# DEVELOP AND PILOT A RESTOCKING STRATEGY FOR EGYPTIAN VULTURES ON THE BALKANS

## Integrated report on the release of captive-bred Egyptian Vultures in the Eastern Rhodopes, Bulgaria in 2019

**PHOTO: Yana Nikolova**

UNDER ACTION C3

LIFE PROJECT 'EGYPTIAN VULTURE NEW LIFE'

LIFE16 NAT/BG/000874

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## Introduction

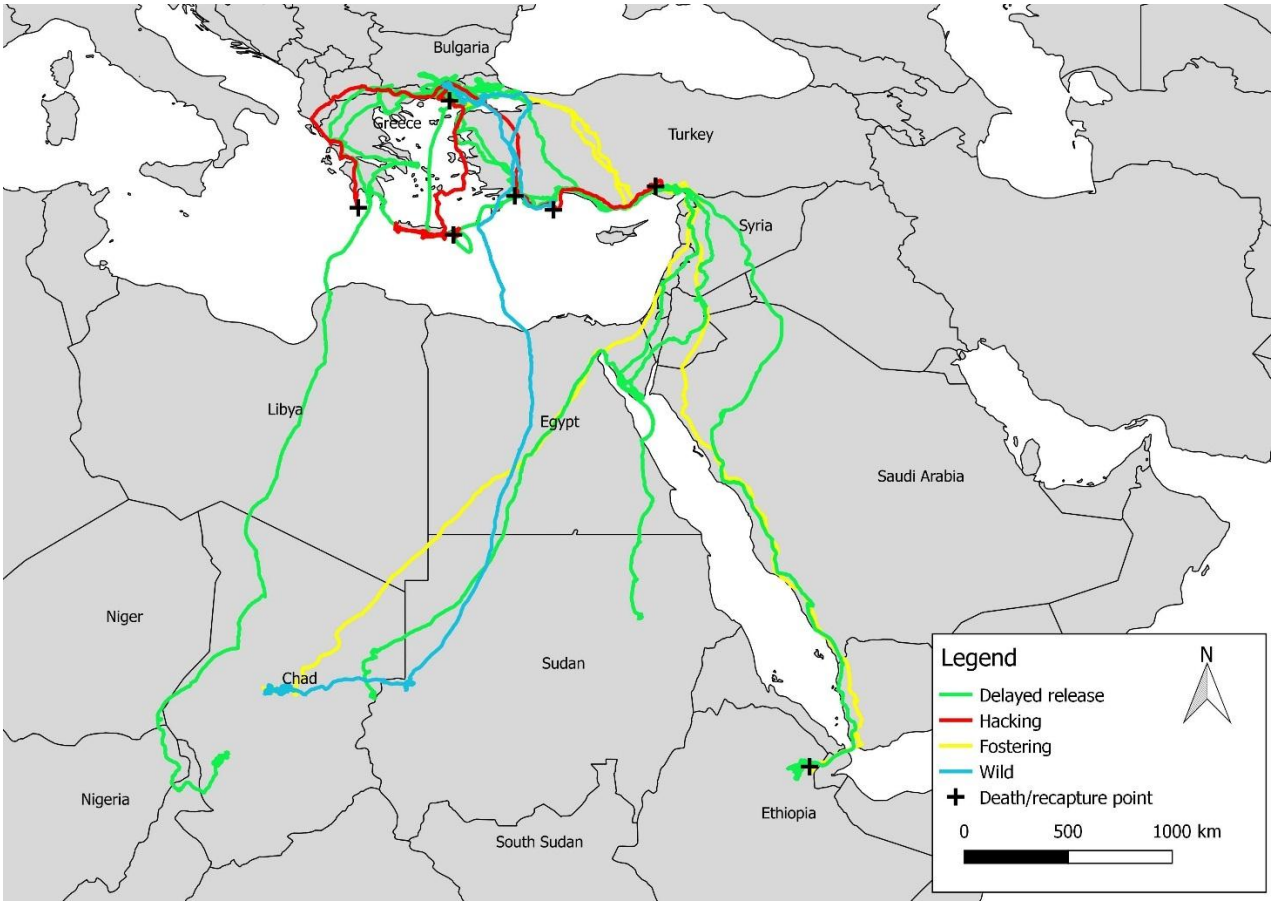
The Egyptian vulture population is declining on a global scale in almost all parts of its' range. The Balkan population of the species has dropped down to about 70 pairs with a calculated decline of about 4-8 % per year over the past three decades (Velevski *et al*. 2015). Along with the long term negative trend, most of the threats to the species, namely the illegal use of poison baits and the high juvenile mortality during the first migration continue to operate which have led to the continuous reduction of the breeding territories accross the Balkans (Oppel *et al.* 2015, Velevski *et al*. 2015). Hence, the reproductive potential of the Balkan population has been significantly reduced leading to an urgent need to reinforce the breeding population. Currently the most feasible approach that could be applied is by the means of captive breeding and reintroduction to ultimately increase the number of survivals and eventually the number of breeding pairs (VCF 2016). The most recent PVA (Population Viability Analysis) of the Egyptian vulture in FYROM suggests that with a sufficient number of restocked birds (with one of the methods mentioned above) and *in situ* conservation measures the negative population trend of the Balkan population could be reversed (Velevski et al. 2014).

The 'Egyptian vulture New LIFE' is a project that unites the efforts of 10 partners accross three continents to reinforce the easternmost population of the Egyptian vulture (*Neophron percnopterus*) in Europe by delivering urgent conservation measures towards eliminating major known threats in the breeding grounds and along the flyway on one hand, and developing a restocking program for the species in the Balkans, on the other. The project objectives are in line with the aims of the most recent strategic document outlining the conservation tactic to save the species: the Flyway Action Plan for the Conservation of the Balkan and Central Asian Populations of the Egyptian Vulture *Neophron percnopterus* (EVFAP), as an integrated key component (Annex 4) of the CMS Vulture Multispecies Action Plan (Botha et al. 2017).

Action C3 of the project LIFE16 NAT/BG/000874 aims to develop and pilot a restocking program for the Egyptian Vulture on the Balkans. More specifically, its primary objective is to test three different methods in Bulgaria (holding the most numerous Egyptian Vulture population in the Balkans) in order to establish the most efficient releasing techniques for the species in the region, more precisely – delayed release, fostering and hacking of captive-bred individuals. We will compare the results in terms of survival during the post-release period and the first south migration. All three release methods will be implemented in the same area which will allow direct comparison of the results and no spatial variance. The results from this action will be used to prioritize the future conservation work, to build and implement a successful restocking program to reinforce and boost the recovery of the Egyptian Vulture population on the Balkans.

## Summary of the results from 2018 and 2019

In 2018 and 2019 14 captive-bred Egyptian Vultures were released in the Eastern Rhodopes, Bulgaria. Seven vultures were released through delayed release method, 5 through hacking and 2 through fostering. Both vultures released by fostering survived during their first autumn migration and reached the wintering grounds, 71% of the delayed released vultures survived the first south migration, while the survival rate of the birds released through hacking was only 20% (Map 1). Based on the criteria for success set for each method and these preliminary results we can classify fostering and delayed release as successful methods for release of captive-bred Egyptian Vultures while hacking can be considered as unsuccessful. However, it should be noted that these are preliminary results and we need larger sample size.




**Map 1.** Migration routes of the Egyptian Vultures released in the Eastern Rhodopes, Bulgaria in 2018 and 2019 through delayed release, hacking and fostering and their wild siblings.



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**Table 1.** Migration parameters of the captive-bred Egyptian Vultures released through delayed release, hacking and fostering and the wild juveniles used as controls in 2018 and 2019 (DR – delayed release, F – fostering, H – hacking, W – wild, A – alive, D – dead, C – captured).

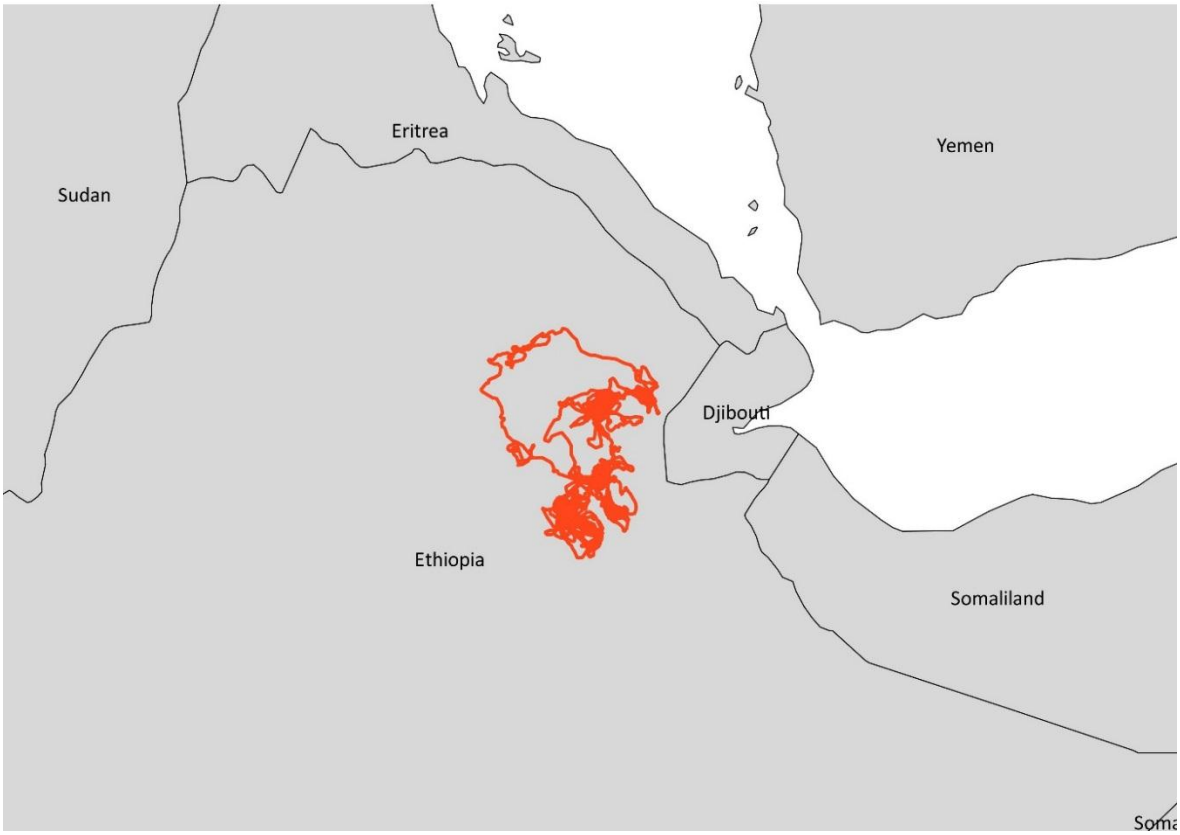
| Individual | Method | Year | Sex | Origin | Status | Migration start date | Average speed (km/day) | Total distance (km) | Migration duration (days) | Distance of sea crossing (km) |
|---|---|---|---|---|---|---|---|---|---|---|
| Polya | DR | 2018 | F | USSR x Kazahstan | A | 19/09/2018 | 94 | 4800 | 51 | 1300 |
| Akaga | DR | 2018 | F | USSR/Kazahstan x Bulgaria | A | 25/08/2018 | 200 | 5600 | 28 | 0 |
| Boyana | DR | 2018 | F | USSR/Kazahstan x Bulgaria | A | 27/09/2018 | 140 | 4600 | 33 | 500 |
| Panteley | DR | 2018 | M | Iberian | A | 18/09/2018 | 25.7 | 1900 | 74 | 114 |
| Belgin | W | 2018 | Unknown | wild | D | 14/09/2018 | 157 | 940 | 6 | NA |
| Blanka | F | 2018 | F | USSR x Kazahstan | D | 02/09/2018 | 167 | 5000 | 30 | 0 |
| Zikmund | H | 2018 | M | Uzbekistan x Bulgaria | C | 10/09/2018 | NA | NA | NA | NA |
| Anna | H | 2018 | F | USSR/Kazahstan x Bulgaria | C | 06/09/2018 | 192 | 1730 | 9 | 0 |
| Sharka | DR | 2019 | F | Balkan x Central Asia | D | NA | NA | NA | NA | NA |
| Andi | DR | 2019 | M | Balkan | A | 10/08/2019 | 134 | 8192 | 61 | 0 |
| Fer | DR | 2019 | M | Iberian | D | 25/10/2019 | 22.3 | 1180 | 53 | 20.6 |
| Hedjet | W | 2019 | Unknown | wild | A | 09/09/2019 | 237 | 5684 | 24 | 659 |
| Oriana | F | 2019 | F | USSR/Kazahstan x Bulgaria | A | 21/09/2019 | 253 | 5322 | 21 | 0 |
| Lenka | H | 2019 | F | USSR x Kazahstan | D | 09/09/2019 | 102 | 1220 | 12 | 250 |
| Romana | H | 2019 | F | Uzbekistan x Balkan | D | 31/08/2019 | 161 | 1451 | 9 | 77.5 |
| Nikola-Spasimira | H | 2019 | F | USSR/Kazahstan x Bulgaria | D | NA | NA | NA | NA | NA |

# Movements of the Egyptian Vultures released in 2018

## Delayed release

### Akaga

She spent the winter in Afar in Ethiopia mostly in Yangudi Rassa National Park and in the area near the towns of Mile and Logya. Akaga did not initiate migration in spring and remained in Ethiopia throughout the year (Map 2).




**Map 2.** Movements of Akaga in the period November 2018 – November 2019.



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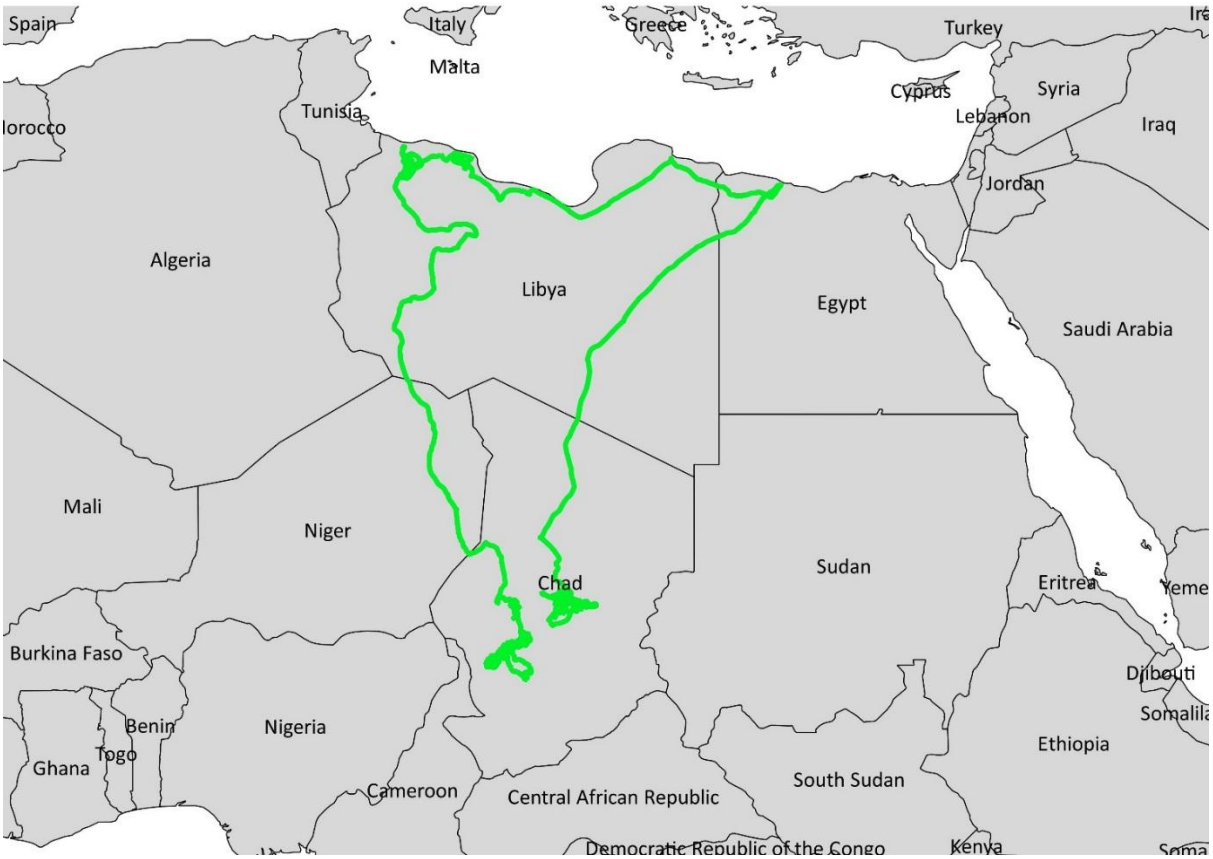
**Boyana**

She spent the winter in Chad – in the area between lake Fitri and 90km east of the capital Ndjamena. On 08th June Boyana started moving north through Sahara and crossing through Niger reached the Mediterranean seacoast in Lybia near Tripoli on 20th June. Then she followed the coast to the east entering into Egypt. Near the town of Marsa Matruh Boyana swirled southwest on 07th July. She went back into Lybia and continued south through Sahara and the Tibesti Mountains. Since 13th July she settled again in central Chad in the area west of Djedid (Map 3).




**Map 3.** Movements of Boyana in the period November 2018 – November 2019.



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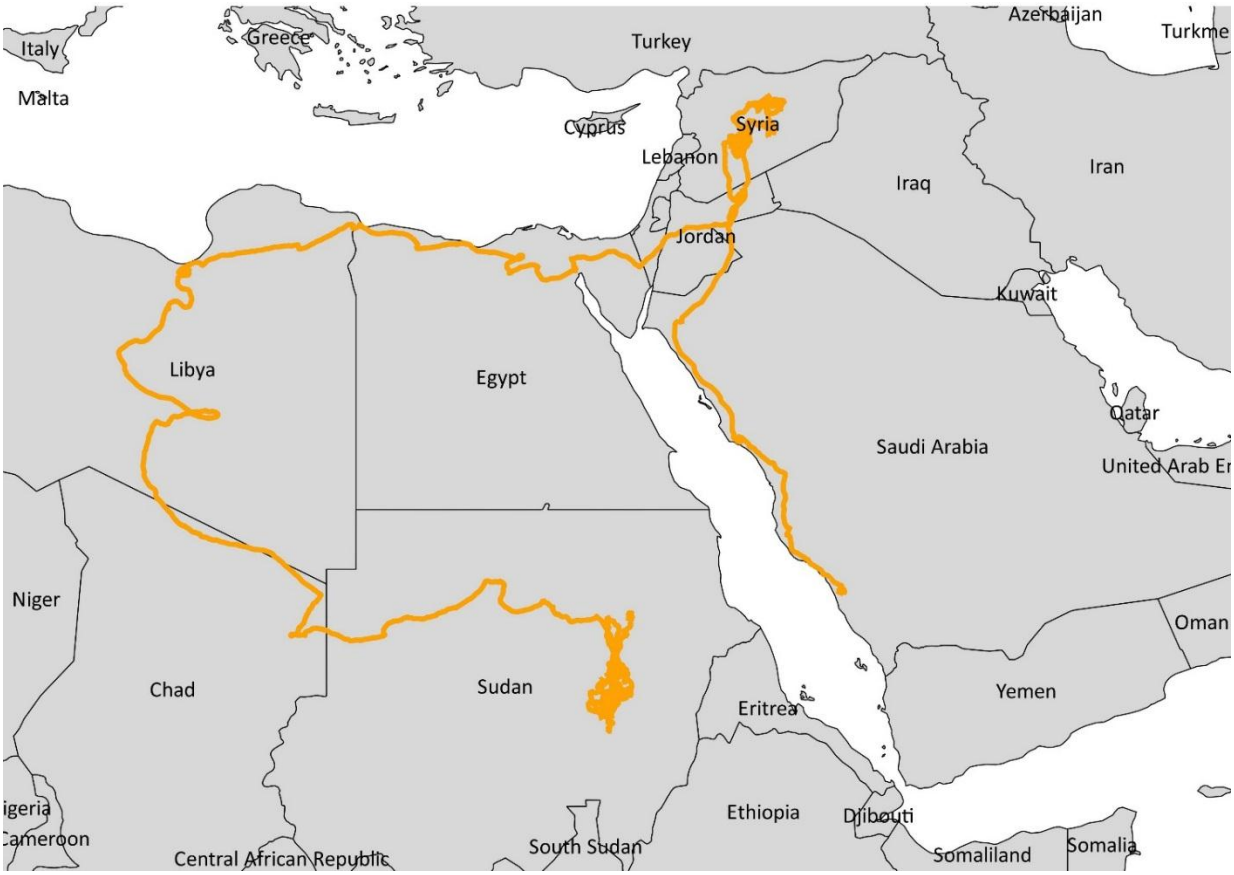
**Polya**

Polya spent the winter in Sudan just 100 km east of Khartoum. On 12th June she started moving west towards Chad. She crossed the northeastern edge of Chad and continued north in Lybia until reaching the coast on 24th June. Polya followed the coastline to the east and on 01st July passed 50 km north of Suez. She then continued through Israel and Jordan until reaching central Syria. Since 04th July she settled in the area between Palmyra and Euphrates river. On 09th October Polya started her south migration. Passing over Jordan she reached Saudi Arabia and followed the eastern Red Sea migration route. On 20th October she reached the area near Al Qunfudhah in the foothills of the Asir mountains about 350 km south of Jeddah. She remained wintering in this area (Map 4).




**Map 4.** Movements of Polya in the period November 2018 – November 2019.



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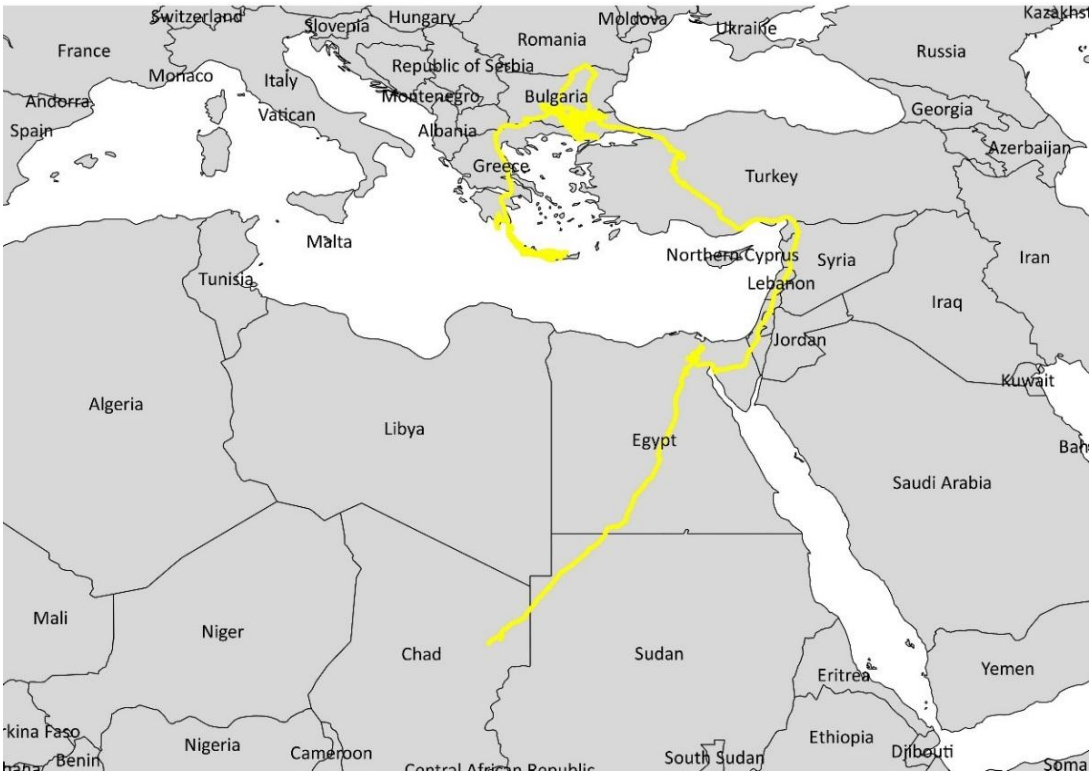
**Panteley**

He spent his first winter in the wild on the island of Crete. On 22th May Panteley moved north and through the islands of Antykithira and Kythira reached mainland Greece. Panteley continued north through Greece, shortly entered into North Macedonia on 26th May but then changed the direction and continued flying east to reach Bulgaria. In the period 27th May – 05th June he settled near Mesta river in the vicinity of the town Gotse Delchev. On the next day he continued east and in the afternoon arrived at release site and landed to feed at the vulture feeding station. On 19th and 20th June he made a two day trip to Danube river and back to the release site. In the next two months Panteley was mainly staying near the release site and the feeding station but was also making regular trips to Greese, Strandzha and Sakar mountain and the lowlands near Maritsa river in Bulgaria. He was also visiting the vulture feeding station in Dadia National Park. Panteley started his south migration on 16th September and this time followed the traditional migration route through the Bosphorus in Turkey towards the Middle East. He passed over the Sarimazi bottleneck on 26th September and continued south through Syria, Lebanon and Israel. On 03th October he crossed the strait of Suez and in the next 5 days stopped for resting and feeding near Nile, just 60 km northeast of Cairo. Then he continued south first following Nile but then crossing through Sahara in southwestern direction. He crossed the northwestern tip of Sudan and on 17th October entered into Chad. Until 24th October he settled in the Ennedi Massif in northeastern Chad (Map 5).




**Map 5.** Movements of Panteley in the period November 2018 – November 2019.



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### Hacking

Two captive-bred Egyptian Vultures were released through hacking in 2018 – Zikmund and Anna. Zikmund was captured in Greece because showed signs of imprinting while Anna dropped exhausted in Turkey during her first migration and was captured as well (for details see Arkumarev *et al.* 2018).

### Fostering

One captive-bred Egyptian Vulture was released through fostering in 2018 – Blanka. She died during wintering in Ethiopia. Her wild sibling Belgin drowned into the sea between Turkey and Cyprus (for details see Arkumarev *et al.* 2018)

## Summary of the results from 2019

### Delayed release

In 2019 three captive-bred Egyptian Vulture were released in the Eastern Rhodopes applying the method of delayed release – Sharka, Andi and Fer. Sharka was killed by a fox during the night only 3 days after the release. Andi and Fer successfully adapted to the local conditions and showed attachment to the feeding station where they were released. They were both successful in finding carcasses in the wild and were interacting with the other Egyptian Vultures in the area. Andi started his autumn migration in August and used the traditional migration route through Turkey and Middle East. He spent almost one month on Sinai Peninsula in Egypt before crossing through Suez to Egypt and continued further south to reach his wintering grounds in Chad (Map 6). Fer stayed near the release site and didn't show migratory behavior until 25$^{th}$ October and then moved south at a low pace reaching the area of Dalaman in south Turkey where he died on 17$^{th}$ December. An investigation of the cause of its death is still underway at the time of compilation of this report.

**Table 2.** Overview of the delayed release individuals

| | Sharka* | Andi | Fer** |
|---|---|---|---|
| Sex | Female | Male | Male |
| Parents origin | Uzbekistan x Balkan population | Balkan population | Spain x Spain |



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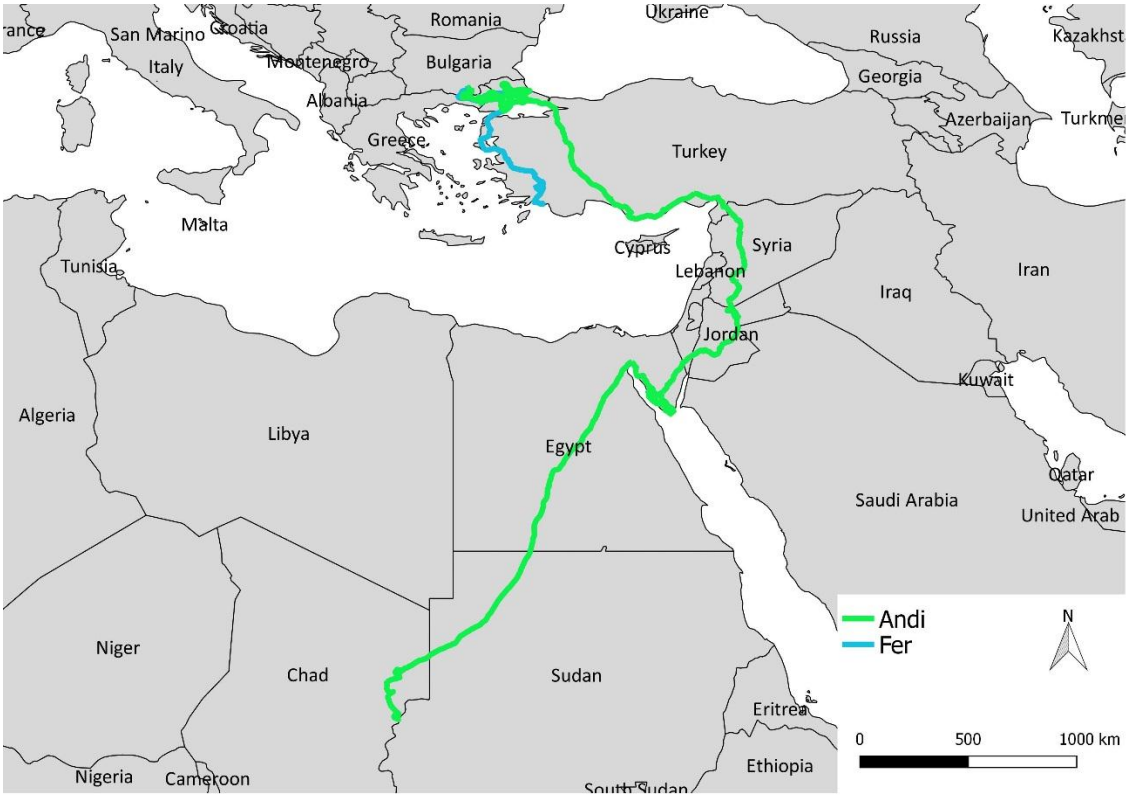
| | | | |
|---|---|---|---|
| Migration start date | NA | 10/08/2019 | 25/10/2019 |
| Average speed | NA | 134 km/day | 22.3 km/day |
| Total distance covered | NA | 8192 km | 1180 |
| Duration of migration | NA | 61 days | 53 |
| Distance of sea crossing | NA | 0 km | 20.6 km |

*Sharka died before the start of the migration.

**Fer died during migration



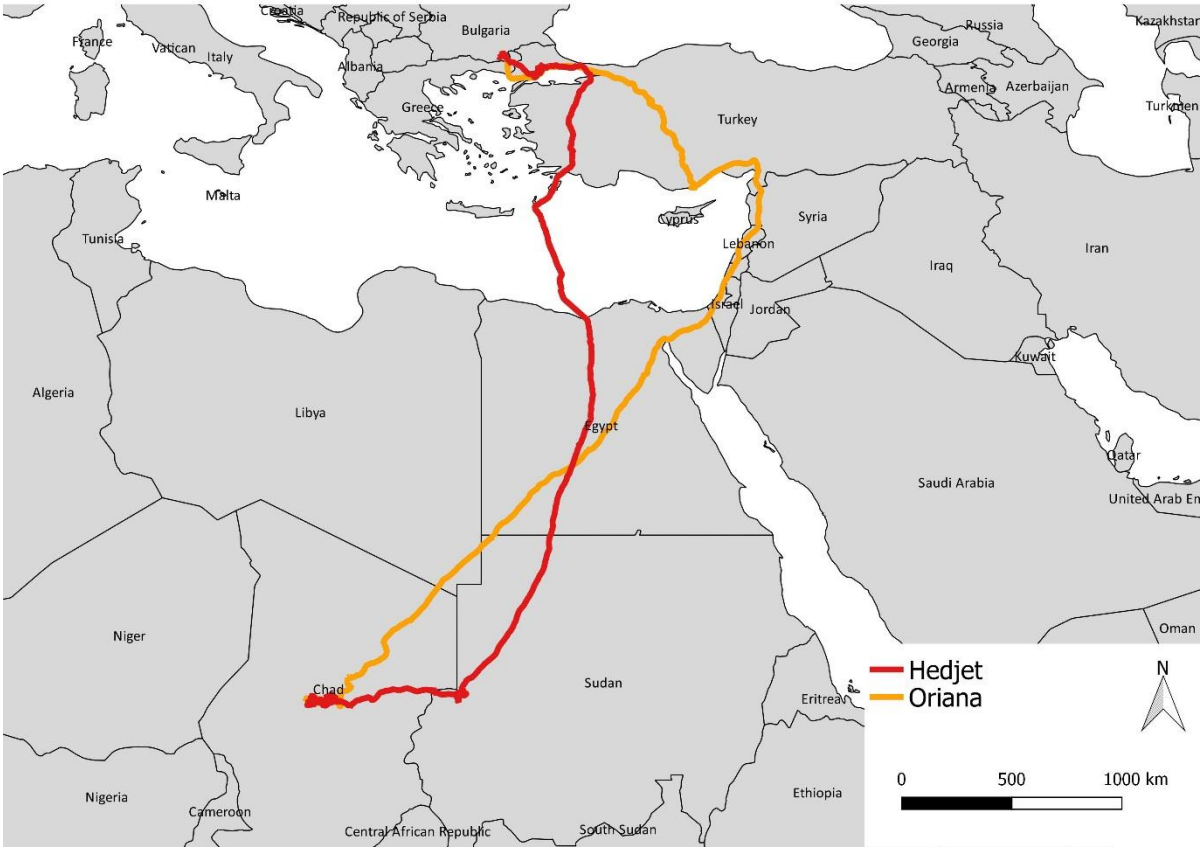

**Map 6.** Migration routes of the two captive-bred Egyptian Vultures released through delayed release

**Fostering**

This year one captive-bred Egyptian Vulture chick (Oriana) was fostered in a wild nest in the Eastern Rhodopes. The chick was inserted in the wild nest at age of 56 days. She was immediately accepted by the parents and the wild sibling named Hedjet. Both chicks successfully fledged. Hedjet fledged first and 10 days later Oriana did as well. Both chicks remained near the nest and were fed by the parents until the start of the autumn migration. Hedjet started his migration first and passed over the Bosphorus. However, he continued southeast through Turkey and when reaching Marmaris crossed to Rhodes island and from there crossed the Mediterranean Sea to reach Egypt. Hedjet continued south and reached his wintering grounds in central Chad. Oriana used the traditional migration route through Turkey and the Middle East, then she crossed through Suez to reach Africa and settled for wintering in central Chad in the same area where Hedjet was wintering (Map 7).

**Table 3.** Overview of the fostered individual and the wild sibling

| | Hedjet | Oriana |
|---|---|---|
| Sex | Unknown | Female |
| Parents origin | Bulgaria | USSR/Kazahstan x Bulgaria |
| Migration start date | 09/09/2019 | 21/09/2019 |
| Average speed | 237 km/day | 253 km/day |
| Total distance covered | 5684 km | 5322 km |
| Duration of migration | 24 days | 21 days |
| Distance of sea crossing | 659 | 0 km |




**Map 7.** Migration routes of the fostered Egyptian vulture and its wild sibling

**Hacking**

In 2019 three captive-bred Egyptian Vultures were released in the Eastern Rhodopes through hacking – Romana, Lenka and Nikola-Spasimira. All three chicks fledged from the hack. However, on the next morning after fledging Romana died due to collision with a powerline. Lenka and Nikola-Spasimira fledged later and both adapted well. They learned to fly and gain height and started feeding on the food provided near the hack. However, none of them visited the feeding station near the hack or was observed to exploit natural food resources. Nikola-Spasimira started its migration first. She moved to the west from the release site and passed through North Macedonia and Albania. When reaching the Adriatic coast, she changed the direction and continued south through Greece. She reached Peloponnese and initiated a sea crossing attempt but after 75 km we lost signal from her GPS and we consider her drowned in the sea. Lenka crossed through the Dardanelles but then followed a route through the Greek islands until reaching Crete. She crossed the island 3 time from east to west and back and made



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few attempts to cross the sea but was always returning to the island. In October Lenka settled in the southeast of Crete where she died on 17th November (Map 8).

**Table 4.** Overview of the captive-bred Egyptian Vultures released through hacking

| | Romana* | Lenka | Nikola-Spasimira** |
|---|---|---|---|
| Sex | Female | Female | Female |
| Parents origin | Uzbekistan x Balkan population | USSR x Kazahstan | USSR/Kazahstan x Bulgaria |
| Migration start date | NA | 09/09/2019 | 31/08/2019 |
| Average speed | NA | 102 km/day | 161 km/day |
| Total distance covered | NA | 1220 km | 1451 km |
| Duration of migration | NA | 12 days | 9 days |
| Distance of sea crossing | NA | 250 km | 77.5 km |

*Romana died after the release

**Nikola-Spasimira drowned into the sea



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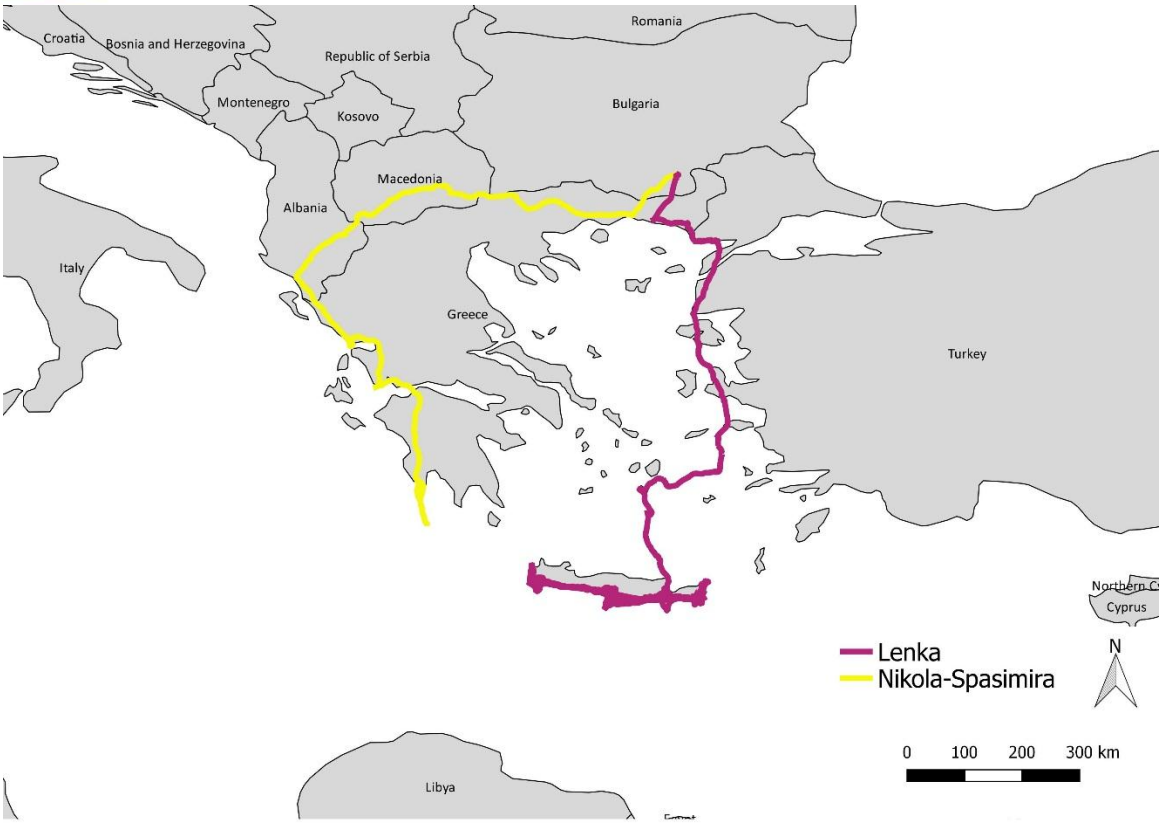


**Map 8**. Migration routes of the captive-bred Egyptian Vultures released through hacking.



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# A. Delayed release

## Hypothesis and criteria for successful experiment

The delayed release technique has been applied for years in Israel where captive-born Egyptian Vultures are released in their 2nd or 3rd calendar year and show high survival rates (Israel NPA unpubl. data; Ohad Hatzofe pers. comm.). In 2017 the method was applied in Italy as a first attempt in Europe. Four captive-bred Egyptian Vultures were released but only one completed the first autumn migration (VCF 2017; Guido Ceccolini pers. comm.).

This method foresees releases of captive-bred Egyptian Vultures in spring when they are in their 2nd or 3rd calendar year. The first year is the most critical period for the wild Egyptian Vultures when they experience the highest mortality rates especially during the first south migration (Oppel et al. 2015). We hypothesize that when the birds are released in the spring of their 2nd or 3rd c.y. they would have enough time before the fall migration to gain experience, improve their physical fitness, socialize with other non-breeding Egyptian Vultures, gain knowledge for important feeding sites, communal roost sites, etc. This might increase their survival probability especially during the first south migration. It is recommended to implement this technique with a group of3-5 birds at a time (VCF 2016). Egyptian vultures are very social especially during the non-breeding stages of their life and the social learning and social bonds between the individuals are of great importance throughout the implementation of this and other release techniques.

<u>The delayed release method will be considered successful if both below listed assumptions are fulfilled:</u>

- At least 80% of the released individuals adapt successfully to the wild and survive the first month after the release.

- At least 50% of the released individuals survive the first south migration.

NB 1: The percentage of the released individuals which migrate over the land, following the main migratory way of the species and avoiding long distance sea crossings between Europe and Africa, will be taken into account when comparing the results and efficiency between the tested release techniques.

NB 2: At this initial stage of the experiment, we would not consider that it failed if released birds become victims of human-induced factors along the flyway or in the wintering grounds. Human induced mortality will be accounted in the final analysis of this study.



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## Origin of the released Egyptian Vultures

All captive-bred Egyptian Vultures were provided from the EEP (Endangered Species Programme, under EAZA). Andi was raised in Schonbrun Zoo by its parents which are of Balkan origin. Fer was raised in Jerez Zoo by parents with Spanish origin. Sharka was provided by Zlin Zoo, originating from a cross between individuals from the Balkans and Central Asian population (Balkan x Uzbekistan. She was raised by foster parents in Prague Zoo.

## Management in captivity

The three birds were kept in the exhibition part of Zlin, Jerez and Schonbrun Zoos in 2018 being exposed to people. They were transported and kept for two months in the storage aviary of Green Balkans Wildlife Rehabilitation and Breeding Centre, together with other immature and subadult conspecifics, without being exposed to human presence.

## Release site

The selection of a suitable release site might be crucial for the overall success of this release technique. As a first release site in Bulgaria was chosen the vulture feeding station near Potochnitsa village in Eastern Rhodopes. The release site was considered suitable as it meets the following conditions:

**Safety of the area.** The release site was located in a vulture safe area where no serios threats for vultures exist. It was located in the core area of the Egyptian Vulture breeding population on the Balkans. The area holds increasing and healthy population of Griffon Vultures and is regularly visited by foraging Cinereous Vultures. In the vicinity of the release site (5km radius) there are no poisoning or poaching events for at least 5 years, there are no windmills and the majority of the powerlines are safe or have been insulated and thus don't pose a risk for the vultures.

**Food availability.** The release site was located near a predictable food source - vulture feeding station. The adaptation aviary faces towards the feeding station which allows the captive-bred Egyptian Vultures to observe the behavior of the other scavengers and their wild conspecifics. Supplementary food was regularly provided at the vulture feeding station during the pre-release period and in the post-release period as well.

**Predator control.** The feeding station was electric fenced in order to avoid the presence and easy access of terrestrial predators (stray dogs, foxes, jackals, wolves, martens etc.).



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**Conspecifics presence.** The release site was in area with regular presence of non-breeding Egyptian Vultures and breeding pairs. The adaptation aviary was located about 1.5km away from an active nest of a wild Egyptian Vulture pair in order to avoid unwanted aggressive interactions with the young birds after the release. However, the feeding station was regularly visited by adult wild Egyptian Vultures and non-breeding individuals. The permanent presence of other non-breeding Egyptian Vultures in the area is important for the socialization of the captive-bred vultures after the release.

**Other species' presence.** The release site was located outside the breeding territories of other territorial raptors in order to avoid aggressive interactions with the captive-bred Egyptian Vultures. Such species are Golden eagle (Aquila chrysaetos), Eagle owl (Bubo bubo), Long-legged Buzzard (Buteo rufinus). In addition, the feeding station was regularly visited by only low numbers of Corvids, e.g. up to 5 Ravens (Corvus corax) and 12 Crows (Corvus cornix). Ravens often congregate in big numbers near vulture feeding stations and compete with the vultures for food and roosting sites showing prominent aggressive behavior. Because only a few Ravens were present at the feeding station they were outcompeted by the Egyptian Vultures and there was no serios risk for the released birds. Griffon and Cinereous vultures were regularly present at the feeding station and in the vicinity of the release site. During the post-release period the captive-bred Egyptian Vultures has the opportunity to interact with the other scavengers at the feeding station and find their place in the intra-guild hierarchy.

**Roosting substrate:** The release site was located in area with high inaccessible cliffs which to be used as a safe roosting sited by the released birds. The availability of dead trees was an advantage as well because very often Egyptian vultures roost on such trees. All pylons and powerlines in the vicinity of the release site were of safe types or were insulated. Egyptian Vultures can use pylons for roosting and the presence of dangerous types of pylons near the release site might be a serios threat for the birds.

## Adaptation aviary

**Location.** The adaptation aviary was located inside the electric fenced feeding station. It was installed about 100 m away from the area where the supplementary food for the wild vultures is placed. This allowed direct visual contact between the birds in the aviary and the feeding place without disturbing the wild vultures. In addition, the aviary was installed under the top of the hill in order to avoid the strongest winds and harsh weather conditions. The area around the aviary was open without bushes or dense forest which might make the vultures feel unsafe.

**Exposition.** The aviary was facing east, south and west. The northern exposition, from where harsher weather conditions usually occur, was covered.

**Size and structure of the aviary.** The dimensions of the aviary constructed for adaptation of 4 Egyptian Vultures were 6m/3m/3m. However, we consider that this is the minimum size and if possible width and the length of the aviary could be higher in order to provide more space for the vultures to fly from one perch to another. This will strengthen their wings and prepare them for their first flight after the release. The main construction was built of metal. Anchors and strong wire ropes were used for stretching the construction and fixing it to solid rock. This made the construction very stable even under harsh weather conditions such as strong winds or heavy rains, heavy snowfalls etc. Wire mesh with 25x25 mm openings was used for covering the aviary. The floor of the aviary remained uncovered to prevent vulture's legs from injuries while walking and feeding. The wire mesh on the sides was extended with additional 20 cm on the ground and covered by solid stones in order to prevent predators from entering in the aviary. One of the short sides of the aviary (the one facing north) was covered by wooden panels instead of wire mesh. This was the side from where the strongest and more frequent winds were expected. This side of the aviary should protect the birds from the harsh weather conditions. All crevices or small holes between the base of the aviary and the solid ground were well covered either by strong wire net or by stones in order to prevent the entry of terrestrial carnivores such as foxes and stone martens. (Fig. 1).

Wooden perches were mounted along the sides of the aviary. The perches were mounted at about 1.8 m height above the ground and about 1.2 m from the top of the aviary. They were about 20 cm wide and were placed about 20 cm away from the net in order to provide enough space between the vultures and the net, thus avoiding any unwanted damages on their flight feathers. Wooden platform was mounted on one of the aviary's corners. The platform was mounted about 10 cm higher than the perches because vultures feel safer when they roost on the highest possible place. This made the platform attractive and regularly used as a roosting site. A waterproof roof covered the platform and was providing shade for the birds. The platform was about 60 cm wide. Vultures were using it for roosting and as shelter during the hottest part of the days or when it rained.

The entrance was placed in the middle of the long side of the aviary. It was wide about 1.5 m and high about 2 m. The highest point of the entrance was higher than the perches. This dimensions and position of the entrance allowed the released birds to leave the aviary by flying out straight from the perches. After inserting the vultures into the aviary, the entrance was be locked with a padlock.



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**Food and water delivery port.** The food and water were delivered through small door at the covered side of the aviary in order to avoid direct visual contact between the keeper and the vultures.

**Video surveillance.** Video camera with wide-angle lens was installed in the corner of the aviary. It allowed to closely monitor the behavior of the vultures during the adaptation period. The camera had good visibility towards the place where the food is delivered in order to closely monitor the food intakes by the different individuals in the aviary.


**Fig. 1.** Adaptation aviary for Egyptian Vultures with size 6/3/3m.

## Adaptation period

**Insertion in the adaptation aviary.** The three captive-bred Egyptian vultures were inserted in the adaptation aviary on 28th March, soon after the arrival of the first breeding pairs which visit the feeding station. For the Balkans this period is between the end of March and the first week of April. This allowed the young birds to observe their wild conspecifics since their first day in



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the adaptation aviary. All birds were ringed with different colored plastic rings to ease the identification during the adaptation period. The ring colors were easily recognizable and visible from the observation point and the webcam installed in the aviary. The color rings were removed before the release.

**Feeding.** Everyday care and observations from a distance were conducted during the adaptation period. The vultures were fed 6 days a week with about 200-300 g per day per individual. However, in cases when whole carcass was provided or the food in the aviary was not completely consumed and is still fresh the frequency of the feedings was decreased until most of the food was consumed. Food and water were provided through a small door from the covered side of the aviary in order to avoid the direct visual contact between the vultures and the keeper. It is important to ensure that vultures won't link the human presence with the food deliveries! Water was kept clean and permanently available. It was provided in a shallow pot which was cleaned and refilled at least once per week. The food provided was as diverse as possible. As the birds have used to some specific type of food (rats, hares, chickens) as a main food source provided during the captivity period, the same food items were used in the first days of the adaptation. After that period the quantity of these food items was gradually decreased and at the same time the quantity of other food items was increased. After the end of the first week start providing mainly new food items and rarely from the specific ones. The Egyptian Vulture is an opportunistic scavenger with very wide diet spectrum which includes carcasses of bigger animals, eggs, invertebrates, slow-moving small animals which are captured alive, faeces etc. (Negro et al. 2002, Hidalgo et al. 2005, Dobrev et al. 2015). Training the captive-bred Egyptian Vultures to recognize different food items might be crucial for their survival and successful adaptation into the wild. Thus, the food provided during the adaptation period was as diverse as possible including whole parts of carcasses (e.g. sheep legs), pieces of red meat or skin and meat from the carcasses, small animals (e.g. lizards, snakes, hares, tortoises, hedgehogs, birds), bones with some meat on them, offal. When providing the food, the different food items were scattered near the food delivery port so that the birds could distinguish the different items and pick according to their interest and preferences. When a new food item was provided for the first time it was prepared to be as attractive as possible. Example: When a hedgehog was provided for a first time, a cut along the whole body was made which made it more attractive for the birds and increased the chances to be consumed. Next time a hedgehog was delivered it was already a known food item and was provided as whole carcass so the vultures would have to tear it apart by themselves. We found that suitable approach for finding and providing diverse food items is collecting road kills from the area



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around the release site. Many small animal species become victims of the traffic every day and especially at night. Some of them were collected and used, e.g. snakes, hedgehogs, small birds, tortoises, lizards etc. Caution: When road kills were collected, predator species (e.g. dogs, martens, cats, foxes, badgers etc.) and mice were avoided as some of them might be poisoned at first place. When bigger carcasses or their parts such as sheep or calf's legs were provided they were opened and cut beforehand. Their skin is too thick and the young Egyptian Vultures might not be able to tear it. The head of hares and smaller animals was opened as well in order to guarantee easy access to the brain which is very nutritious.

**Monitoring.** The behavior and the interactions between the vultures in the aviary were permanently monitored and recorded. Direct observations were made from a distant observation point (about 400m) in order to avoid any disturbance to the wild and captive-bred Egyptian Vultures which might alter their normal behavior. Observations and recordings with a camera mounted in the aviary were made as well. An experienced observer was recording how often and which individuals are feeding, which food items are consumed, any aggressive behavior between the birds or social exclusions.

**Tagging.** All Egyptian Vultures were tagged with GSM/GPS transmitters prior to release. They were tagged on 13th May or 2 days before the release. If the birds are tagged earlier, they might start pecking the transmitters as they are bored in the aviary and doesn't have much other activities. However, the transmitters were mounted a few days before the release because the birds need some time to get used wearing the devices. During the tagging the birds were thoroughly examined by vets and treated against ecto- and endoparasites because this was their last handling prior to release. The transmitters will allow to closely follow the behavior of the birds after the release and their survival which aims to successfully evaluate the success of this release technique. We used 30g solar powered Ornitela GSM/GPS transmitters. The tags were set to provide high frequency of GPS points (GPS locations every 5 min) and high frequency of data deliveries (30min). This allowed the field team to immediately react if the birds experience some problems after the release. The transmitters were mounted as backpacks with Teflon harness. All vultures were ringed with metal rings and had microchips for identification. The color rings used during the adaptation period were removed as in the wintering grounds in central Africa some birds are killed because of the color rings. Color rings are much more visible than the transmitter or the metal ring and might attract unwanted attention in the wintering grounds.



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## Release technique

**Release period.** The adaptation period lasted 48 days. All vultures were released on 15th May. The release took place after the arrival of the first non-breeding Egyptian Vultures in order to allow the inclusion of the captive-bred birds into the social structure of the wild conspecifics near the feeding station. In the Balkans the non-breeding birds start arriving in early May.

**Feedings.** At the day of the release supplementary food was provided at the feeding station. About 300 kg of offal was provided and was scattered on the feeding station. The aim was to ensure that the released vultures will have access to food even if Griffon Vultures monopolize the food and outcompete the other vultures.

**Release.** The vultures were released in the early afternoon on 15th May by opening the main entrance of the adaptation aviary. The field team opened the aviary and left the place as fast as possible with little disturbance to the birds. All further observations were held from a distance of about 400 m in order to avoid disturbance. The vultures should leave the aviary whenever they are ready. The first vulture left the aviary about 30 mins after the entrance was open. Andi left the aviary last about 3 hours after the door was open.

## Post-release monitoring and actions

**Monitoring.** After the release the captive-bred Egyptian Vultures were closely monitored by experienced field team of 2 people. The most critical period was expected to be the first night when the birds might not roost on a high safe place. Andi remained roosting on the feeding station during the first night after the release. Fer was roosting on a high inaccessible for mammalian predators cliff near the release site. Sharka was roosting on a small accessible rocks 1.7 km from the release site where he was exposed to high risk of predation from terrestrial predators. In the middle of the night he moved 450m from this location. Inspection of the field team on the next morning revealed that Sharka was most probably scared by wild boars during the night. The monitoring of the released birds continued 7 days until the released vultures started regularly feeding on the feeding station and roosting on safe, inaccessible for terrestrial mammals, places. After that period the released birds were closely monitored by the GPS transmitters and visual observation about once per week. We worked in close collaboration and exchanged information with other NGOs which maintain vulture feeding station in Bulgaria and in the Greek part of the Eastern Rhodopes in order to ensure that if the released vultures move to neighboring areas they would find safe food in good quantity.



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**Feeding.** Supplementary food was permanently present at the feeding station after the release and until the start of the fall migration. This approach aimed to attach the birds to a safe food source and in area visited by other non-breeding Egyptian Vultures. Whole carcasses and offal were regularly provided. Food items were scattered in order to ensure easy access to food for the released vultures even when the Griffon Vultures are feeding as well. The released individuals never returned to feed inside the adaptation aviary.

## Movements, migration and wintering

### Sharka

**Post-release movements.** Sharka was the first individual to leave the adaptation aviary and immediately moved 1.7km from the release site. He spent the first night roosting on small rocks which were accessible for predators. On the second day Sharka was mainly practicing her flight abilities and was moving in short distances along a high ridge. He settled on a steep rocky slope with good view towards the feeding station. On the third day he was observed flying very well and attacking one adult Egyptian Vulture passing nearby. The two birds did cartwheeling for few seconds and then the adult moved away and Sharka landed on the cliffs. On the night of the third day Sharka was killed by a predator, most likely a fox. He was roosting on rock high about 3m on a very steep rocky slope. The predator attacked her in the middle of the night and dragged his body 40m to the top of the hill where it was found early on the next morning. Teeth marks were visible on the leg of the bird and its neck was broken; however, the carcass was not consumed by the predator (Fig. 2).



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**Fig. 2.** The carcass of Sharka

## Andi

**Post-release movements.** Immediately after the release Andi landed on the feeding station and started feeding. He spent the first night roosting on a rock inside the fenced area of the feeding station. Since then he was regularly feeding there but started roosting on the high inaccessible cliff nearby. On the 01st June Andi made it first exploratory flight moving 12 km south and returning back to the feeding station. In the next days Andi was exploring further and further but always roosting on the same cliff near the release site. On 11th June he made its first long journey visiting a local breeding pair in Greece in the area of the Kompsatos river valley. This area is 60 km on a straight line from the release site. Andi spent there two days before returning back. On 19th June he moved southeast and visited the vulture feeding station in Dadia National Park in Greece. Two days later Andi moved west from Dadia visiting the Kompsatos area and spending one night there before returning to the release site on 22nd June. On the next day he explored the area to the northwest reaching the lowlands near Mineralni Bani, about 47km from the release site. In the next month Andi was making shorter exploratory



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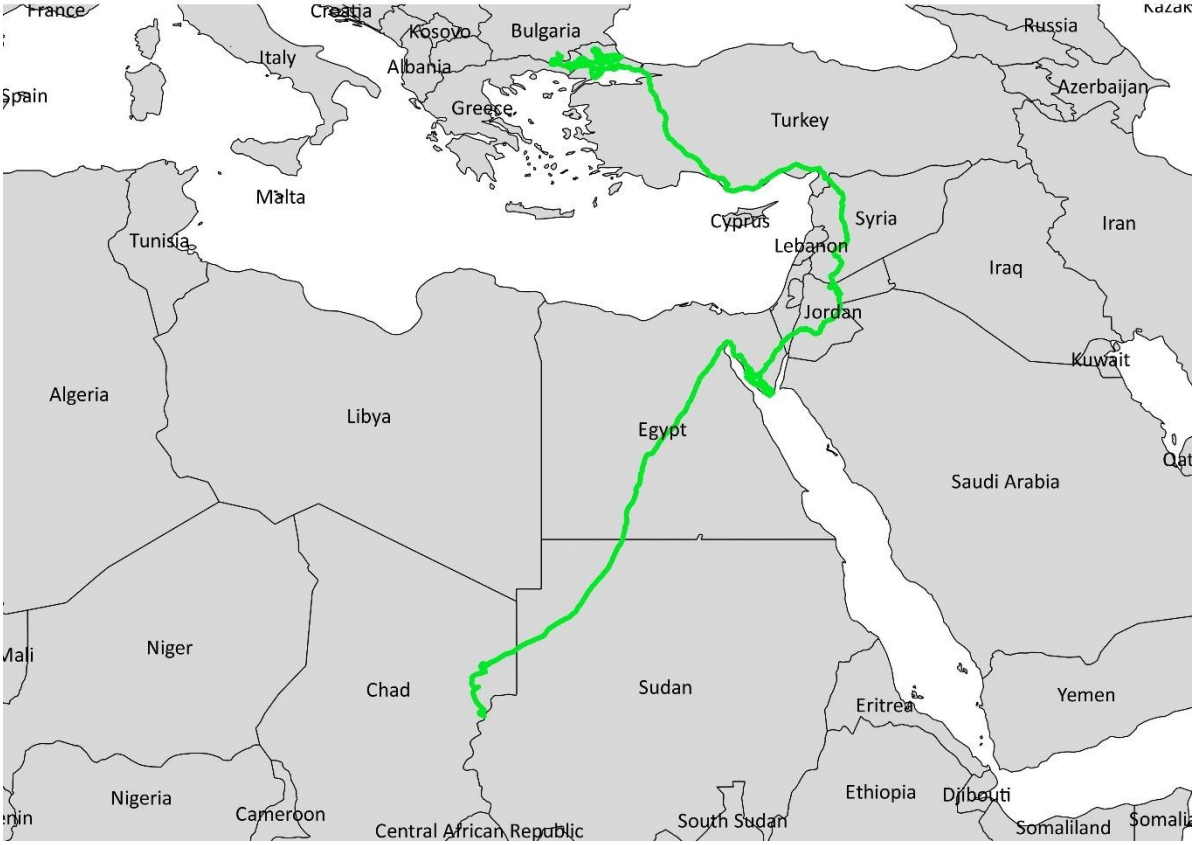
flights in all directions from the release site. On 24th July he made the longest trip so far by reaching the town of Perushtitsa which is 110 km on a straight line to the nortwest from the release site. On 26th July Andi visited the feeding station in Dadia again and two days later returned to the release site. However, after one night he moved to Dadia again and from there started his autumn migration on 10th August. During its stay in the Eastern Rhodopes Andi was recorded feeding on natural carcasses found outside the feeding stations which proved his ability to find food in the wild.

**Migration.** Andi started his south migration on 10th August from Dadia, Greece. He made one previous attempt on 02nd August when he reached the Marmara Sea near Sarkoy and followed the coast but then moved northeast reaching the Black Sea and from there returned straight to Dadia. However, on 10th August he reached the same location at the Maramara sea near Sarkoy and followed the coast to the east. When reaching the suburbs of Istanbul, he returned 140 km back north to Kirklareli where he spent 4 days. On 18th August Andi moved back south again and on 19th morning he crossed the Bosphorus but was flying over the sea parallel to Istanbul and not passing over the city itself. From there Andin continued south through Eskisehir and Isparta regions until he reached the sea about 100 km east of Antalya. He followed the coast and on 24th August passed over the bottleneck near Sarimazi. Andi continued south through Syria and on 28th August reached Jordan. He spent 5 days in the area about 100 km east of Amman and then continued southwest reaching Sinai Peninsula on 04th September. Andi settled in the mountains north of Sharm el-Sheikh and was regularly visiting the area of few sewage ponds where probably was feeding. He spent almost one month on Sinai and on 02th October crossed through Suez to enter into Africa. He then continued southwest through Sahara crossing Egypt and Sudan to reach his wintering grounds in Chad on 09th October (Map 9). During his first south migration Andi flew over 8192 km for 61 days with average speed ca. 134 km/day. He had one main stopover site – Sinai where he spent almost one month.




**Map 9.** Migration route of Andi

**Wintering.** Andi settled for wintering in Chad in the area of Ennedi Massif. After two weeks on 25th October he moved further south and reached the border area with Sudan east of Iriba. On 30th October Andi crossed the border of Sudan and moved south finally reaching South Darfur just 50 km north off the border with South Sudan (Map 10). He settled there over the next month but due to limited GSM coverage data transfers from this are were rare.



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**Map 10.** Movements of Andi in the wintering grounds for the period 10th October – 21st November)

## Fer

**Post-release movements.** After the release Fer settled on the high cliffs nearby. He was flying mainly around the cliffs and roosting on high inaccessible places. On the 20th May Fer landed for the first time on the feeding station and started feeding. Since then he was regularly visiting the feeding station. On 30th May he made the first longer trip to visit the feeding station at the hunting reserve "Studen kladenets" located 10km from the release site. During June and July Fer was mainly moving within 15 km around the release site and regularly visiting the feeding stations. He was also recorded to feed on carcasses found in the wild. On 26th July he moved southeast and visited the vulture feeding station in Dadia National Park in Greece. He returned to the release site the same evening. In the next two weeks Fer was making almost daily travels to Dadia or northern Greece. From 14th to 19th Fer settled in the area near the Greek village Chamilo. During the same period Panteley, released by the same method in 2018 was present in the same area and the two vultures were roosting together on trees. On the 19th he made

trip to the Western Rhodopes and the same evening returned back to the release site. On 26th August he made another long trip this time in northwestern direction reaching almost Plovdiv (near 100 km on straight line from the release site). In the next week Fer made few trips to north and south and on 03rd September he reached Alexandroupolis but returned back to the release site. Fer remained at the release site feeding regularly at the feeding station until 25th October.

**Migration.** Fer started moving south on 25th October. In the first day he reached Dadia NP in Greece where he spent one day. On 27th October he continued first north and then south reaching the coast of Marmara Sea near Tekirdag and then following the coast towards the Dardanelles. At noon on 29th October he crossed the Dardanelles near Canakkale and continued south. Three days later he flew over the island of Lesbos and then returned back to mainland Turkey. Fer slowly was moving south and spent 12 days just south of the town Nazilli. On 05th December he reached the Mediterranean coast east of Marmaris and on the same day flew 20 km over the sea crossing short the gulf to the east. On 06th December Fer settled on trees near agricultural fields just 2.5 km from Dalaman International Airport. In the next 9 days Fer remained mostly stationary making just short flights over the airport to some hill east of it. On 15th December he moved 7 km to the west and landed in a forest on a steep slope neat the village Sarigerme (Map 11). Two days later on 17th December the ACC data showed that Fer is dead at the same spot. Predators moved the body two days later. Its carcass was found by team of Doga Dernegi/BirdLife Turkey on 21st December (Fig. 3). It was transported to vet office for necropsy and samples were taken for toxicological analyses. No dangerous powerlines were found near the location where Fer died indicating that the death was not caused neither by collision nor electrocution.



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**Map 11.** Migration route of Fer

**Fig.3.** The carcass of Fer found in Turkey



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## B. Fostering

### Assumptions, hypotheses and criteria for successful experiment

The fostering is a well-known method to restock wild populations, but it has not been applied on a large scale in wild Egyptian vultures. Two experiments have been done in Italy and even though they were successful (Ceccolini & Cenerini 2005, Di Vittorio et al. 2006), still it seems that the empirical experience with this method in situ is not sufficient. For the aim of restocking, the fostering represents a technique where captive bred birds (in Zoos or a Wildlife breeding centers) or wild chicks which have been rescued and then rehabilitated, are introduced in a wild foster nest of the species. Once they have been accepted and raised by the foster parents they leave the nest as wild birds. For the captive bred individuals, the fostering provides the chance to develop the instincts and imprint the behavior of the wild foster parents.

All the releases will be done in Eastern Rhodopes, where the stronghold of the Balkan population of the species is (Velevski et al. 2015) and where the use of poison baits and poisoning are considered not a common and wide spread practice (Skartsi *et al.* 2014), and to be able to compare the results with the other releasing methods under the same experiment. Another point to consider is that the more eastern the origin of the juveniles from the Balkans is, the greater is the chance that they follow the safer way over land to the wintering grounds and not crossing the sea, where mortality is very high (Oppel et al. 2015). We assume this should be valid at some extent also for the restocked chicks because the more to the east they are released, the higher is the probability to find migrating conspecifics or other migrating soaring birds.

**The fostering method will be considered successful if all below listed assumptions are fulfilled:**

- At least 80% of the cases: the fostered chicks are accepted by the wild foster parents; no aggression is shown between the two chicks and between the parents and chicks; adults take care of the two chicks and they both grow and develop proportionally and normally (none of the chicks is sluggish, lifeless, languid and not feeding) and the two chicks fledge successfully.
- At least 80% of the fostered individuals adapt successfully to the wild and survive the first month after fledgling (i.e. after leaving the nest).
- At least 30% of the fostered individuals survive the first south migration.



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NB 1: The percentage of the released individuals which migrate over the land, following the main migratory way of the species and avoiding long distance sea crossings between Europe and Africa, will be taken into account when comparing the results and efficiency between the tested release techniques.

NB 2: At this initial stage of the experiment, we would not consider that it failed if released birds become victims of human-induced factors along the flyway or in the wintering grounds. Human induced mortality will be accounted in the final analysis of this study.

## Selection of the foster pairs

Not all pairs were suitable for fostering, that's why we chosed pairs who fulfiled the following criteria:

- The pairs should have been subject of long-term monitoring (at least for the last five years);
- The age of the chick of the foster pair should be very similar to the fostered chick (the difference in the age between the two chicks should not exceed 4-8 days, which is usually the natural difference in the age of the siblings in the wild);
- To be an experienced pair (the ratio of successful breeding is at least 80%; the ratio of successful breeding is calculated by dividing the number of years when the pair has raised successfully chicks by the number of years the pair has been monitored);
- To be located close to a secure source of food (i.e. vulture restaurant): up to 5 km;
- To be located in a territory with high occupation rate (Arkumarev et al. 2018);
- To be a traditionally successful pair (that have successfully raised and fledged chicks at least three times in the last five years);
- To have no antagonistic behaviour towards its brood;
- To be a pair that has raised only one chick in the given breeding season because when the number of pairs is limited (the experiment is implemented in a small population) we aim to keep adults safe and increase the breeding success in the same time. In this line introducing an extra chick (third one) to pairs already raising two chicks could



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potentially increase the risk of extra energy loss in the adults prior to migration. Additionally, this can decrease the amount and frequency of food delivered to all three chicks resulting in poorer fitness before their first migration. Last but not least, it is very often that in Bulgaria Egyptian vulture pairs breed in small caves or ledges where the coexistence of three chicks will not be comfortable in temrs of space needed;

- To be a pair that breeds in easily accessible ledges or caves (mostly in small cliffs not exceeding 15-20 meters in height);
- To be a pair easy to observe from a close distance without being disturbed (e.g. pairs that breed in large caves or wide ledges open towards the observation point);
- It is necessary to choose always at least two potential foster pairs for each captive bred chick in case something goes wrong with one of the pairs right before the fostering technique is carried out. For instance, if one of the selected foster pairs unexpectedly loses their chick for more than 2-3 days before the captive-bred one is foreseen to be introduced, then the fostering should be implemented with the other foster pair;
- The nest was easily accessible by the project team in a short time, e.g. 1 hour (a very important particular which allowed the field team to reach the nest as fast as possible in the case of emergency);

## Pre-intervention monitoring

Once the potential foster pairs were selected and all permits were granted, we carried out an intense monitoring to ensure that:

1. The pairs fulfil all selection criteria also in the given breeding season;
2. To set the timing between the dates of hatching of the chicks in captivity and in the wild population.

*NB: If the fostering is done with early age chicks, it is very important to check the targeted potential foster pairs a couple of days before the intervention to ensure that there is no second chick. This could be done by a drone if the traditional monitoring methods (e.g. observation by a telescope) cannot provide this information. However, the inspections of the nest with invasive methods which will disturb the parents should be as quick as possible and during appropriate part of the day – not during hottest parts of the day or in cold and rainy weather. The absence of the adults during such conditions might be detrimental for the wild chicks.*

## Origin of the released Egyptian Vultures

The fostered chick named Oriana originated from a captive pair formed by one individual with Bulgarian origin and the other with origin from the USSR/Kazahstan.

## Management in captivity

The captive-bred Egyptian Vulture was hatched and raised by a captive pair in the Wildlife Rehabilitation and Breeding Center of Green Balkans in Bulgaria, in the frame of the EEP (Endangered Species Programme, under EAZA) for the Egyptian Vulture.

## Introducing the captive-bred chicks into the wild foster nests

The captive-bred chick was introduced in the wild nest on 02nd August at age 56 days. The wild chick was about 5-7 days older. Both chicks were tagged with metal rings and 30 g GSM/GPS Ornitela tags. The captive-bred chick was also marked with a microchip.

Some extra food (rabbits and rats) was provided directly into the nest for both chicks. Few hours after the insertion of the captive-bred chick both individuals were behaving normally. On the next day everything in the foster nest looked fine and juveniles behaved just if they were raised together – laying into the nest, feeding and pecking feathers each other. The parents were providing food and both chicks were eagerly feeding.

## Post-fostering monitoring and actions

**Monitoring**

After the chick was inserted in the wild nest intensive monitoring was carried out in order to follow the development of both chicks in the nest. A field assistant observed the captive-bred chick and the wild sibling in the nest until their fledging. The observation was made from the observation point which is close enough to the nest, so the observer was able to tell if both chicks were fed by the parents, if some agression exists between the juveniles. The close up observations would have allowed also to intervene in a case of emergency.

**Feeding**

Even though both chicks were regularly fed by the foster parents prior to their fledgling and afterwards (up to 4-5 times per day in some cases) extra food was delivered not only because of nutrition but also to stimulate the juveniles to find food by themselves. We provided extra food couple of times very close to the nest and the cliffs around to attract the juveniles. The quantity of the food was always about 1.5-2 kg in small pieces which were placed on cliff edges by the field assistants. Couple of times Hedjet and Oriana were interested but they were not observed feeding. Both parents are very experienced adults and took excellent care of Hedjet and Oriana

even after fledging. We suggest that placing the extra food for them around is a good instrument to provoke them explore even if they don't take advantage of the food.

## Post-fledging behaviour

The wild chick named Hedjet fledged on 11th August. Oriana, the captive-bred chick fledged on 21th August at age 75 days. Both chicks remained in the area of the nest and were regularly returning back to the nest. Parents were regularly feeding both chicks either in the nest or on the cliffs around. Hedjet was making longer travels from the nest than Oriana. On 19th August he moved 5 km from the nest and later returned back. In the next few days Hedjet made few other trips in a radius of 4 km around the nest. On 01st September he moved 24 km to the southwest but on the same day returned back to the nest. On 09th September Hedjet started his south migration. Oriana was moving only within 500m radius around the nest. She started her south migration on 21st September.

## Migration and wintering

### Oriana

**Migration.** Oriana started the south migration on 21st September (aged 106 days). On the first day she reached the seacoast east of Alexadroupolis and continued along the coast in eastern direction. Two days later she crossed the Bosphorus and continued south through the Central Anatolian Plateau. On 27th September she reached the Turkish coast near the village Yesilovacik and followed the coast to the east. On 29th September Oriana passed over Iskenderun. She flew over Syria, Lebanon and Israel for only 3 days. On 02nd October she passed over Suez and continued to southwest through the Sahara desert. On 11th October Oriana reached her wintering grounds in central Chad (Map 12). During her first south migration Oriana flew over 5300 km for 21 days with average speed ca. 253 km/day.



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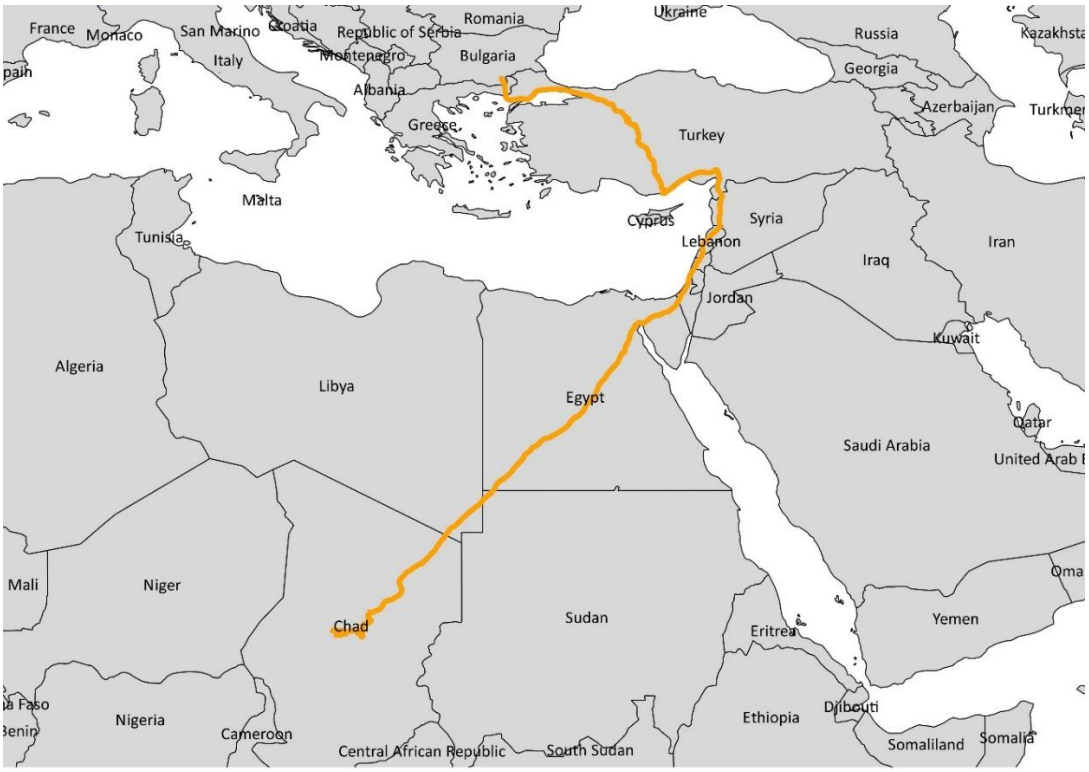


**Map 12.** Migration route of Oriana

**Wintering:** Oriana settled for wintering in the same area in central Chad where her wild sibling is wintering. The two vultures were foraging in the same areas and even using same trees for roosting but on different days. On 31st October she moved south towards lake Fitri but then turned north again and on 06th November settled in the southwest corner of Bahr el Gazel region. On 28th November she left this area behind and moved southwest to reach the lake Chad basin where she settled during December (Map 13).



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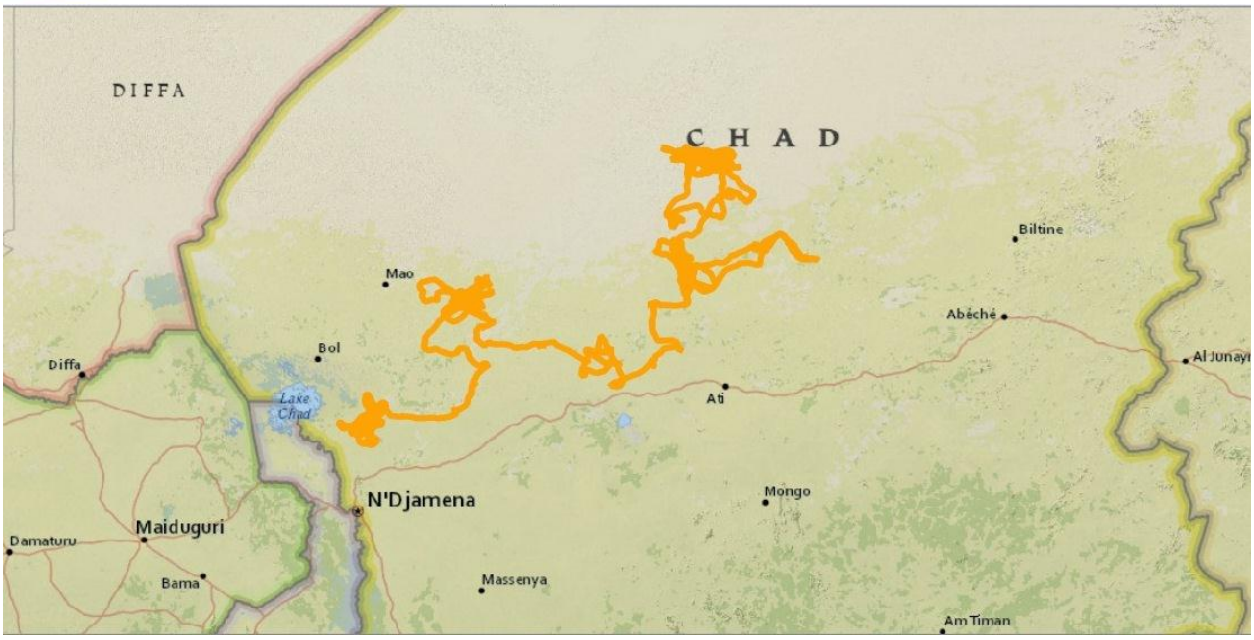
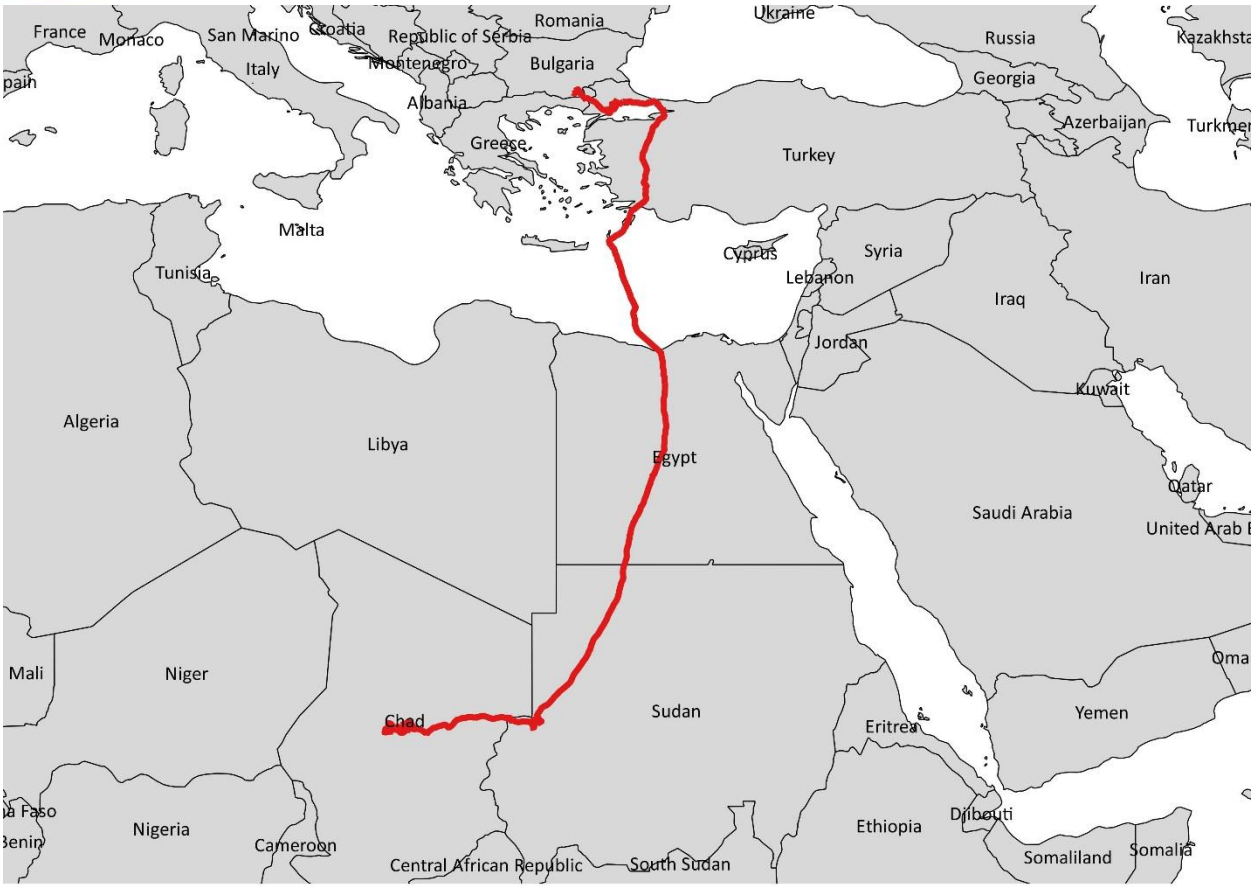



**Map 13.** Movements of Oriana for the period October – December 2019 in the wintering grounds in Chad.

## Hedjet

**Migration.** Hedjet started his south migration on 09th September. The same day he reached near the coast close to the town of Tekirdag, then she swirled west along the coast reaching Sarkoy. On the next day Hedjet moved east again. On 12th September he reached the area of Tekirdag again and this time moved east towards the Bosphorus. He was roosting on a hill in Istanbul and on the next day crossed the Bosphorus. Then he continued southwest until reaching Marmaris. On 15th September Hedjet crossed to the island of Rhodos. At 13:14 he left the land behind and initiated crossing of the Mediterranean Sea. Hedjet crossed 569 km over the water for 09h30min and reached the shore in Egypt. His flight was supported by strong tailwinds (60km/h). Due to these suitable weather conditions he was flying with over 100 km/h at times and his average speed was about 67 km/h. Hedjet made the longest and at the same time the fastest crossing of the Mediterranean ever recorded. On the next day he continued south through the Sahara Desert and on 02nd October he reached his wintering grounds in central Chad (Map 14). During his first south migration Hedjet flew over 5680 km for 24 days with average speed ca. 237 km/day.




**Map 14.** Migration route of Hedjet

**Wintering:** Hedjet settled for wintering in central Chad in the same area where Oriana is wintering in the bordering area of Batha, Bahr el Gazel and Borkou regions. On 23th October he moved south and after 10 days reached the lake Fitri basing where he spent only two days before moving again north towards Djedaa. On 13th November Hedjet left this area and initiated a long travel south towards Sudan. He crossed the border just three days later and on 20th October entered into South Sudan. In the next ten days he settled in a small area in the north parts of Western Bahr el Ghazal region. On 01st December he moved again to the east and trough Warrap region entered into Abyei where he stayed until 11th December. Then Hedjet moved north and settled at the border area of South Kordofan and South Darfur (Map 15).



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**Map 15.** Movements of Hedjet for the period October – December 2019 in the wintering grounds.

## C. Hacking

### Assumptions, hypotheses and criteria for successful experiment

Hacking has been successfully applied for releases of captive-bred Egyptian Vultures in Italy (Ceccolini & Cenerini 2005) and Israel (Ohad Hatzofe pers. comm.). This method foresees releases of captive-bred Egyptian Vultures at age of fledging from hack, which is specially designed and installed on natural breeding substrate. The hack can be a big cage mounted on cliffs or natural cliff niche which is netted preventing early fledging of the vultures. The juveniles spend a few weeks in the hack adapting to the local conditions. When they reach the age of fledging the entrance of the hack is opened so that vultures can fledge naturally.

**The hacking method will be considered successful if all below listed assumptions are fulfilled:**

- At least 80% of the released individuals adapt successfully to the wild and survive the first month after fledgling (i.e. after leaving the nest).

- At least 30% of the released individuals survive the first south migration.

NB 1: The percentage of the released individuals which migrate over the land, following the main migratory way of the species and avoiding long distance sea crossings between Europe and Africa, will be taken into account when comparing the results and efficiency between the tested release techniques.
NB 2: At this initial stage of the experiment, we would not consider that it failed if released birds become victims of human-induced factors along the flyway or in the wintering grounds. Human induced mortality will be accounted in the final analysis of this study.

## Origin of the released Egyptian Vultures

All captive-bred Eyptian Vultures were provided from the EEP (Endangered Species Programme, under EAZA). Romana was born in Zlin Zoo by parents with Balkan and Uzbekistan origin. Lenka was raised in Prague Zoo by parents from USSR x Kazahstan. Nikola-Spasimira is the elder sister of Oriana. She was born in the Wildlife Rehabilitation and Breeding Center of Green Balkans by pairs with Bulgarian origin and USSR/Kazahstan origin.

## Management in captivity

Romana was born in Zlin Zoo but was raised by a foster pair in Prague Zoo. Lenka was born and raised by her parents in Prague Zoo. Nikola-Spasimira was raised by its parents in the Wildlife Rehabilitation and Breeding Center of Green Balkans.

## Release site

The selection of a suitable release site might be crucial for the overall success of this release technique. As a release site was chosen a cliff niche historically used as a nest by an Egyptian Vulture pair. The hack was located near the town of Madzharovo approximately 800m from a vulture feeding station. The release site was considered suitable as it meets the following conditions:

**Safety of the area.** The hack was located near the border of a protected area in a vulture safe area where no serios threats for vultures exist. It was located in the core area of the Egyptian Vulture breeding population on the Balkans. The area holds increasing and healthy population of Griffon Vultures. In the vicinity of the release site (5km radius) there are no poisoning or poaching events for at least 5 years, there are no windmills and the majority of the powerlines are safe or have been insulated and thus don't pose a risk of electrocution for the vultures.

**Food availability.** The release site was located near a vulture feeding station. Supplementary food was regularly provided at the vulture feeding station since the vultures were inserted in the hack. The provision of food continued until the start of the fall migration.

**Conspecifics presence.** The release site was in area with regular presence of two Egyptian Vulture pairs. The hack was located about 1.2km away from an active nest of a wild Egyptian Vulture pair. This pair was not breeding this year.

**Other species' presence.** The release site was located outside the breeding territories of other territorial raptors in order to avoid aggressive interactions with the captive-bred Egyptian Vultures. Such species are Golden eagle (Aquila chrysaetos), Eagle owl (Bubo bubo), Long-legged Buzzard (Buteo rufinus). There was one pair of Ravens breeding 1.5km from the hack. In addition, the feeding station was regularly visited by only low numbers of Corvids, e.g. up to 3 Ravens (Corvus corax) and 3-4 Crows (Corvus cornix).

**Roosting substrate:** The hack was built on a cliff which is part of a big cliff complex with high inaccessible cliffs which to be used as a safe roosting sites by the released birds. All pylons and powerlines in the vicinity of the release site were of safe types or were insulated. EgyptianVultures can use pylons for roosting and the presence of dangerous types of pylons near the hacking site might be a serios threat for the birds.

## Hack specifications

**Location.** The hack was built in a natural cliff niche which has been used by an Egyptian Vulture pair for over 20 years but was abandoned 5 years ago. The cliff is situated near the border of protected area on the south shore of Arda river. The distance between the feeding station and the hack is about 800 m.

**Exposition.** The hack is facing southwest and receives direct sunlight from the afternoon until the evening.

**Size and structure of the hack.** The niche is long about 4 m, deep about 1.3 m and 1 m high. The front of the niche is covered with wire mesh with 25x25 mm openings (Fig. 4). The wire mesh is extended to cover part of the cliff closing all openings in order to prevent predators from entering. The door dimensions are 2x1.5 m. During the adaptation period the door was kept closed by two metal nails mounted on both sides of the door. The nails are hanging on metal strings leading to the top of the cliff. This allows to open the door without descending to the hack but just by pulling up the nails out of their holes which releases it. The door is tied with separate long metal string which allows to pull the door up when releasing the birds. By tying this rope on the top of the cliff the door would remain open so that the vultures can return to the hack after fledging



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**Food and water delivery port.** The food and water are provided through tubes from the top of the cliff. The tube for the food is with 25 cm diameter, while the water tube is about 4 cm.

**Video surveillance.** Video camera with wide-angle lens is installed in the corner of the hack. It allows to closely monitor the behavior of the vultures during the adaptation period. The camera has good visibility towards the place where the food is delivered in order to closely monitor the food intakes by the different individuals in the hack. A second camera is installed in 2019 on the top of the cliff facing the entrance of the hack and the cliff top above. It allows close monitoring of the first flights of the fledglings and monitoring of the area on the top of the cliff where food is provided after the release.

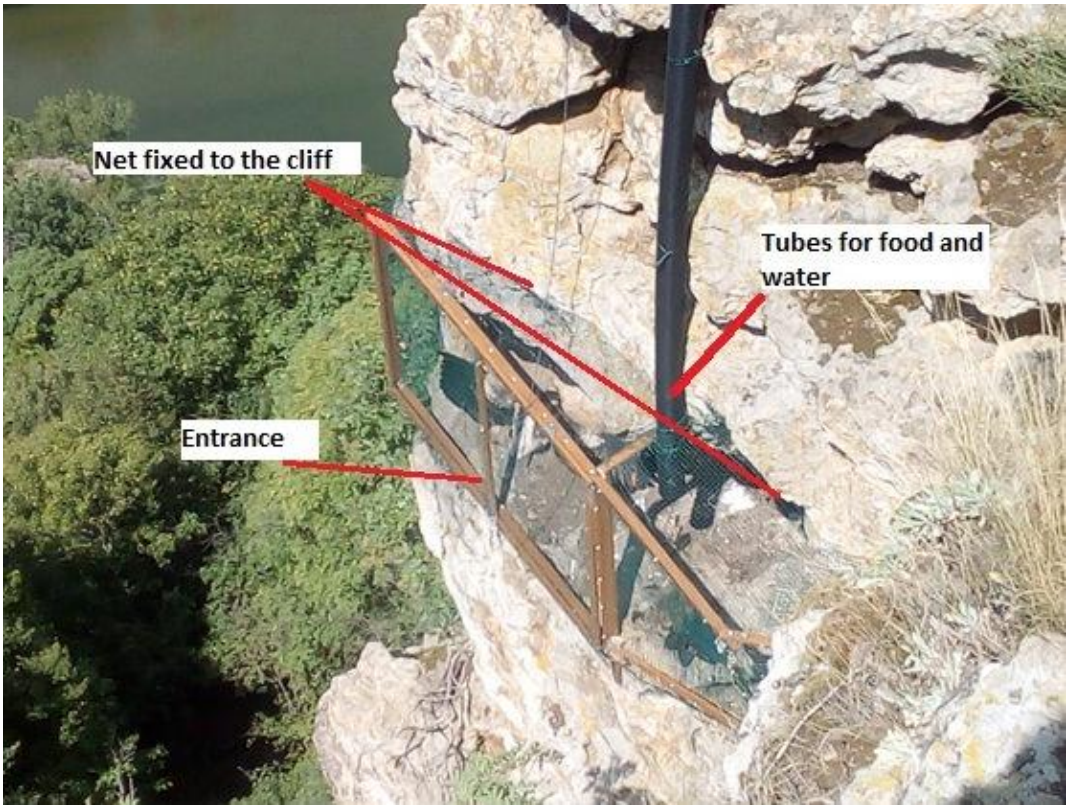


**Fig. 4.** Hack for release of Egyptian Vultures

## Adaptation period

Romana, Lenka and Nikola-Spasimira were inserted in the hack on 02th August at age respectively 65, 51 and 52 days old. The adaptation period lasted 21 days.

**Feeding.** Everyday care and observations from a distance were conducted during the adaptation period. The vultures were fed 4-5 days a week with about 200-300 g per day per



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individual. However, in cases when the food in the aviary was not completely consumed and is still fresh the frequency of the feedings was decreased until most of the food was consumed. Food and water were provided through tubes and there was no direct visual contact between the vultures and the keeper. Food items with high nutritious value were provided to the vultures during the adaptation period. This includes 1-2 days old chickens, rats, rabbits, red meet etc.

**Monitoring.** The behavior and the interactions between the vultures in the aviary were permanently monitored and recorded. Direct observations were made from a distant observation point (about 600m) in order to avoid any disturbance. Observations and recordings with a camera mounted in the hack were made as well. An experienced observer was recording how often and which individual is feeding, which food items are consumed, any aggressive behavior between the birds or social exclusions.

**Tagging.** All Egyptian Vultures were tagged with GSM/GPS transmitters prior to insertion in the hack. During the tagging the birds were thoroughly examined by vets and treated against ecto- and endoparasites because this was their last handling prior to release. The transmitters will allow to closely follow the behavior of the birds after the release and their survival which aims to successfully evaluate the success of this release technique. We used 30g solar powered Ornitela GSM/GPS transmitters. The tags were set to provide high frequency of GPS points (GPS locations every 5 min) and high frequency of data deliveries (30min). This would allow the field team to immediately react if the birds experience some problems after the release. The transmitters were mounted as backpacks with Teflon harness.

## Release technique

**Feedings prior to release.** Food was delivered on few suitable spots visible from the hack and on the top of the cliff as well in case the vultures return to feed there after the release.

**Release.** The entrance of the hack was open in the morning of 23th August. The field team opened the hack and left the place as fast as possible with little disturbance to the birds. All further observations were held from a distance of about 600 m in order to avoid disturbance. The vultures should leave the aviary whenever they are ready. Romana (aged 86 days) left the hack first about 3 hours after the door was open. Nikola-Spasimira (aged 74 days) fledged on the next day – 24th August. Lenka (aged 75 days) fledge last on 26th August.



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## Post-release monitoring

**Monitoring.** After the release the captive-bred Egyptian Vultures were closely monitored by experienced field team. The most critical period was expected to be the first night when the birds might not roost on a high safe place. After the fledging we worked in close collaboration and exchanged information with other NGOs which maintain vulture feeding station in Bulgaria and in the Greek part of the Eastern Rhodopes in order to ensure that if the released vultures move to neighboring areas, they would find safe food in good quantity.

**Feeding.** Supplementary food was permanently present at the feeding station after the release. Food was delivered in the hack as well and on the top of the cliff. In addition, pieces of meat and rabbits were delivered to other suitable visible places between the hack and the feeding station.

## Post-fledging behaviour

After fledging Romana landed on cliffs about 260m from the hack. She made few circles over the cliffs mainly by flapping. She spent the night on these cliffs. At 08:10 on the next morning Romana took off from the cliffs and collided with a powerline at about 350m from the roosting site. She died immediately and was found by the ground team. After fledging Nikola-Spasimira landed on the base of the cliffs very near the hack. She spent 3 days on this location and on 27th August managed to gain height and landed on the top of the hill about 400m from the hack. Since then Nikola-Spasimira did not return near the hack and was mainly flying over the ridge and roosting on cliffs. Food was provided on the rocks nearby. On 30th August he landed on the cliffs near the feeding station and spent there about 5 hours. However, he didn't land on the feeding station. On the next day he started his autumn migration. After fledging Lenka remained near the hack roosting on the cliffs nearby (up to 300m from the hack). Food was regularly provided on the cliffs around and on the top of the cliff with the hack. On 08th September Lenka was eagerly feeding from the food provided. In the morning on the next day she started her south migration.

## Migration and wintering

### Lenka

**Migration.** Lenka started the south migration on 09th September (aged 89 days) or two weeks after fledging. On 11th September she crossed the Dardanelles near Canakkale and continued southwest following the Turkish coast. Lenka crossed the sea reaching the island of Lesbos and continued south to the island of Samos and then Fournoi where she roosted. On the next day



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Lenka moved further south to the islands of Patmos, Amorgos, Keros, Iraklia, Ios and Thira. On 20th September she flew over the sea about 150 km to reach Crete. In the next 3 weeks Lenka crossed the island 3 times from east to west and back. During this period 5 times she initiated sea crossing towards south but after 5-10 km she was returning back to land. Lenka visited also the islands of Crysi and Koufonisi but after that was always returning back to Crete. For the period 20th September – 16th October she flew 2500 km over the island of Crete (Map 16).


**Map 16.** Migration route of Lenka

**Wintering**

On 16th October Lenka settled near the village Moni Kapsa in the southeast corner of Crete. She was roosting mostly on trees about 1.5 km east of Moni Kapsa and visiting the nearby farms daily. Over the next one month she was not moving further than 6 km from this area, visiting the cliffs north of Kalo Nero in few occasions (Map 17). On 17th November we lost her signal and two days later the site was visited by a local birdwatcher who found her dead at this spot under a bush. The body was intact with no obvious signs of injuries (Fig. 5). Her carcass was

collected and sent to the Natural History Museum of Crete. Samples were taken and sent for toxicological analyses in Athens to identify the cause of her death.


**Map 17.** Movements of Lenka during wintering on Crete

**Fig. 5.** The carcass of Lenka found under a bush



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Nikola-Spasimira

**Migration.** Nikola-Spasimira started her migration on 31st August (aged 81 days) or one week after fledging. She moved to southwest and reached the seacoast in Greece near Fanari. Afterwards she continued moving west reaching North Macedonia and spent one night in the area of Demir Kapija. On 03th September she reached Albania roosting 14 km north of Korca. On the next day she was observed by the field team of PPNEA. Nikola-Spasimira looked well and after gaining height she continued west until reached the Adriatic coast north of Sarande. From there she followed the coast moving south and on 06th September reached Peloponnese. On the next day she reached the Messenian Peninsula and was roosting there. At 10:00 on 08th September Nikola-Spasimira initiated sea crossing but after 10 km over the water she returned back to land. However, at 13:45 she made a second attempt to fly over the sea. For about 3 hours she passed only 72 km and we lost signal from her GPS. Most probably she drowned in the sea (Map 18). There were almost no winds during that day and the high-frequency GPS data shows that Nikola-Spasimira was struggling to gain height over the water.


**Map 18.** Migration of Nikola-Spasimira

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