

HUSBANDRY AND PATHOLOGY OF BEARDED VULTURES IN SWISS ZOOS THAT PARTICIPATE IN THE ALPINE REINTRODUCTION PROJECT

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Summary

Five Swiss zoos are involved in one way or another in the project to reintroduce the bearded vulture into the Alps. The vultures are kept under conditions which meet the requirements of the Swiss animal welfare legislation and the recommendations of the CITES Authorities. While eggs have been laid in all zoos and chicks have hatched in four zoos, only one zoo was successful in rearing the offspring and providing birds for the project, either for release or for breeding in other institutions. The paper also contains information on the nutrition, longevity and reproductive biology, as well as an overview of the necropsy findings of bearded vultures in Swiss zoos.

Zusammenfassung

Fünf schweizerische Tiergärten tragen in der einen oder anderen Weise zum Projekt zur Wiederansiedlung des Bartgeiers in den Alpen bei. Die Geier werden unter Bedingungen gehalten, die der schweizerischen Tierschutzgesetzgebung und den Empfehlungen der Fachkommission Artenschutz entsprechen. Während es in allen Zoos zur Eiablage und in vier Zoos zum Schlupf von Küken kam, konnte nur ein Zoo die Jungtiere erfolgreich aufziehen und Vögel zur Wiederansiedlung oder zur Zucht in anderen Einrichtungen an das Projekt abgeben. Im weiteren enthält der Beitrag Informationen über Fütterung, Lebenserwartung und Fortpflanzungsbiologie sowie einen Überblick über die Sektionsbefunde bei Bartgeiern in schweizerischen Zoos.

Résumé

Cinq zoos suisses contribuent d'une façon ou d'une autre au projet de réintroduction du gypaète barbu dans les Alpes. Ces vautours sont détenus dans des conditions conformes aux prescriptions suisses sur la protection des animaux et aux recommandations de la commission d'experts pour les questions en rapport avec la conservation des espèces. Si dans tous ces zoos on a observé la ponte d'œufs et, dans quatre d'entre eux, l'éclosion des œufs, seul un zoo est parvenu à élever les jeunes vautours avec succès et a pu en remettre à d'autres institutions à des fins de réintroduction ou d'élevage. Cet article contient enfin des informations portant sur la nutrition, l'espérance de vie et la biologie de la reproduction et donne un aperçu des résultats d'autopsies pratiquées sur des gypaètes dans des zoos suisses.

Key Words

Bearded vulture, *Gypaetus barbatus*, conservation, breeding, husbandry, legislation, mortality, pathology

Introduction

Until the second half of the 19th century, the bearded vulture (*Gypaetus barbatus*) was a common breeding bird in the Alps of France, Switzerland, Italy and Austria. In the Alpine area of Switzerland, which covers about 15.000 km², there are 20 places known to have once been breeding sites of the vulture. Around 1890, the bearded vulture disappeared as a breeding bird, but solitary vagrants were occasionally seen until the 1980ies (8).

Already in the 1920ies, STEMMER had promoted the idea of reintroducing the bearded vulture into the Alpine area, noting that vultures could easily be purchased from Sardinia – at a price of 120 to 150 Swiss francs per bird - and that keeping and breeding in captivity was not too difficult (7). Unfortunately, at that time the bearded vulture still had the reputation of being a dangerous predator, and Stemmer's idea was not taken up by the Swiss League for the Protection of Nature. It was only in 1978, when the World Conservation Union IUCN held a meeting at its then headquarters in Morges to set guidelines for a 20-year project to re-establish a stable breeding population of bearded vultures in the Alps. The scheme was unusual in that captive-born birds, rather than wild-caught ones, were to be released as founders of the wild breeding stock. Subsequently, an organisation was established for this project, involving WWF, IUCN, the Frankfurt Zoological Society, University Institutions and a number of zoos (1), including the Swiss zoos keeping bearded vultures at that time. On 4th May 1992, this organisation became the Foundation for the Conservation of the Bearded Vulture. In 1990, an Association for the Re-introduction of the Bearded Vulture into the Swiss Alps was created. This was transformed into the foundation "Pro Bartgeier" on 12th February 1999. In 1998, 30 zoos or breeding stations owning a total of 105 birds participated in the project (3). From 1986 to 1998 a total of 80 captive bred vultures were released into the Alps, 60 of which are believed still to live in the wild (4). The year 1999 saw the release of another eight vultures. The first, unsuccessful, breeding was registered in 1996 in Savoy. From 1997 to 1999, seven more breeding attempts were noted at different release sites, four of which were successful.

In Switzerland, five zoos have been, or still are, involved in the project. The present paper aims to give an overview of the keeping of bearded vultures in these zoos, to provide information on animal health problems encountered, and to make some recommendations regarding the prevention of diseases and accidents.

Legal requirements for the keeping bearded vultures

The Swiss Federal Ordinance on Animal Welfare of May 27, 1981 subjects the keeping of all raptors to licensing. Except in cases where the birds are kept for falconry purposes, the enclosures must come up to the space requirements laid down in Annex 2 of the Ordinance (see Table 1).

Table 1 Legal minimum requirements for the keeping of raptors in Switzerland

| Species | N | for groups up to n animals | | for each additional animal | | Shelter for non-frost resistant species, surface per animal |
|--|---|----------------------------|-----------|----------------------------|-----------|---|
| | | outdoor enclosure | | surface m² | volume m³ | |
| | | surface m² | volume m³ | | | |
| <i>Gypaetus barbatus</i> and other Old World vultures, condors, large eagles | 2 | 30 | 120 | 10 | 40 | 3 m² |
| Small New World vultures, Egyptian vulture, small eagles, fish eagle | 2 | 20 | 60 | 8 | 24 | 2 m² |
| Caracaras, large falcons, buzzards, kites, harriers | 2 | 10 | 25 | 4 | 10 | 2 |
| Small falcons | 2 | 5 | 10 | 2 | 4 | 1 |
| Pygmy falcons | 2 | 2 | 3 | 0.5 | 0.75 | (indoor aviary) |

In the case of wild-caught animals of species listed in Appendix I of CITES, an import permit will be granted only if the standards set by the Scientific Authorities of Switzerland and Liechtenstein are met. For all other species, these standards serve as recommendations and are not legally binding (see table 2).

Table 2 *Swiss CITES recommendations for the keeping of raptors*

| Species | N | for groups up to n animals | | for each additional pair | | Shelter for non-frost resistant species, surface per animal |
|--|---|----------------------------|-----------|--------------------------|-----------|---|
| | | outdoor enclosure | | surface m² | volume m³ | |
| | | surface m² | volume m³ | | | |
| <i>Gypaetus barbatus</i> and other Old World vultures, condors, large eagles | 2 | 60 | 240 | 30* | 120* | - |
| Small New World vultures, Egyptian vulture, small eagles, fish eagle | 2 | 30 | 120 | | | 3 |
| Caracaras, large falcons, buzzards, kites, harriers | 2 | 10 | 30 | | | 3 |
| Small falcons | 2 | 8 | 20 | | | 2 |
| Pygmy falcons | 6 | 5 | 10 | | | (indoor aviary) |

*colony-breeding vultures only

Keeping conditions

The dimensions of the aviaries in which bearded vultures are, or were, kept by the five zoos are shown in table 3.

Table 3 *Dimensions of bearded vulture aviaries in Swiss zoos*

| Zoo | surface m ² | av. height m | volume m ³ |
|----------------------|------------------------|--------------|-----------------------|
| Basel | 135 | 6.5 | 880 |
| Berne | 66 | 4 | 264 |
| Goldau exhibit | 805 | 8.5 | 8843 |
| Goldau breeding (2x) | 228 | 8 | 1824 |
| Goldau separation | 96 | 8 | 768 |
| La Garenne | 110 | 5 | 660 |
| Zurich (until 1976) | 85 | 4.1 | 356 |

The backside of Basel Zoo's bearded vulture exhibit consists of artificial rock, partly overgrown by ivy. For breeding, a wooden box measuring 1.3 x 2.5 x 0.8 m is located on top of the wall. There are natural tree trunks for perching, a small stream runs through the planted exhibit, and an iron oxide mud bath is provided. The aviary is fenced in by vertical steel wires.

At Berne Zoo, the rectangular aviary has a short front side towards the public, with the roofed nesting site, measuring 1.5 x 1.5 m, being located as far away from the public as possible, and visually protected from the neighbouring aviary by wood panels. The floor is covered with sand and planted with some small pines. There are natural tree trunks for perching, an iron oxide mud bath, and fluent water. Fencing is assured by a 48x48 mm welded wire net. Temporarily, mountain hares were kept together with the vultures.

The huge bearded vulture exhibit of Goldau Animal and Landscape Park, an irregularly shaped tent construction, is situated on a slope. Its highest point is 22 m. The back wall consists of an artificial rock containing two potential nesting sites, which can be supervised by a video camera. There are natural perches and natural rocks throughout the exhibit, and the soil has a grass and shrub cover. A water course with two bathing pools runs through the exhibit, and there is an iron oxide mud bath. Up to one meter above ground, the aviary is fenced by a 1 cm steel net, otherwise fencing is assured by a nylon net with a mesh width of 10 x 10 cm. Since 1995, snow hares (*Lepus timidus*) or brown hares (*Lepus europaeus*) have been kept in the exhibit to show that bearded vultures are carrion feeders and do not hunt.

The breeding station consists of two aviaries for breeding pairs and a smaller pen to be used for separating surplus animals. 8 x 8 cm nylon mesh is used for fencing. The whole complex is naturally planted and there are a water course, bathing pools, mud baths and wooden platforms for perching and feeding at a height of 4 m above ground level. Wooden boxes mounted on concrete platforms serve as nesting sites. One of the nests is supervised by a video camera.

At La Garenne, public and staff access to the aviary is restricted to one side only. It contains a water bath and an iron oxide mud bath at ground level. There are natural perches and vegetation through-

out the pen with perches being replaced regularly when necessary. The perimeter fence is 5 cm mesh with solid backing in the corner area of the nest platform. Checks of the nestlings used to be made from a small door right by the nest, but this bothered the birds, and now the keepers approach from the front of the pen, climb up to the roof and walk across the mesh to look down. This seems to frighten the birds much less.

Diet

At the zoos of Basel and Berne, the diet consists of entire guinea pigs, rabbits, rats and goat or sheep skulls, or sheep bones.

At Goldau Animal and Landscape Park, the vultures are fed split sheep skulls, long bones of sheep in part with the skin, mouflon and deer carcasses from the park, rabbit quarters without intestines, and guinea pigs without intestines.

At La Garenne, adults are fed lower legs of calves cut into pieces of about 10 cm length, which amount to a total of 1 to 2 kg per meal per day. Occasionally, depending on availability, roe deer, goat or sheep legs may be given. The birds are not fed daily but rather on an irregular schedule and at varying times of day, however the average amount provided is approximately 1 kg per bird per day. In addition, supplement of vitamin E (natural source d'-alpha tocopherol) is given. When there are young in the nest, one whole rabbit or guinea pig (possibly two if they are small) is added to the diet each day.

Animals kept

During the periods reviewed, the five zoos have kept a total of 72+ bearded vultures. 20 of these originated from the wild, 19 had been born in other facilities, 30+ had been bred at the respective zoo, and in 3 birds, the origin could not be determined. 30+ vultures had died at the zoos, 24 were transferred to other institutions, and 6 were released. At the end of 1999, the zoos had a total of six pairs in their collections. For the offspring produced but not reared by the first pair that was kept at Zurich Zoo until 1955, only incomplete data are available.

Table 4: Bearded vultures kept at the zoos of Basel, Berne, Goldau, La Garenne and Zurich

| Zoo | Basel | Berne | Goldau | La Garenne | Zurich | Total |
|------------------------------|---------|---------|---------|------------|---------|------------------|
| Time period | 1954-99 | 1966-99 | 1995-99 | 1979-99 | 1932-76 | |
| Total kept | 6.3.1 | 5.6.1 | 3.5.1 | 6.12.6 | 5.5.7+ | 25.31.16+ |
| n from the wild | 2.1.1 | 3.2.0 | 0.0.0 | 1.1.0 | 5.4.0 | 11.8.1 |
| n born in other facility | 4.2.0 | 1.3.0 | 3.5.0 | 0.1.0 | 0.0.0 | 8.11.0 |
| n born at the zoo | 0.0.0 | 0.0.1 | 0.0.1 | 5.10.6 | 0.0.7+ | 5.10.15+ |
| info on source not available | 0.0.0 | 1.1.0 | 0.0.0 | 0.0.0 | 0.1.0 | 1.2.0 |
| n died | 3.1.1 | 1.1.1 | 0.1.1 | 0.2.6 | 3.2.7+ | 7.7.16+ |
| n released | 0.0.0 | 0.0.0 | 0.1.0 | 0.5.0 | 0.0.0 | 0.6.0 |
| n to other zoo | 2.1.0 | 3.4.0 | 0.0.0 | 5.4.0 | 2.3.0 | 12.12.0 |
| Stock on 31.12.99 | 1.1.0 | 1.1.0 | 3.3.0 | 1.1.0 | 0.0.0 | 6.6.0 |

1.0.0 = male, 0.1.0 = female, 0.0.1 = sex unknown

Breeding and survival

The oldest birds that died had reached an age of 34 to 35 years (La Garenne) and 30 to 32 years (Berne). At Basel Zoo, one bird was kept for 28 and at Zurich another one for 26 years. In 1999, the birds currently kept were 8 and 5 (Basel), 8 and 7 (Berne), 35 and 10 (La Garenne), 16, 13, 10, 9, 7 and 2 (Goldau) years old.

During the breeding season, the female dominates the male. Nest building begins in November / December. Nesting material such as cut browse and lambs wool is supplied. There are 10 to 15 matings per day and both birds are very vocal during this period. Egg laying begins in late November or early December with the majority of eggs being laid in mid-December. At Berne Zoo, the first eggs were repeatedly laid in January only. The more experienced the pair the earlier these steps occur in the season. The incubation averages 52 days. The earliest time vultures hatched successfully at La Garenne was in early January (1983) but the majority hatch out at the end of January or the beginning of February.

Zurich Zoo kept a pair of the African subspecies, *Gypaetus barbatus meridionalis*, which was imported from Ethiopia and produced a series of clutches between 1943 and 1955. In each of the years 1943, 1944, 1945, 1946, and 1948, a single young hatched, which was killed by its parents at the age of 2 to 3 days. In 1955, two chicks hatched but were not reared either.

Egg laying was recorded at Basel Zoo in December 1980 and December 1981. A total of three eggs were produced which were all broken. It is not known whether they had been fertilised or not.

At Berne Zoo, 2.0 birds kept since 1966 and believed to be a pair showed mating, nest building and brooding behaviour. When one of the males was replaced by a female, the new pair proved to be incompatible. After the death of the female, a new female was introduced which resulted, after two years, in mating and nest building, but with no breeding success. A new pair, acquired in 1987, started egg laying in January 1988, but the eggs were either destroyed by the parents or, when artificially incubated, were not fertilised. The first apparently fertile eggs were obtained in 1991. The first, and so far only, chick hatched on 17 March 1992. It died the same day. A new pair obtained in 1992 has not produced any offspring yet.

At Goldau Animal and Landscape Park, the first egg was laid on 17 January 1999. On 6 March, the egg was removed from the nest and placed into an incubator. The female chick had hatching problems and needed assistance to get out of the egg shell. It died on the day of hatching of an umbilical infection. The same pair laid two eggs in January 2000.

La Garenne has been the only success story: the first breeding pair had offspring every year from 1980 to 1985, as well as in 1987, 1989, 1994 and 1995. The female laid an average of 2 eggs each year. In total, 31 eggs were produced with 19 hatching and 13 being reared. Of the 6 juveniles that died, 3 were hand-reared and 3 were naturally raised. All surviving birds were parent reared. The reasons for the losses are unknown. After the death of the breeding female in 1995, the male has been paired with a new, much younger female who has produced three eggs – only one per year - with two surviving offspring so far.

Mortality and pathology

At Basel Zoo, one bearded vulture died of avian tuberculosis combined with aspergillosis, eight years later, another death occurred owing to chronic aspergillosis. In a bird that was assumed to have died of a lead intoxication caused by shot pellets present in partridges that were used as food, an *Aspergillus fumigatus* infection (and trichomoniasis) was also diagnosed. The two birds that died in February 1993, showed symptoms of an intoxication. Chloralosis used by the zoo to combat brown rats, as part of its zoonoses control programme (2), was suspected to be the causative substance but this could not be proven by gas chromatography. In addition, the male had suffered from arteriosclerosis, which may have been the result of a permanently stressing situation because the female was very dominant. In this bird, which originated from the Vienna Breeding Unit, the presence of ascarid nematodes, *Porrocaecum depressum*, was also diagnosed. The female also showed parasite granulomas in the liver. The female "Nina" from Goldau Zoo contracted a lead intoxication from a roe deer that had been found dead and had been brought to the zoo to be fed to scavengers. The bird was treated but died after 15 days. During necropsy, no shot pellets could be found in the intestinal tract, and a muscular necrosis was diagnosed. A female at Berne Zoo died as a result of intraspecific aggression. The first breeding female of La Garenne died as a result of cranial trauma. It is not known how this happened but it may be that the maturing fledgling became aggressive to its parents during the night and scared them off the perch. The nestlings that died at La Garenne were all too autolysed for diagnosis. The five death cases at Zurich Zoo were due to suffocation caused by a bone (14 cm long) in the throat, head trauma, flight injury, enteritis / cardiovascular disease, and mycosis of the respiratory tract.

Contribution to the reintroduction project

Apart from Zurich Zoo where the keeping of bearded vultures ceased already in 1976, all zoos contributed to the reintroduction project by integrating their animals into the breeding pool managed by Vienna University. Five of the birds bred at La Garenne were released, and so was one vulture originally bred at Wuppertal Zoo and kept at Goldau Animal and Landscape Park. Zurich Zoo continued to contribute to the project after having abandoned the keeping of bearded vultures by making their zoo veterinarian available when vultures were released in the Swiss National Park.

Discussion, conclusions and recommendations

All aviaries exceed not only the minimum requirements of the Animal Welfare Ordinance, but also the recommendations of the Scientific Authority for CITES. When Zurich Zoo still had bearded vultures in its collection, they used to be kept in a row of aviaries occupied by different vulture and eagle species. The pen just met the recommendations. Its design however (long public front side, nest sites relatively close to the public, public able to touch the wire net of the pen, keeper accessing from the back side, other Accipitriformes to the left and the right) may have been the reason for the killing of all offspring by the adults. Obviously, other birds kept in the adjoining pens felt also disturbed, and killed or abandoned their offspring, including griffon vultures (*Gyps fulvus*) and raven (*Corvus corax*). The dimensions of the current aviary at Berne Zoo are slightly below the recommendations made by the co-ordinator of the reintroduction project (5), but this does not seem to have been a critical factor for the lack of breeding success because the distance from the public to the nest site is fairly long. Factors that may have a potentially **negative impact** on breeding at Berne are the immediate neighbourhood of other birds of prey and the not very sunny location of the raptor exhibit in a beech forest. As the Berne zoo's raptor exhibit is fairly old, the zoo should consider to replace it. All other aviaries in Swiss zoos come up to the guidelines of the project co-ordinator.

Intraspecific aggression has sometimes resulted in injuries when birds flew into the fence. This has been one of the main problems in keeping bearded vultures. Some death cases could have been avoided if more flexible material (nylon nets, steel wires) had been used for fencing.

Bearded vultures are probably highly susceptible to **lead poisoning**. Dead wild animals delivered to the zoos should, therefore, be x-rayed before being fed. In wild birds, the impact of lead shot shell (and lead fishing weights) has, so far, mainly been reviewed with regard to waterfowl, although secondary lead shot poisoning has been documented in several raptor species in North America and Europe, and has been studied, in particular, in bald (*Haliaeetus leucocephalus*) and golden (*Aquila chrysaetos*) eagles in Canada and in the United States. Mortality from eating prey animals with lead shots embedded in their tissues or the gizzards of birds with ingested lead shot accounts for an estimated 10-15 % of the recorded post-fledgling mortality in the two species (6). The risk of lead poisoning may, therefore, also exist for the bearded vultures released to the wild, and this would be another argument for banning hail shot made from lead.

Aspergillosis was also relatively frequently found, and it seems that poisoned birds in particular may be prone to contract *Aspergillus* or other infections.

The guidelines of the project co-ordinator do not provide for regular testing of the birds for **parasitic diseases**. Some of our necropsy data suggest that parasites may be a problem. A modification of the guidelines to include an endoparasite testing and treatment protocol is, therefore, recommended.

While the overall contribution to the project by providing birds for release has, until now, been relatively modest, the publicity efforts of the zoos - in particular of Goldau Animal and Landscape Park - has been a critical factor in the success of the reintroduction project. The **publicity campaign** has aimed to make people aware that the bearded vulture, in spite of its size, is not a dangerous predator but a harmless and even useful scavenger, which should not be persecuted.

As the current breeding stock in Switzerland consists mostly of young birds, and several suitable aviaries were constructed during the past few years, the number of offspring available to support the project is likely to increase in the future.

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