killed by the female parent and fed to the nestlings: (a) captured nestling fighting to escape, (b) captured nestling just before it was killed, (c) dead nestling being fed to focal nest's nestlings, and (d) dead nestling almost completely fed to the nestlings of the focal nest.

During the same morning and prior to the incident, there were at least four feeding bouts in the focal nest (0726 H, 0850 H, 0913 H and 1116 H), during which the male parent brought food to its mate to feed the nestlings. On those occasions, the female was standing over the prey, making it impossible to identify. However, we could see that the prey items were small, most likely insects, which might not have been sufficient to satisfy the energy requirements of the nestlings. The cannibalistic event began 14 min (1130 H) after the last of these four recorded feeding visits. At 9 min before the incident (1121 H), the male parent stood in the nest, while the female was away, presumably capturing the young nestling from a neighboring nest.

Because the colony was monitored during the entire breeding season, we were able to identify the nest from which the nestling was likely taken (hereafter, "target nest"). We did this by identifying those nests that were expected to have nestlings approximately 7–9 d old, and then checking if any of them was missing a nestling of that age. We concluded that the target nest was one situated 116 m from the focal nest (Fig. 2): on 19 August, there were three eggs in the target nest. During the next nest survey on 25 September 2013 (T. Hadjikyriakou unpubl. data), there was no sign of any nestlings and the target nest was presumed abandoned.

The focal nest was one of the most successful in our study area on Cyprus over the 3-yr study period, with three fledglings each year, which was approximately double the estimated colony mean of 1.5 young per breeding pair (T. Hadjikyriakou unpubl. data). Cannibalistic behavior might have been a contributory factor to the focal pair's high reproductive success. We cannot be certain, however, that the pair occupying the focal nest was made up of the same individuals from year to year, because they were not color-banded; however, the combination of a dark-morph female and a light-morph male was consistent over the 3 yr. Regardless, the target nest was in direct line of sight of the focal nest, potentially increasing the opportunity for predation by the focal female. We considered predation from the ground (e.g., by rats) unlikely, because the target nest was well protected on a vertical sea cliff. Although other factors might have been responsible for the target nest's reproductive failure, it is possible that the focal pair may also have taken other hatched nestlings from the target nest. We cannot verify this conjecture, because the camera view did not show the entire nesting hole, the female was obscuring the view of some incidents, and the camera was triggered at intervals and so did not continuously record activity in the nest.

Because intraspecific predation in birds is rarely witnessed (Jones and Manez 1990), little attention has been directed to the role of cannibalistic behavior in hatchling loss during the breeding season. Among Herring Gulls, breeding success was substantially reduced by a few persistent cannibals within the breeding colony

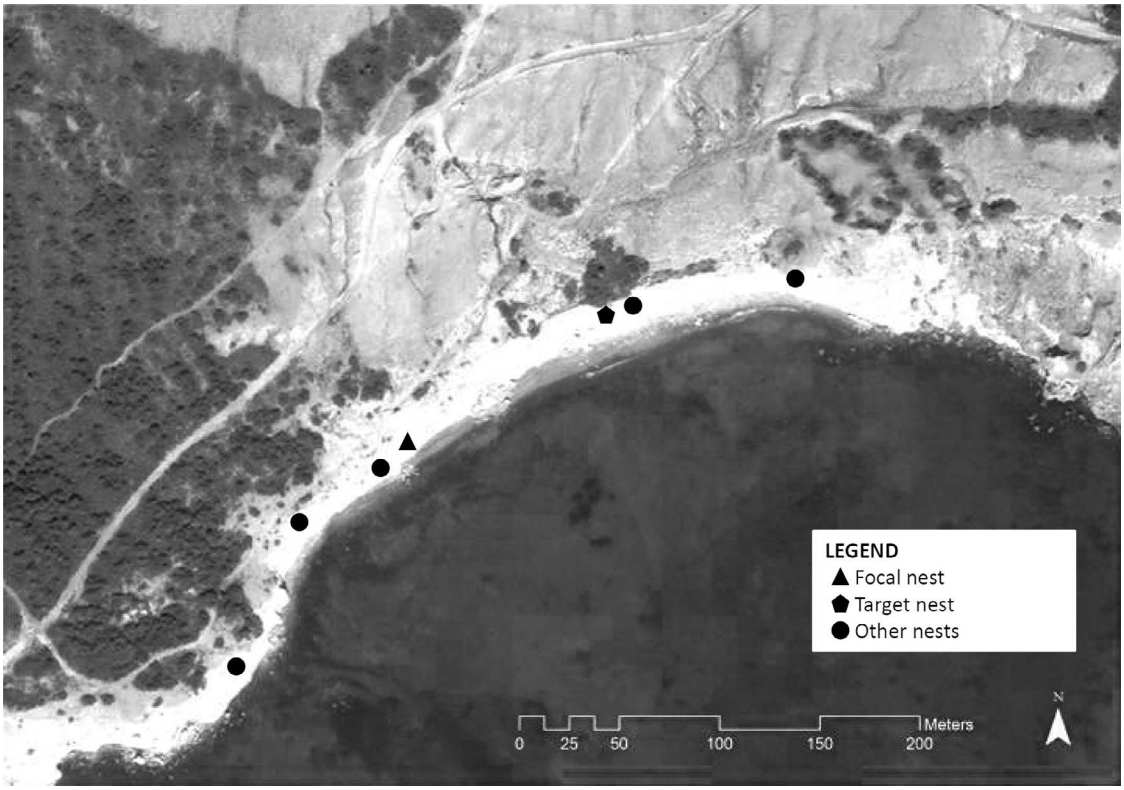

Figure 2. Eleonora's Falcon nesting colony, with focal nest, target nest, and other active nests during the 2013 breeding season (Background image: ESRI 2014).

(Parsons 1971). Indeed, higher breeding density, with more offspring to feed within a colony, may increase the possibility of intraspecific predation (Polis 1981). Likewise, when food is scarce, intraspecific predation may significantly affect breeding success in Eleonora's Falcon breeding colonies (Gangoso et al. 2015). Intraspecific predation of nestlings from other nests provides a two-fold benefit from the predator's perspective: food for the predator's young, and fewer nestlings in the colony needing food and thus reduced competition for food resources.

We sincerely thank the late Spyridon Mavrides who we lost so early, for his valuable work in installing and collecting the cameras from the nesting cliffs. We also thank Efthymia Nicolaou, Kouliana Anastasiou, and Antaia Christou for their work on video indexing. Special thanks also to the A.G. Leventis Foundation for providing funding toward the study. I also thank the Sovereign Bases Areas Adminstration (SBAA) Environment Department for the granting of a licence to install the cameras at the nests and to monitor the breeding colonies. To see the video footage described in this report, please go to: https://ucy.ac.cy/biol/documents/Personal/KirschelA/Eleonoras_cannibalism.zip and download zip file (password: ElefaTHAK).

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