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Short note

The Longest Food Deprivation Period of a Griffon Vulture (Gyps fulvus) Recorded in the Wild and Exceptionally Long Nest Attendance

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Abstract. The Eurasian Griffon Vulture (*Gyps fulvus*) is an obligate scavenger that feeds on large carcasses and provides critical ecosystem services. Vultures evolved various ecological and physiological adaptations to cope with the unpredictability of the food resources and withstand long starvation periods. However, there is a lack of empirical data from wild individuals. Here we describe a case of a male Griffon Vulture tagged with GSM/GPS-ACC transmitter, which withstood without food for over 36 consecutive days. It is the longest food deprivation period recorded for the species in the wild. This unusual behavior occurred during the incubation period. The loss of the female and the strong parental instinct forced the male to continue with the incubation of the egg and attend the nest for 31 consecutive days.

Key words: food deprivation, lone breeding, GPS tracking, Accelerometer, remote sensing.

The Eurasian Griffon Vulture (*Gyps fulvus*) is a large Old-World vulture with a wingspan reaching 2.8 m and weight 6-11 kg (Cramp & Simmons, 1980). Its range spreads from Portugal to the Himalayas (BirdLife International, 2021). The species population on the Balkan Peninsula has significantly declined in the mid-XXth century, but in the past three decades it showed recovery in Serbia, Bulgaria and Croatia while in continental Greece and North Macedonia it still experience a decline due to various threats and increased mortality (Dobrev et al., 2021). The Griffon Vulture is an obligatory scavenger that feeds mostly on carcasses of livestock and wild ungulates (Cramp & Simmons, 1980; Margalida et al., 2011; Arkumarev et al., 2021). Vultures forage over large areas by travelling great daily distances with minimal energy expenditure (Spiegel et al., 2013; Duriez et al., 2014). Thus, vultures evolved various adaptations to cope with the food resource unpredictability e.g. high foraging efficiency, gregarious lifestyle, storage of large body reserves and mechanisms to decrease metabolic rates (Prinzinger et al., 2002; Ruxton & Houston, 2004; Spiegel et al., 2013). These ecological and physiological adaptations allow vultures to withstand long

food deprivation periods (Houston, 1976). However, there is a lack of quantitative data from free-living vultures on how long they can sustain with no food. Here we describe the longest food deprivation period of a Griffon Vulture recorded in the wild due to a partner loss and an exceptionally long nest attendance during incubation.

In May 2017 in the Eastern Rhodopes, Bulgaria an adult male Griffon Vulture was captured and tagged with 57 g GSM/GPS and accelerometry transmitter (E-Obs GmbH; Munich, Germany) attached as backpack with 11.2 mm Teflon ribbon. The vulture was still wearing the transmitter after the end of this study. It was also marked with a color wingtag, plastic colour ring and metal ring to ease its identification in the wild. The transmitter harness, rings and wingtag did not exceed 3% of the bird's body mass in accordance to the recommended limits to avoid adverse effects (Bodey et al., 2018). The vulture was aged following Forsman (2003). Blood samples were taken and used to determine the sex of the bird. The transmitter was programmed to acquire a GPS fix and ACC data every 5 min during the day (between 03:00 – 17:00 UTC) with dormancy periods during the night. However, when the battery charge dropped below 50% the transmitter was acquiring a GPS fix every 30 min but the ACC data was kept at 5 min intervals. The ACC sensor was set to measure the acceleration in three perpendicular axes at 7 HZ frequency for 4 s each. All data were automatically downloaded and incorporated into Movebank. We used ACC-based classification of the Griffon Vulture behavioral modes (Nathan et al., 2012). We used the web application AccelaRater (Resheff et al., 2014) and a training set of ground-truthed behaviors (n = 244) collected by direct visual observations of tagged birds at a feeding station and at nests (for details see Arkumarev et al., 2021). For the aim of this study we were interested to determine vulture's feeding, flying and incubating behavior.

The Griffon Vulture was successfully breeding in Thrace, NE Greece (Evros Regional Unit) in 2017, 2018 and 2019. In 2020 the pair occupied the same breeding cliff where it raised chicks in two consecutive breeding seasons. According to transmitter's data, the first brooding behavior was recorded at 12:42 (UTC) on 30th of January. Until 01st of March the tagged vulture was incubating on average for 47h:29min which is similar to previous records for this species (Xirouchakis & Mylonas, 2007) and indicated that the female was alive and relieving the male from incubation (Table 1).

Table 1. Periods and duration of nest attendance during incubation by the male Griffon Vulture derived from the GPS and ACC data.

Nest attendance start time (UTC)	Nest attendance end time (UTC)	Duration (hours)	Duration (days and hours)
30.01.2020 12:42	03.02.2020 15:05	98h:25min	4 days 2h:25min
06.02.2020 12:20	08.02.2020 09:05	44h:45min	1 day 20h:45min
11.02.2020 10:45	13.02.2020 13:40	55h:55min	2 days 2h:55min
15.02.2020 08:45	15.02.2020 13:20	04h:35min	0 days 4h:35min
16.02.2020 07:10	17.02.2020 12:15	29h:05min	1 days 5h:05min
21.02.2020 10:55	23.02.2020 14:15	51h:20min	2 days 3h:20min
27.02.2020 09:35	29.02.2020 14:55	53h:20min	2 days 5h:20min
01.03.2020 13:30	01.04.2020 07:15	737h:45min	30 days 17h:45min
01.04.2020 13:30	03.04.2020 07:30	42h	1 day 18h

When the female was in the nest the male was searching for food and feeding at the supplementary feeding station in Dadia-Lefkimi-Soufli Forest National Park or on carcasses found in the field. On 24th of February it visited the supplementary feeding station for the last time and on 27th of February at 07:00 it attended a feeding event near the village of Ragada (Fig. 1). This was the last recorded feeding behavior based on the ACC data.

The field team visited the area on 26th of March and observed the vulture drinking water on the top of the cliff after rain and then immediately returned back to the nest. The next feeding behavior was recorded on 03rd of April at 11:40 near Plagia Village, hence the food deprivation period lasted for a record 36 days 04h:40min (Fig. 2). We suppose that this unusual behavior was caused by a loss of the breeding partner. The male had to incubate the egg alone, with no possibility of leaving the nest and searching for food. This hypothesis was confirmed by the ACC, GPS data and visual observations. The male stayed in the nest for 30 days 17h:45min. On 01st of April at 07:15 it left the nesting cliff and made a foraging flight, but the attempt was unsuccessful and it returned to the nest at 13:30. Although, it spent another 42h in the nest (lying and standing), it abandoned it at 07:30 on 3rd of April. At 11:40 the ACC data indicated feeding behavior and later the same day the vulture was observed by the field team perching on the breeding cliff with dirty head which was an evidence that it had fed.

Griffon Vulture's incubation period is 54-58 days (Shirihai, 1996; Xirouchakis, 2010). If we assume that the egg was laid at the same day when the male showed brooding behavior for the first time – 30th of January, we could expect that the chick would hatch in the period between 24th and 28th of March. The ACC data indicated that the vulture was moving more often and was spending more time standing in the nest after 26th of March which coincides with the expected hatching period. During a field visit on that day the observers noticed that the vulture is moving more than before in the nest but chick was not seen. Based on these records we can assume that a chick successfully hatched. However, the presence of a chick in the nest could not be verified. During the next field visit, three days later, the vulture was moving more often than the previous days suggesting a presence of a hatchling. Due to the COVID-19 restrictions in Greece, the field team could not conduct observations of the nest on a daily basis. During the subsequent field visit on 3rd of April the nest was already empty and we assumed that the chick had probably died.

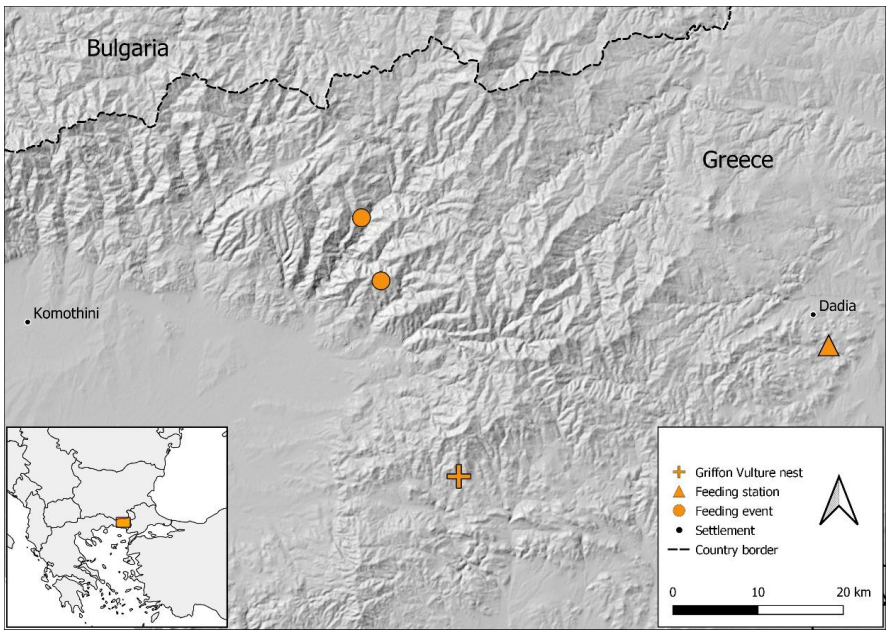

Fig. 1. Map of the study area presenting the locations of the Griffon Vulture nest, the nearest supplementary feeding station and the feeding events recorded in the wild.

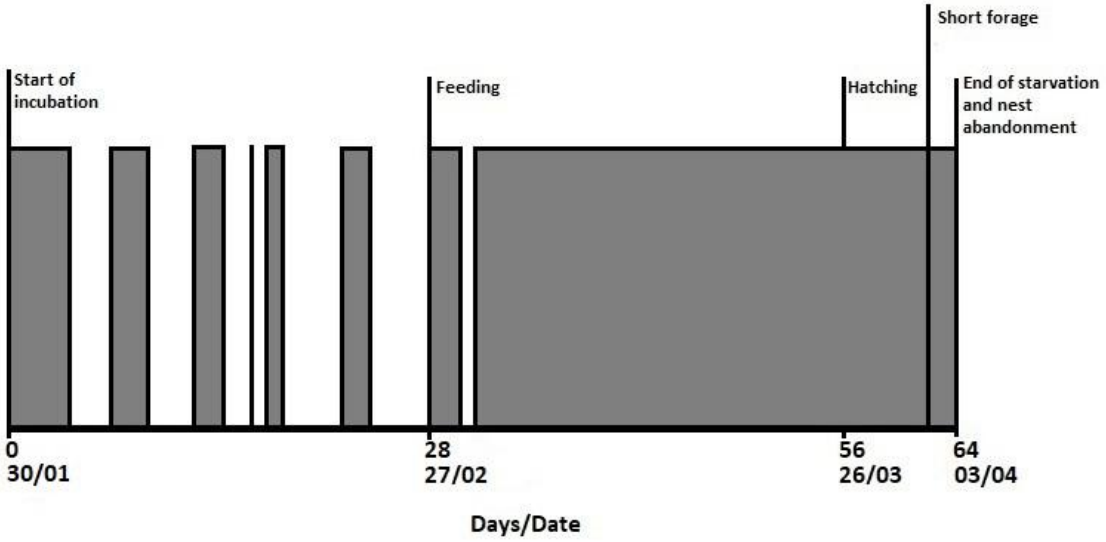

Fig. 2. Nest attendance by a male Eurasian Griffon Vulture incubating an egg without a partner from day 31 onwards and not feeding for 36 consecutive days (from day 28 until day 64) (Grey bars – days when the male is present at the nest, white gaps – days when the male is absent from the nest).

We report a case of long food deprivation experienced by a wild Griffon Vulture due to exceptionally long nest attendance during incubation. Our tracking data indicated that the vulture fully recovered from the long starvation, but did not breed in the next breeding season. As a response to starvation, Griffon Vultures can change their foraging strategies (Spiegel et al., 2013) and significantly decrease metabolic rates to minimize their energy requirements (Bahat et al., 1998). However, in our case the recorded prolonged food deprivation period was not caused by an inability for foraging. Instead, the vulture probably lost its partner and was devoted to lone-incubation. In *Gyps* species, usually both sexes are equally committed to brooding and parental care (Mundy et al., 1992). Thus, it is not clear why the male vulture continued the lone-incubation for one month without being able to forage efficiently but this could be an adaptive behavior in social species breeding in colonies. A non-breeding individual from the colony might replace the lost partner and take shifts in the incubation increasing the chances for a successful breeding attempt. Johnson (2018) describes a solo breeding attempt by a closely related White-backed Vulture (*Gyps africanus*) in South Africa. A female vulture laid an egg and incubated it alone for 30 days. However, the solo breeder has left the egg unattended in 55 occasions, ranging from 5 min to 45 hours. In one occasion, the bird was observed returning from foraging with full crop and blood on the face, which evidenced feeding. In the case we describe the vulture did not leave the breeding cliff for 31 consecutive days and did not show feeding behavior for 36 days in total. In 2017 in Kresna gorge, Bulgaria two female Griffon Vultures, which lost their partners due to poisoning (Peshev et al., 2018), showed similar behavior. The two females continued incubation for 24 and 25 days respectively after their mates were poisoned. One of them hatched a chick, which died two days later probably due to starvation (E. Stoynov pers. comm.). In another case in Spain an adult Griffon Vulture was recorded incubating alone after a partner loss for about 30 days. An inspection of the

nest revealed that the egg has hatched, but the chick most probably died of starvation after 2-3 days. However, in these cases the vultures were not tagged with GPS devices and were not constantly monitored so they might have left their nests unattended and searched for food. During long deprivation periods Giffon Vultures may decrease their night body temperature requirements (Bahat et al., 1998) but there is no data what consequences such drop of the body temperature of the adults may have on the embryos during incubation. We have no direct prove that in our case the male vulture hatched a chick, but the ACC data suggested that. More studies are needed in this field to fully understand the ecological and physiological adaptations, which vultures have developed to withstand such long periods of food deprivation, which are with no doubt unique in the avian community and the adaptive value this behavior may have for the successful reproduction.

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