# Nonparental Infanticide in Colonial Eleonora's Falcons (*Falco eleonorae*)

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# LETTER

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## NONPARENTAL INFANTICIDE IN COLONIAL ELEONORA'S FALCONS (*FALCO ELEONORAE*)

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Infanticide denotes the act of an adult killing a conspecific infant, either its own offspring, the offspring of its future mate, or the offspring of any other conspecific individual (Hrdy 1979). During unfavorable conditions non-parents can exploit infants as food or kill them to reduce future competition (Hrdy 1979).

Infanticide is most notably known from carnivores such as lions (*Panthera leo*) and brown bears (*Ursus arctos*), where it is sexually selected (Bertram 1975, Swenson et al. 1997), but it is common also in birds (Moreno 2012). For raptors, recorded cases of infanticide include parents killing their own offspring to feed siblings (Bortolotti et al. 1991, Korňan and Macek 2011, Ortega-Jimenez et al. 2011), and a case of a nesting female Lesser Kestrel (*Falco naumanni*) taking nestlings from conspecifics in a breeding colony (Negro et al. 1992).

Recording behavior at nests of breeding raptors was traditionally accomplished by direct observations (Bildstein and Bird 2007), a time-demanding method for achieving continuous monitoring for extended periods. Video technology has enabled efficient remote *in situ* monitoring of prey deliveries and other behaviors at raptor nests (Dawson and Bortolotti 2000, Steen 2009, Steen et al. 2011, 2012). Such video monitoring has revealed rare cases of raptor behavior, such as parental infanticide (Korňan and Macek 2011, Solaro and Sarasola 2012, Franke et al. 2013). Here we provide camera documentation of a case of nonparental infanticide in colonial Eleonora's Falcons (*Falco eleonorae*) in Greece.

We studied Eleonora's Falcons breeding in a colony on the islet of Anidro in the eastern part of the Aegean Sea, Greece (37°24′N, 26°29′E). Anidro is a small (0.3 km$^2$) uninhabited islet, with scattered vegetation dominated by tree spurge (*Euphorbia dendroides*). The vegetation is heavily grazed by domestic goats, which are seasonally brought to the islet. Eleonora's Falcons feed their nestlings almost exclusively with small birds migrating from Europe to Africa during August and September (Walter 1979, Gangoso et al. 2013). The young stay in the nest for approximately 35–37 d (Vaughan 1961).

We used cameras to study a total of 12 breeding pairs over three breeding seasons: four breeding pairs during 14–20 September 2013, four during 6–16 September 2014, and four during 7–16 September 2015. The main objective of our study was recording food provisioning by Eleonora's Falcons. In 2014 and 2015, when conspecific nest predation was documented, we used Reconyx HyperFire Professional PC900 and PC850 camera traps (Reconyx, Inc., Holmen, WI U.S.A.), customized for close-up recording. In both years cameras were installed about 1 m from each nest when the nestlings were approximately 1 wk old. We used one Reconyx PC900 at each nest in 2014, and one Reconyx PC900 and one PC850 at each nest in 2015. The camera trap captured still images at a rate of two frames per sec during movements at the nest. In total, we monitored with cameras 24 hr/d for about 80 d, an average of about 6.7 d per nest.

The camera traps recorded three cases of conspecific nest predation, at one nest in 2014 and at two nests in 2015. In 2014, the images showed an intruding Eleonora's Falcon adult arriving at one of the nests on 14 September at 0641 H and attacking the three nestlings resting at the nest entrance. The theft of a nestling was not directly seen on the images, but only one of the three nestlings remained at the entrance after the attack. At 0657 H, the intruder returned. This time the two remaining nestlings were resting inside the nest cavity; the intruder went inside, came out at 0658 H with a nestling in its talons, and flew off with it (Fig. 1). At 0702 H, the intruder returned again and entered the cavity, but came out after a few seconds without a nestling. However, it was visible to the camera for only a short time. At 0705 H, the conspecific intruder

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Figure 1. The nonparental Eleonora's Falcon leaves the nest with one of the nestlings in its talon. Image captured by the camera-trap at one of the nests on the islet of Anidro in the eastern part of the Aegean Sea, Greece.

appeared a fourth time, but this time it was attacked by the female parent andthey battled for approximately 40 sec. The intruder was held down by the parental female, but managed to escape. The age of the nestlings during the attack was about 12–14 d (estimated from photos, D. Ristow pers. comm). The one remaining nestling was fed by the parents, at least until the next day, when we removed the camera.

In 2015 we observed conspecific nest predation at two different nests. On 12 September, at the same nest described above, an intruding Eleonora's Falcon arrived at the nest at 0642 H and left the cavity at 0647 H with the sole nestling in its talons and flew off with it. At 0654 H, the intruder returned again, entered the cavity, and flew off at 0657 H. The age of the nestling was about 15–16 d. At 0659 H, the female parent arrived with prey and tried to provide food to the missing nestling. Both the female and the male continued arriving with prey for provisioning until we removed the camera on 15 September.

On 14 September 2015 a neighboring nest, approximately 70 m away, was also predated by an intruding Eleonora's Falcon. It arrived at 0651 H and attacked one of the two nestlings, but the nestling fought back with its talons. After battling for 1 min 20 sec, the nestling escaped and found shelter under the bush covering the nest. Subsequently, the intruder attacked the second nestling; the nestling fought back for about 1 min before succumbing. The intruder gripped the nestling firmly with its talons, then plucked and handled the nestling for about 2 min, at which point it was clearly dead. The images did not show whether the intruder flew off with the dead nestling, but the nestling was not present when we removed the camera the next day. The age of the nestlings was about 18–20 d.

The parental male and female were a dark and a light morph, respectively, at the first nest (both in 2014 and 2015), and light morphs at the second nest 2015, but the intruder in all cases was a dark morph (see Ristow et al. 1998), with eye-rings that were dull gray with a slight touch of yellow. Further, the tarsi, toes, and cere of the intruder were not as orange-yellow as a male's, indicating that the intruder was a female (see Ristow et al. 1998). Due to the repeated visits, we assumed that the intruder

did not rob the nest for self-feeding, but rather to feed its own brood, although we cannot exclude the possibility that the intruder may have stored the nestlings for later self-feeding.

Together with video evidence from Hadjikyriakou and Kirschel (2016), ours is the first camera documentation of infanticide behavior in the Eleonora's Falcon. However, such behavior has been documented indirectly and by direct observations. On Sardinia, Italy, in 1983, Spina (1992 and pers. comm.) twice observed a female Eleonora's Falcon providing a dead conspecific nestling to its own offspring. Also in the mid-1970s, a conspecific nest robbery was observed on Sardinia (D. Ristow pers. comm.). Finally, several cases of nonparental infanticide have been indirectly revealed by the recovery of rings of juveniles that have been ringed at one nest and later found in a neighboring nest: one case in 1971 at Crete in Greece (D. Ristow pers. comm.) and 21 cases on Alegranza in the Canary Islands during July and October in 2007–2011 (Gangoso et al. 2015).

Despite the evidence of nonparental infanticide among colonial Eleonora's Falcons, it remains unknown how frequently this behavior occurs and its adaptive significance. Conspecific infanticide should be rare if its costs exceed its benefits (Glass et al. 1985); hence, this strategy should be selected against if taking nestlings from conspecifics results in a sufficiently increased mortality risk to a bird's own nestlings due to other infanticidal parents, which is more likely if nonparental infanticide is widespread in the population (Glass et al. 1985). We propose that the cost-benefit relationship is likely influenced by colony size, nest density, and food availability during the breeding period. To our knowledge there are no studies on the frequency of nonparental infanticide, but we propose that this behavior might be an important factor influencing the reproductive success of Eleonora's Falcons. According to Gangoso et al. (2015), it becomes one of the most important factors affecting breeding output during periods of low prey availability. This emphasizes the importance of parental guarding to protect nestlings from conspecifics (Glass et al. 1985), and further suggests that the risk of conspecific infanticide is higher in colonial raptors such as the Eleonora's Falcon compared to raptors breeding solitarily (see Negro et al. 1992).

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