

# Movements of translocated Griffon Vultures (*Gyps fulvus*) from Sardinia to Corsica call for the transboundary management of an expanding vulture population

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**Abstract** - The conservation of Griffon Vulture (*Gyps fulvus*), the most abundant and widespread vulture in Europe, has been the focus of two LIFE project in Sardinia, that foresaw, among other actions, the release of individuals to increase population size. Within the project LIFE Under Griffon Wings (2015-2020), out of 76 Griffon Vultures that have been released in North Western Sardinia, 43 have been fitted with GPS/GSM tags. On the 3<sup>rd</sup> of April 2023, one of these Griffon Vultures, named “Caniga”, crossed the Strait of Bonifacio and reached Corsica. It stayed on the island for 20 days, before returning to Sardinia on the 23<sup>rd</sup> of April. Despite Griffon Vultures have been occasionally reported in Corsica in the last decades, this was the first time that one of the individuals released within the LIFE “Under Griffon Wings” project was recorded there. This observation provides evidence that expanding Griffon Vultures in Sardinia could also include Corsica in their movements and calls for the transboundary management of vulture populations between the two islands, including both monitoring and conservation actions minimizing anthropogenic mortality.

**Keywords:** Old-World vultures, France, LIFE Safe for Vultures, exploratory movements, GPS telemetry, conservation translocation.

**Riassunto** - Gli spostamenti di un grifone (*Gyps fulvus*) dalla Sardegna alla Corsica, sono un invito alla gestione transfrontaliera di una popolazione di avvoltoi in espansione.

La conservazione del grifone (*Gyps fulvus*), la specie di avvoltoio più abbondante e diffusa in Europa, ha riguardato due diversi progetti LIFE, svolti in Sardegna a partire dal 2015. Questi hanno previsto, tra le varie azioni di conservazione, la traslocazione di individui provenienti dalla Spagna, per aumentare il numero di grifoni della popolazione sarda. Nell’ambito del progetto “LIFE Under Griffon Wings” (2015-2020), su un totale di 76 grifoni rilasciati nel Nordovest della Sardegna, 43 individui sono stati equipaggiati con trasmettenti GPS/GSM. Il 3 Aprile 2023 uno di questi, soprannominato “Caniga”, ha attraversato lo Stretto di Bonifacio, raggiungendo la Corsica. Quindi vi è rimasto per 20 giorni, ritornando in Sardegna il 23 Aprile. Malgrado diversi grifoni siano stati segnalati in Corsica negli ultimi decenni, questa è la prima prova di un simile spostamento, per uno degli individui rilasciati nel progetto “LIFE Under Griffon Wings”. Questa osservazione testimonia l’esistenza di una connettività ambientale per i grifoni, tra la Corsica e la Sardegna, e la possibilità che questi includano la Corsica nei loro spostamenti. Inoltre è l’occasione per pensare ad una gestione transfrontaliera delle popolazioni di avvoltoi tra le due isole, che includa azione condivise di monitoraggio e minimizzazione della mortalità per cause antropiche.

**Parole chiave:** avvoltoi del Vecchio Mondo, Francia, Life Safe for Vultures, movimenti esplorativi, telemetria satellitare GPS, traslocazioni.

## INTRODUCTION

The Griffon Vulture (*Gyps fulvus*) is the most abundant and widespread vulture in Europe, where the population currently reaches about 40,000 breeding pairs (Terraube *et al.*, 2022). Despite the species having a global conservation status of “Least Concern” and being abundant in the Iberian Peninsula, in other countries populations, albeit recovering, are much more depleted and fragmented, and are often concentrated at relatively few colonies, mostly located in traditional agricultural landscapes where populations can have a locally unfavourable conservation status (Terraube *et al.*, 2022). These populations sometimes originate from conservation reintroductions, and/or were subjected to restocking/reinforcement programs that had the goal of counteracting density-dependent dynamics or ensuring an increase in genetic diversity (Le Gouar *et al.*, 2008).

In the Mediterranean, some islands like Crete (Xirouchakis *et al.*, 2019), Cres (Sušić, 2021), Mallorca (Cortés-Avizanda & Tavecchia, 2021), Cyprus (Phipps & Vogiatzakis, 2021) and Sardinia host some populations

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Received for publication: 7 August 2023

Accepted for publication: 28 November 2023

Online publication: 22 April 2024

of griffons which are important both from a conservation and an ecosystem viewpoint. For example, with approx. 316-338 individuals (64 breeding pairs) Sardinia hosts a considerable share of Griffon Vultures occurring in Italy (Berlinguer *et al.*, 2022; Terraube *et al.*, 2022). Despite these numbers being lower than those in the 1950's, when approx. 1,000 individuals occurred on the island, griffons still deliver valuable ecosystem services, such as risk mitigation for endemic zoonoses and the reduction of greenhouse gas emissions (Berlinguer *et al.*, 2021).

Two projects, financed by the European Commission through the LIFE program: LIFE Under Griffon Wings (2015-2020, LIFE14/NAT/IT/000484) and LIFE Safe for Vultures (2021-2026, LIFE19 NAT/IT/000732), focused on the conservation of Griffon Vulture in Sardinia. These envisioned multiple actions, such as the creation of farm feeding stations, the release of translocated individuals to increase population size ( $n = 79$ , to date including 4 individuals released within the after-LIFE actions), as well as actions against illegal poisoning and to mitigate the risk of electrocution. Although these actions were effective at increasing both population size and productivity (Aresu *et al.*, 2022), the long-term conservation of Griffon Vulture in Sardinia also partly depends upon increasing the connectivity of local population with other colonies in mainland Europe.

The ideal route to reach the mainland would be across the island of Corsica (France, Fig. 1), as Griffon Vultures, unless drifted away by strong winds (e.g., during storms, Cortés-Avizanda & Tavecchia, 2021), do not cross long traits of sea (Bildstein *et al.*, 2009). Through this route

griffons can move from Sardinia to Corsica across the Strait of Bonifacio (~ 12 km), and then from Corsica to the island of Capraia (~ 25 km), from Capraia to the Elba Island (~ 30 km), and then from Elba to the coast of the Italian peninsula (~ 10 km).

Over the last few years, there has been some evidence that vultures could use this route to move from the Italian peninsula to Corsica and then to Sardinia. First, in 2005-2006 a colour-ringed Cinereous Vulture (*Aegypius monachus*), that was released in France, was observed for a few weeks in Corsica and then from mid November to early April in Sardinia (Brichetti & Fracasso 2018;). Then, in 2015, an immature Griffon Vulture, also colour-ringed, that was born in Forgaria del Friuli (Northern Italy) was re-observed in Corsica (<https://www.sardegnaforeste.it/notizia/la-straordinaria-storia-del-grifone-kronos>). In June and July 2020, two immature Bearded Vulture (*Gypaetus barbatus*) that were released in Corsica, reached Capraia (Italy), before returning to Corsica (<https://4vultures.org/blog/meet-the-bearded-vultures-that-flew-above-seas-and-travelled-vast-distances-in-2020/>). Moreover, there have been some records, between 1980 and 2012, of Bearded Vultures in Sardinia, which is plausible that came from Corsica (Grussu & Seguin, 2015; Brichetti & Fracasso 2018).

However, over the last few decades there has been no evidence for any movement of Griffon Vultures from Sardinia to Corsica, nor any evidence obtained through telemetry. With this study we aim to describe the characteristics of the first documented movement of a Griffon Vulture from Sardinia to Corsica.

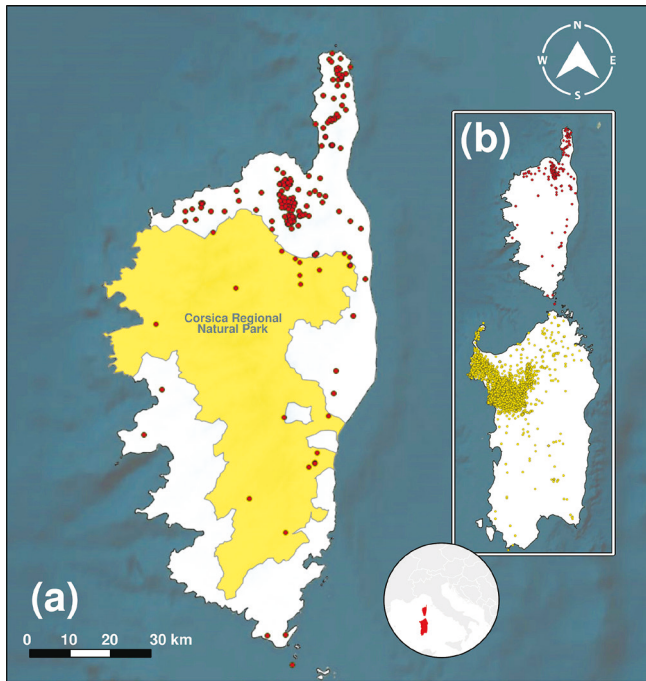


Fig. 1 - Overview of GPS locations from Caniga in Corsica (a) and in both Corsica and Sardinia (b). GPS locations are represented as dots, while the territory of the Corsica Regional Natural Park is highlighted. / Mappa raffigurante le localizzazioni GPS di Caniga in Corsica (a) e nell'area compresa tra la Corsica e la Sardegna. Le localizzazioni GPS sono rappresentate come punti, mentre il territorio del Parco Naturale Regionale della Corsica è evidenziato in giallo. (CCBY 4.0 NC ND).

## METHODS

Within the project LIFE Under Griffon Wings (LIFE14 NAT/IT/000484), funded by the European LIFE program, 64 Griffon Vultures were released in Sardinia between 2016 and 2021, with permission from the Ministry for the Environment Agency (ISPRA - Istituto Superiore per la Protezione e la Ricerca Ambientale) and from the Sardinian Regional Department for the Environment. Released Griffon Vultures came from wildlife rescue centres in Spain or captivity breeding programmes in Germany and The Netherlands and were translocated by Vulture Conservation Foundation. In addition to these individuals, 12 Griffon Vultures from the Sardinian population were recovered in a wildlife rescue centre in Sardinia (Centro di Recupero e Allevamento della Fauna Selvatica di Bonassai - Agenzia FoReSTAS), rehabilitated and released back in the wild.

Griffons were hard-released (with no acclimatization) or soft-released (with a short – 3 months – or long – 15 months – acclimatization period in an aviary) Fozzi *et al.*, (2023). Before being released, all vultures were fitted with PIT tags, with ISPRA (Istituto Superiore per la Protezione e la Ricerca Ambientale) engraved metal ring placed on one tarsus and a plastic ring to facilitate long distance identification on the other tarsus. In order to make their identification during monitoring easier, the remiges or the rectrices were bleached, with a different combination marking for each individual.

Furthermore, 43 vultures were also fitted with solar-powered GPS/GSM and VHF transmitters attached with a Teflon leg-loop harness constituted by three assembled strings (round silicone cord 2mm+ tubular approx ribbon 0.2500 and 0.4400, following Hegglin *et al.*, 2004). GPS/GSM transmitters were Ecotone (n. 40) and Ornitela (n. 3).

The transmitter harness and rings did not exceed 3% of the total body mass of a bird, according to recommended limits to avoid negative effect on individual behaviour and fitness (Bodey *et al.*, 2018). The transmitters were fitted following the best practice in animal welfare – the heads of the birds were covered to guarantee minimal stress and the transmitter placement time was reduced to less than ten minutes.

To monitor the position of the animals we used the platform Wildlife Monitor (<https://wildlifemonitor.org/>, date of consultation 2023), developed by the non-profit organization SWILD, an independent research and consulting association of wildlife biologists, together with the platform Slack (Slack 2023) to receive notifications on the animals' positions on our smartphone.

We used dynamic Brownian Bridges Movement Models (Kranstauber *et al.*, 2012) to estimate the area covered by Caniga so far in its daily movements after the release, both in Northwest Sardinia and in Corsica. Moreover, after we discovered that Caniga had travelled to Corsica, we quantified the number of times that griffons equipped with GPS-GSM telemetry had approached the area within 20 km from the Strait of Bonifacio.

## RESULTS

On the 3<sup>rd</sup> of April 2023, between 10:00 and 12:00 AM, one female Griffon Vulture, named “Caniga”, crossed the Strait of Bonifacio and reached Corsica. Caniga was born in spring 2018, recovered at a wildlife rehabilitation centre in Spain and then released in Sardinia in October 2019, within the project LIFE Under Griffon Wings. It has been equipped with a GPS/GSM transmitter (Ecotone Crex) that transmitted its location approx. every 2 hours. At the time of this movement, it was entering its 6<sup>th</sup> calendar year, and was therefore approaching sexual maturity. In the years that followed its release, it covered an area of approx. 1,316.59 km<sup>2</sup> (95% isopleth of the utilization distribution), mostly in an area of 48.26 km<sup>2</sup> (50% isopleth of the utilization distribution) around the griffon colonies of Porto Conte Regional Park and Bosa (Fig. 1). Nevertheless, it had already visited the area of the Strait of Bonifacio in May/June 2021 and in February/March 2022 (<https://www.sardegnaforeste.it/notizia/rapaci-sardi-volo-verso-la-corsica>).

In less than 48 hours, Caniga had crossed the entire length of Corsica, reaching the northernmost part of the island, around the village of Luri, on the 4<sup>th</sup> of April at 12:00 AM. On the 7<sup>th</sup> of April it was photographed by Barthélemy Agostini, while flying above Cape Corse, the peninsula in the Northeast part of the island (Fig. 2). Then, after 20 days, on the 23<sup>rd</sup> of April 2023, Caniga returned back to Sardinia, crossing again the Strait of Bonifacio at 12:00 and being reported in the northernmost portion of the island at 13:00 and then inside of its main home

range at 16:00. While in Corsica Caniga regularly utilized an area of approx. 40 km<sup>2</sup> (Fig. 1). By using maps from the Gridded Livestock of the World database (<https://data.apps.fao.org/catalog/dataset/glw>), we found that this area hosted one of the highest livestock densities in Corsica, with a density of approx. 29 sheep, 11 cattle and 7 goats per km<sup>2</sup>. Most GPS locations fall outside the Corsica Regional Natural Park, relatively far away from feeding stations activated for Bearded Vultures (Fig. 2).

## DISCUSSION

Although Griffon Vultures had already been observed in Corsica during the 20<sup>th</sup> century (Thibault & Bonaccorsi, 1999), and despite observations increased in the early 2000s (73 sightings since 2015; Seguin, personal communication), this study documents the first record of a Griffon Vulture moving from Sardinia to Corsica, obtained through GPS/GSM telemetry.

Interestingly, despite Griffon Vultures preferring to cross the sea with tailwinds (Bildstein, 2009), Caniga moved across the Strait of Bonifacio in two phases characterized by major crosswinds, and on its way back to Sardinia, also maybe by headwinds. According to ERA5 Climate Reanalysis data (<https://cds.climate.copernicus.eu/cdsapp#!/dataset/reanalysis-era5-single-levels>), at 100 m above the sea level, on the 4<sup>th</sup> of April 2023 at 11:00 AM wind speed ranged between 2.9 and 7.6 ms<sup>-1</sup> and wind direction between 221.6 and 262.4 degrees North, corresponding to westward or south-westward winds. Then on the 23<sup>rd</sup> of April 2023, at 11:00 AM wind speed ranged between 3.7 and 9.9 ms<sup>-1</sup> and wind direction between 111.8 and 161.4 degrees North, corresponding to southeastward winds. However, as we



Fig. 2 - Caniga, photographed on the 7<sup>th</sup> of April 2023 while flying above Cape Corse. / Caniga, fotografata il 7 Aprile 2023 mentre sorvolava Capo Corso. (Photo: / Foto: Barthélemy Agostini).



did not have information about real-time fly height, it is unclear if Caniga was also subjected to these wind conditions during its crossing. Moreover, these wind conditions could have been compensated by thermal updrafts.

Out of 42 Griffon Vultures that were tagged with GPS/GSM transmitters and released in Sardinia, a good proportion ( $n = 13$ , approx. 30%, see Table 1) had already approached the area within 20 km from the Strait of Bonifacio on multiple occasions. While 9 GPS/GSM transmitters are still functioning and we can affirm that they never moved to Corsica, 2 GPS/GSM transmitters failed, and the birds were not resighted, so we are currently unaware of their movements. Anyway, it seems rather common for Sardinian Griffon Vultures to approach the area of the Strait, while engaging in exploratory movements outside their usual home range. It might be possible that some non-marked griffons from the Sardinian population, as well as some restocked Griffon Vultures without GPS/GSM transmitters ( $n = 34$ ), could have already visited Corsica and gone undetected, albeit detectability of vultures moving across the two islands, through photography, seems to be high. Indeed, on one occasion, a tagged individual (named “Timidone”) was observed on the Maddalena island, altogether with 4 non-marked individuals.

Overall, Sardinia and Corsica host 3 of the 4 species of vultures occurring in Europe. Sardinia has now two colonies of Griffon Vultures, and a third one will hopefully be created in the Southeast portion of the island within the project LIFE Safe for Vultures. Moreover, since 2019 a pair of Egyptian Vultures (*Neophron percnopterus*) breeds in the Porto Conte Regional Park (De Rosa *et al.*, 2024). Conversely, Corsica hosts a population of Bearded Vultures (Seguin *et al.*, 2010), with 4 breeding pairs. Unfortunately, the local population of the species has decreased continuously in recent years, and it is in danger of extinction (Bretagnolle *et al.*, 2004). Ongoing restocking and conservation efforts within the LIFE GYPRESCUE project (LIFE20NAT/FR/001553) aim to prevent the extinction of the Bearded Vulture population on the island, one of the last autochthonous breeding populations in Europe. Considering that our data show that vulture movements across the Strait of Bonifacio can indeed occur, and that moving vultures could span significant portions of these two islands in little time, this calls for transboundary collaboration in the management of vulture populations between these two islands.

The foundation for transboundary collaboration would lie in the fact that all the three species of vultures share similar threats, mostly related to accidental or deliberate poisoning, collisions with powerlines and wind turbines, as well as a constrained availability of carrion, due to sanitary regulations.

These threats are common to both Sardinia and Corsica, and they have been addressed by previous and current projects for vulture conservation. For example, both LIFE Safe for Vultures and LIFE GYPRESCUE projects envision actions aimed at minimizing the risk of electrocution with powerlines, at detecting illegal wildlife poisoning and at increasing the availability of safe carrion to vultures. However, these two projects focus respectively on the Griffon Vulture and the Bearded Vultures, two spe-

cies with different ecological needs and differences in the practical implementation of conservation actions. Mutual learning initiatives could be useful for exporting actions that were found to be successful either in Sardinia or in Corsica, on the other island. For example, reproducing the creation of supplementary feeding schemes designed for Bearded Vultures in Corsica, could be useful to assist some individuals dispersing to Sardinia in the near future. Moreover, a better diversification of supplementary feeding strategies between the two islands could reduce interspecific competition between scavengers (Moreno-Opo *et al.*, 2015) and also safeguard other species such as the Golden Eagle (*Aquila chrysaetos*) or the Red Kite (*Milvus milvus*). Monitoring could also be improved by organizing simultaneous counts of vultures on the two islands. Since 2015, between November and December, censuses from vantage points have been carried out in Northwest Sardinia, to estimate the total number of Griffon Vultures on the island. These counts could be extended to Corsica, particularly around the flyway used by Caniga, which is likely to be used by other vultures, including Bearded Vultures.

Transboundary collaboration could also take the form of data sharing initiatives, with the goal of developing habitat suitability models (SDMs, Guisan *et al.*, 2017) or population-wide utilization distributions (Beal *et al.*, 2021) for the three species of vultures in the two islands, to identifying areas that could be suitable for their establishment and where conservation initiatives aimed at reducing threats and disturbance could be strengthened. Similarly, to what has been done for other Old World Vultures (Reid *et al.*, 2015; Vignali *et al.*, 2021; Cervantes *et al.*, 2023), these models could be overlapped with maps representing the risk of colliding with human infrastructures, to drive the development of energetic infrastructures in a way that could minimize mortality for vultures. Currently, the development of wind energy in the Mediterranean is increasing fast, including both islands. A sound understanding of which areas are most used by vultures, also as flyways, obtained from telemetry data of both Griffon and Bearded Vultures, is ultimately needed for careful territorial planning, aimed at avoiding ecological traps (Gauld *et al.*, 2022) and ensuring the long-term viability of these populations.

Mediterranean islands play a crucial role in restoring large-scale demographic and genetic connectivity between vulture populations living across the Mediterranean Basin, by connecting Spain/France, Italy and the Balkans. To attain these conservation goals, and also to minimize mortality associated with large-scale movements, transboundary conservation actions are needed.

### Acknowledgements

The following study was co-financed by the European Commission through the LIFE “Under Griffon Wings” (LIFE14 NAT/IT/000484) and the LIFE “Safe for Vultures” (LIFE19 NAT/IT/000732) projects.

We are thankful to the Vulture Conservation Foundation for supporting and organizing the translocation of Griffon Vultures to Sardinia and for providing its guidan-

ce about GPS tags deploying on the animals. We are also profoundly grateful to the Artis Royal Zoo, the Selwo Aventura Zoological Park, the Dresda Zoo, Acciòn por el Mundo Salvaje, and the Los Hornos Wildlife Rescue Centre, as well as to the Centro di Recupero e Allevamento della Fauna Selvatica di Bonassai – Agenzia FoReSTAS, for providing us with the 76 Griffon vultures that were released afterwards under the project LIFE “Under Griffon Wings”. We would also like to thank FoReSTAS Agency who managed both the restocking program and the rehabilitation and release of the local vultures at the Centro di Recupero e Allevamento della Fauna Selvatica di Bonassai. A total of four Griffon Vultures were released

within the after-LIFE actions. They were donated by the Artis Royal Zoo and the Dresda Zoo, which covered the expenses for their transport to Sardinia while their acclimatization and release was funded by Forestas Agency. Three of them were equipped with satellite transmitters, of which two were donated by the Artis Royal Zoo and one was funded by University of Sassari, who also covered the GSM fees for their monitoring. We would also like to thank the vulture observers in Corsica, Barthélemy Agostini for providing the photo and the observation of Caniga in Corsica. Our deep appreciation also goes to all those who helped us with monitoring and management activities within the LIFE “Under Griffon Wings” project.

Tab. 1 - List of tagged Griffon Vultures, released within the Life “Under Griffon Wings” project, that had frequented the area of the Strait of Bonifacio. Available fixes were updated to February 2023. Variables are: the name of each individual (Name), the biological sex (Sex), the birth date (Birth date), the number of GPS locations located in a radius of 20 km from the Strait (N. of GPS locations), the number of occasions when a certain individual frequented the area of the Strait (N. periods), the time when the last GPS location was collected by the system (Last fix), the date when a certain individual was resighted (Last resight) and the fate of each individual, indicating if it was still alive at the time of the study, or dead, or if this was not known (Fate). / Elenco dei grifoni taggati, rilasciati nell’ambito del progetto Life “Under Griffon Wings”, che hanno frequentato l’area dello Stretto di Bonifacio. Le correzioni disponibili sono state aggiornate al febbraio 2023. Le variabili sono: il nome di ogni individuo (Name), il sesso biologico (Sex), la data di nascita (Birth date), il numero di posizioni GPS situate in un raggio di 20 km dallo Stretto (N. of GPS locations), il numero di occasioni in cui un determinato individuo ha frequentato l’area dello Stretto (N. periods), l’ora in cui il sistema ha rilevato l’ultima posizione GPS (Last fix), la data in cui un determinato individuo è stato riavvistato (Last resight) e il destino di ogni individuo, indicando se era ancora vivo al momento dello studio, se era morto o se non era noto (Fate).

Name	Sex	Birth date	N. of GPS locations	Dates	N. periods	Last fix	Last resight	Fate
Barca	Female	01-04-2015	1	08-04-2021	1	Still active	22-12-2022	Alive
Bulga	Female	01-04-2015	4	30-04-2018	1	30-07-2019	-	Dead
Corte	Male	01-04-2018	4	23-03-2021 06-05-2021	2	Still active	-	Alive
Cristallo	Male	01-04-2015	14	12-05-2018 26-05-2020 17-06-2021 09-04-2021	3	Still active	20-06-2022	Alive
Cuada	Female	01-04-2015	9	27-02-2020 06-05-2020 26-05-2020 04-07-2020 23-03-2022	5	Still active	22-12-2022	Alive
Dresda1	Unknown	01-04-2021	1	18-05-2022	1	Still active	22-12-2022	Alive
Entulzu	Unknown	01-04-2019	5	01-07-2021 18-05-2022 06-06-2022 19-06-2022	4	Still active	22-12-2022	Alive
Idile	Male	01-04-2019	1	14-04-2019	1	Still active	22-12-2022	Alive
Pabelanasa	Female	01-04-2016	1	21-02-2020	1	Still active	15-08-2022	Alive
Pituabile	Male	01-04-2016	5	29-01-2019 12-07-2020	2	08-08-2021		Dead
Timidone	Male	01-04-2015	11	30-04-2018 16-02-2019	2	Still active	22-12-2022	Alive
Tottubella	Female	01-04-2018	10	01-06-2020 07-07-2020 06-05-2021 08-06-2021 25-02-2022 14-05-2022	6	10-09-2022	-	Unknown
Urinucle	Male	01-04-2016	3	03-07-2020	1	10-03-2021	-	Unknown

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