

Bearded Vulture European Endangered Species Programme (EEP): Guidelines for Feeding Bearded Vultures in Captivity

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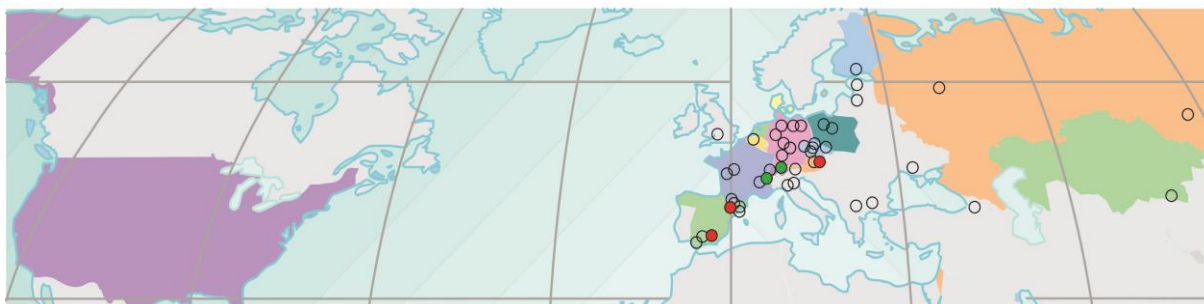
INTRODUCTION

The international Bearded Vulture breeding network (EEP: European Endangered Species Programme) is a collaboration between zoos and similar institutions, breeding centres, and private partners. Between 1978 and 2014, 435 juvenile Bearded vultures were reared successfully as part of the programme. The offspring reared are used for re-introduction projects in Europe – in the Alps, Andalucía, and the Cévennes. Working in collaboration with the Vulture Conservation Foundation (VCF), the ultimate aim of the programme is to establish a European metapopulation of Bearded vultures, creating gene flow between the existing isolated autochthonous populations in Europe (in the Pyrenees, Corsica, and Crete) and with populations in North Africa and Asia.

Between 1978 and 2014, the programme lost 127 birds. These birds died between the ages of 1 and 54 years old. Of these, 13 birds died after ingesting unsuitable food. Eight birds died because they were fed the carcasses of animals killed with lead ammunition and five died after eating poisoned rats that died inside the aviary following a rat extermination campaign. Additionally, if the quantity and quality of the food provided is not adequate for the species, this has severe consequences for their general condition and consequently birds are more vulnerable to other diseases (e.g. aspergillosis).

It's well known that the pathogenicity of *Aspergillus* spores decreases with increasing altitude (*Aspergillus* completely loses its pathogenicity above 900masl). That's why the Bearded vulture, as a mountain species, had not needed to develop immune resistance to this type of infection. And because almost all zoos and other breeding centres are located at lower altitudes than wild birds normally live, *Aspergillus* infection is one of the biggest problems which this species is confronted in captivity (26 of the 127 birds lost between 1978 and 2014 died from aspergillosis). This can only be prevented by offering the birds the best possible housing conditions and food quality, to keep their fitness levels and resistance to disease high.

These guidelines for feeding Bearded vultures in captivity are based on more than 35 years of experience of keeping and breeding this species in captivity. They have been made possible thanks to the wonderful collaboration and exchange of information between all of the EEP partners.



In 2014, the EEP included 35 zoos (most in Europe), 3 large (≥ 10 birds) specialised breeding centres (red spots), 2 small (< 10 birds) specialised breeding centres (green spots), and 3 private keepers, with a combined total of 151 birds.

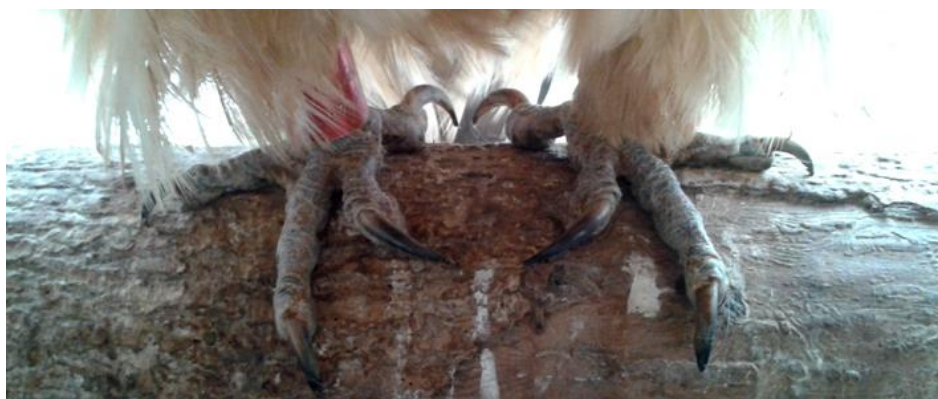
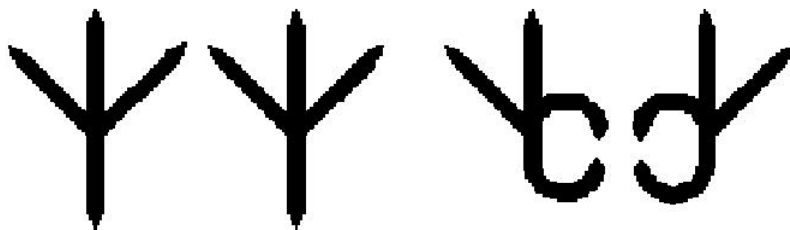
GUIDELINES FOR FEEDING BEARDED VULTURES IN CAPTIVITY

BIOLOGICAL BACKGROUND

The Bearded vulture is a highly specialised bird of prey that consumes the prey remains left by predators or other scavengers. In the wild, around 70% of the biomass of their diet is bone. Of the remainder, 25% consists of soft tissue and 5% of skin (Hiraldo et al., 1979). Only during the period when they are raising young do they need soft tissue.

Bearded vultures preferentially consume large bones up to around 25 cm in length and 3.5 cm in diameter, such as humerus, radius, femur, tibia, metatarsus, metacarpus, and ribs (Anonymous, 1978; Brown, 1988; Brown et al., 1982; Llopsi, 1996; Thibault et al., 1993; Vitovich et al., 1988). The Bearded vulture's large gape, extendable oesophagus, and the lack of a clear division between the crop and the stomach are all specific morphological adaptations to swallowing these kinds of bones. Bearded vultures generally consume the bones of animals from the subfamily Caprinae, of the genera *Ammotragus*, *Ovis*, *Capra*, *Naemorthedus*, *Budorcas*, *Capricornis*, *Rupicapra*, and *Hemitragus*. In fact, it seems likely that the Gypaetini (the taxonomic group to which the Bearded vulture belongs) evolved alongside the Caprinae, since the two groups are almost always found sharing the same habitats, with the exception of the American Caprinae (Valverde, in Hiraldo et al., 1979).

To access these bones, Bearded vultures take the carcass apart by the joints, stretching and tearing ligaments and tendons with its beak, while the toes hold firmly onto the carcass. A special adaptation of the 1st and 2nd toes allows them to be used as pincers to clamp firmly onto the food (Keller, 1886; Llopsi, 1996). Each foot grips one of the major bones, leaving the joint accessible to the beak, between the feet.



Top left: Representative diagram of the feet of a Golden eagle. Above top right: Representative diagram of the feet of a Bearded vulture, showing 'pincer'-type adaptation of the 1st and 2nd toe that allow it to clamp firmly onto bones (Girtanner, 1879). Below: the normal position of the 1st and 2nd toe in the Bearded vulture.

Once the bird has dismembered the carcass, large bones are swallowed whole, and this can take some time, with bones sometimes remaining in the bird's mouth for a while (Mundy et al., 1992). The gastric juice of the Bearded vulture has a pH of roughly 1, so bone tissue can be digested without problems. Houston and Copsey (1994) found that after four hours, birds excrete small amounts of faeces, but only excreted the maximum quantity 24 hours after ingesting food. They assumed that the first excretion corresponds to the soft tissues found around the bones and the main excretion with the bone tissue itself. This has been corroborated in captivity (authors). Chicks that are fed only on soft tissue during their first few weeks of life start to excrete four hours after receiving their first meal in the morning.



Left: Thanks to the specially adapted 1st and 2nd toe, each foot can securely grip one of the major bones of the carcass, keeping the joint in between, where it is accessible to the beak. Right: the morphological adaptations of the upper digestive system allow large bones to be swallowed easily.

Bearded vultures have also developed a special behaviour that makes the consumption of even very large bones possible. Bones that are too large to be swallowed whole are held by the feet and taken up to a height between 20 y 70 m (Boudoint, 1976; Brown, 1988; Grubac, 1987; Huxley, 1963), from where they are dropped onto a rocky surface. The bird then collects the fragments and the marrow. Several of the Bearded vulture's names in different countries reference this 'bone breaking' behaviour: e.g. 'Quebrantahuesos' in Spain and 'Boanbrüchl' in Austria.

Fresh bone is comprised of 49% water, 16% fat and carbohydrate, 12% protein, and 23% minerals (Boudoint, 1976), while meat contains 70% water (Mundy et al., 1992). Brown (1988) calculated the energy value of 100g of Bearded vulture food (70% bones, 25% tendons, and 5% skin) to be 674 kJ compared with 586 kJ for 100g of meat. Houston and Copsey (1994) found that the digestibility of bone tissue is lower than that of meat (50% and 75% respectively), but there is no significant difference in the amount of energy produced per 100g between the bone tissue and muscle tissue (387 kJ and 440 kJ, respectively). Bones also have one big advantage: they do not rot.

The benefits of being so highly specialised are evident. Apart from the fact that bones don't rot, Bearded vultures do not have to compete with other consumers for this resource. They need only wait until the remains are ready, and their need for food is remarkably reduced compared to other

large predators. Because these remains, composed principally of bones, don't rot, Bearded vultures are not adapted to eat putrefied food.

The daily food requirement of a fully-grown bird is roughly 250-350g, which is only around 5% of its weight. Donazar (1993) showed that Spanish Bearded vultures required between 5-10% of their own body weight in food daily.

In the wild, Bearded vultures feed every day, once in the morning, and once in the late afternoon. If weather conditions are bad, birds feed on remains stored in the rocks of roosting sites or in nests.

Ingested hairs or feathers of prey remains are not digested (as with other birds of prey and owls). Pellets are therefore ejected from time to time. They are difficult to find because birds destroy them immediately, searching for bone fragments, which are eaten again.

Feeding captive Bearded vultures with high quality food in sufficient quantities is the most important husbandry practise there is to ensure perfect condition, healthy constitution, long lifespan, and successful reproduction. It is important to remember how easily mistakes can be made. Several birds have been lost to lead poisoning in the past after they were fed with shot animals (rabbits, musk-rats, roe deer and other wild ungulates). Lead poisoning is one of the most important threats to wild Bearded vultures, but 6.3% of losses in captivity are also caused by lead poisoning. Birds have also been lost due to perforation of the stomach, poisoning after consuming poisoned rats, and the wrong composition of soft tissue and bone.

It is essential that nestlings are provided with the highest possible quality of food if they are to grow up into birds of a condition suitable for use in in situ projects and captive breeding.

Summary:

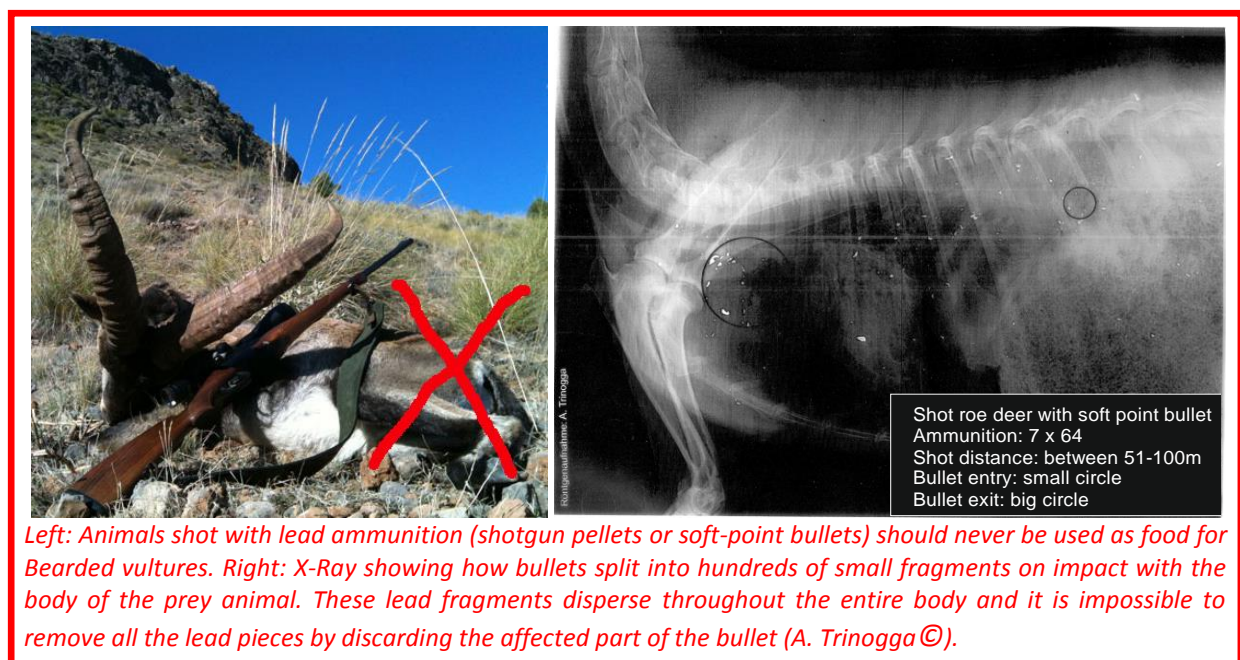
- ☞ It is important to put the time and effort into developing an optimal feeding practice.



RECOMMENDATIONS REGARDING FOOD QUALITY

The food provided to captive Bearded vultures should resemble that of wild birds in composition. If the food provided meets the species' nutritional requirements, birds should not require additional vitamin supplements (Cade et al., 1977; Carpenter et al., 1987). It is therefore important to provide both bones and meat.

In Europe, most hunters still use ammunition made of or mixed with lead, and Bearded vultures are very sensitive to lead poisoning. It is not just shot from shotguns that pose a threat. The meat or bones from wild animals shot with soft-point bullets is even more dangerous. The ingestion of only a very few tiny lead particles is lethal to a Bearded vulture. Even the cleaned bones of shot animals can be dangerous. Lead fragments are very difficult to detect and may often be hidden under the periosteum. Consequently, birds should never be fed on carcasses obtained from taxidermists, or of unknown origin, because the animals may have been shot or even poisoned.



Furthermore, because the diet of Bearded vultures is composed mainly of bone, they bring up pellets only very occasionally, usually after consuming feathers or hair. This means that, compared to other birds of prey, lead fragments can remain in the stomachs of Bearded vultures for a long time.

To prevent lead poisoning, Bearded vultures should only be fed on the meat and bones of domestic animals. The bones of small animals such as rabbits, guinea pigs, and domestic rats can be offered whole and are perfect food for Bearded vultures. It is important to check that animals from laboratories (such as rats and guinea pigs) have not been used in experiments or given any kind of medication.

Fully-grown birds should receive a diet composed of 70% bone and 30% soft tissue. Rabbits weighing one kilo have the ideal ratio of bone to soft tissue to be used as food for birds of this age. This ratio

should be reversed to 70% soft tissue and 30% bone for younger birds aged over four weeks, until they have reached full size. Rabbits weighing three kilos have the right ratio of bone to soft tissue for these younger birds. Chicks below the age of four weeks are fed on 100% soft tissue.

To increase the proportion of bone in the diet, we recommend providing the lower leg bones of calves, sheep, and goats. These can be obtained from abattoirs. Because Bearded vultures in captivity cannot use the bone-breaking behaviour of birds in the wild, larger bones need to be broken up for them into pieces that can be swallowed easily. Two captive Bearded vultures have died from perforated stomachs caused by sharp bone splinters. Calf bones are particularly dangerous in this regard. Bones should therefore be sawed into sections, rather than smashed up. Sections of bone should be roughly 10 cm in length.



Left: Splinters, particularly of calf bones, should not be fed to Bearded vultures, as they can perforate the stomach, or even the oesophagus.

Right: Large bones, particularly calf bones, should be sawed into pieces roughly 10cm long to avoid dangerous splinters.

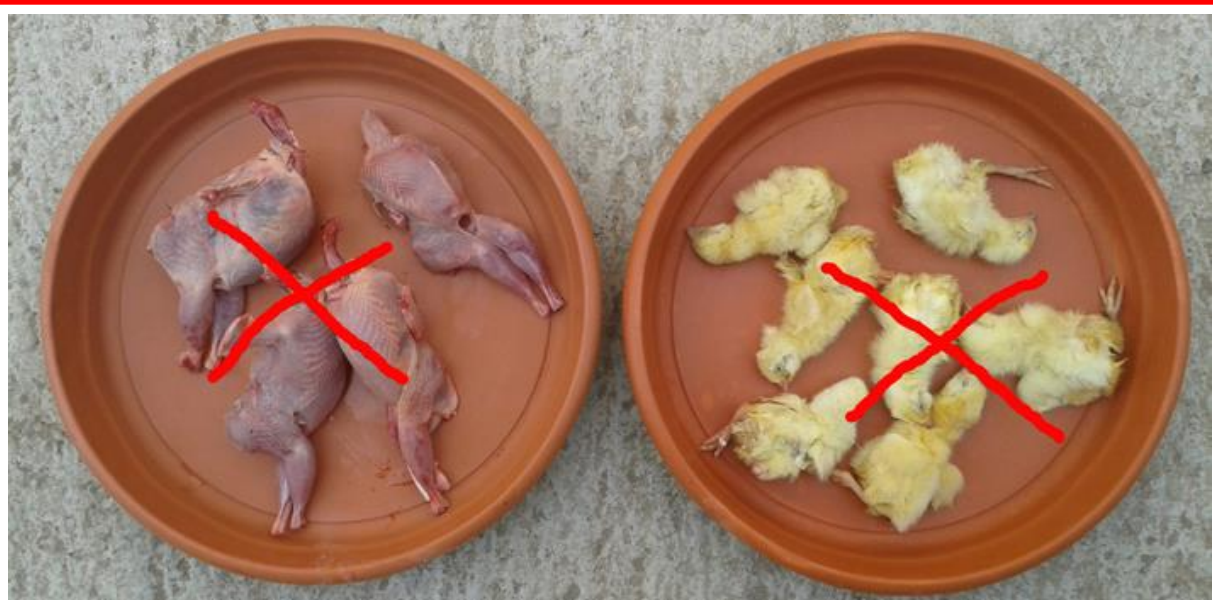
In zoos and other collections that also keep other large birds of prey, rabbit skulls and the lower leg bones of rabbits can be used to increase the proportion of bone in the Bearded vulture's diet. It is important to provide the food with the skin and fur still on, to keep the birds busy for as long as possible.

With its diet of bone, the Bearded vulture is the last link in the food chain. This is why they never needed to evolve aggressive behaviour, since they consume the remains left behind by other predators and scavengers, which they do not need to compete for. By the time wild Bearded vultures feed on a carcass, the internal organs and most of the soft tissue has been eaten by other predators and scavengers. This means that wild Bearded vultures do not consume internal organs, such as intestines. These should therefore be removed from all carcasses before they are fed to captive Bearded vultures.

The bones of domestic pigs can be offered from time to time, but not too regularly, because there is a possible risk of arteriosclerosis. Although a definite link between arteriosclerosis and a diet rich in

pig bone has not been demonstrated, we do not recommend feeding Bearded vultures on pig bones because at one centre where birds were fed principally on pig bones, four birds died whose autopsies later revealed generalised arteriosclerosis.

Although Bearded vultures are incredibly resistant to bacterial and viral diseases, there are risks when it comes to avian diseases. It is not advisable to feed Bearded vultures on the carcasses of other birds, because of the risk of disease transmission. We have also been advised that the viral strains used to vaccinate poultry may be dangerous for vultures. Furthermore, poultry and day-old chicks are not recommended due to their low nutrient content.



Bearded vultures should not be fed on other birds, poultry, or day-old chicks, because of the risk of disease and low nutrient content.

Bearded vultures are not adapted to consuming putrefied food, like some other scavengers are. Food should therefore be provided fresh or freshly thawed daily. However, we do not recommend feeding a diet composed principally of frozen food, because it has recently been shown that levels of B vitamins are reduced during the thawing process by the enzyme thiaminase.

The osteophagus diet of the Bearded vulture leads to an increased need for water. Fresh water should therefore be provided at all times.

Summary:

- ☞ **For fully-grown birds, the Bearded vulture's diet should be composed of 70% bones and 30% soft tissue.**
- ☞ **By contrast, for chicks over four weeks old until they are fully grown, the dietary proportions should be reversed to 70% soft tissue and 30% bone (chicks below the age of 4 weeks should be fed on 100% soft tissue).**

- ☞ Bearded vultures should be fed on the meat and bones of domestic animals such as rabbits, guinea pigs, and rats (with the skin and fur left on), calves, goats, and sheep.
- ☞ Food should be fresh and large bones should be cut into pieces ~10cm long that can be swallowed easily.
- ☞ Sharp splinters of bone should be avoided, particularly from calf bones, because these can perforate the stomach or oesophagus.
- ☞ A diet composed principally of pig bones should be avoided, because of the possible risk of generalised arteriosclerosis.
- ☞ Birds, poultry, and day-old chicks should not be used as food because of the risk of disease transmission and low nutrient content.
- ☞ Avoid feeding birds only on frozen food because the enzyme thiaminase reduces levels of B vitamins during the thawing process.
- ☞ Do not feed using animals of wild or uncertain origin (e.g. shot animals, taxidermy carcasses, roadkill). These animals may have been shot with lead shot or bullets (which could cause lead poisoning) or have been poisoned themselves.

1. Food quality during the chick-rearing period

Chicks are fed by the parents on the day they hatch or, at the latest, on the following day. For the first few days, the food consists of small pieces of meat roughly the size of a lentil, free of skin, hair or hard tissue, mixed with saliva. This was observed by Thaler & Pechlaner (1979, 1980) in the pair at the Alpenzoo Innsbruck. In some cases, some of the meals during the first few days of the chick's life are made up almost entirely of saliva. This use of saliva has also been observed in the White-tailed eagle, Eagle owl, Bald eagle, and Lappet-faced vulture (Fentzloff, 1983; Wiemeyer, 1981; Mendelssohn & Marder, 1989). These authors also refer to the fact that saliva provides the chick with fluid to slake thirst, enzymes that help to digest food, and calcium to promote bone formation. A study carried out on Eagle owls showed that the amount of calcium in the saliva increased during the period of chick rearing (Fentzloff, 1983). This explains why chicks that are reared artificially on the same diet as their parents (meat only) often get rickets (Fentzloff, 1983; Thaler & Pechlaner, 1979, 1980; Wiemeyer, 1981).

Generally speaking, the diet for pairs that are rearing a chick should be the same as described above (in 'Recommendations Regarding Food Quality'). However, the chick's diet is composed principally of soft tissue: 100% soft tissue for the first four weeks, and 70% soft tissue thereafter. Therefore, sufficient quantities of meat should be available to the birds every day. Furthermore, food should be given fresh (not frozen and thawed).

Rats, guinea pigs, and rabbits weighing up to three kilos with the digestive tract removed are the best food to provide during the chick-rearing period. The parent birds prepare the food for the hatchling themselves. Normally, they remove the fur from the food outside the nest, before transferring it to the nest.

It is well known that most losses of Bearded vulture chicks happen during the first few days of a chick's life. The second¹ main cause of death in chicks is starvation due to loss of vision caused by rabbit fur stuck in the chick's eyes. To understand this problem, it is important to know that Bearded vulture chicks are not fed in the same way as other raptor chicks, where adults will put the food in the chick's bill. Instead, Bearded vulture chicks must take the food from its parent's bill. This means that if the chick is too weak (due to malnutrition) or has vision problems (because it has rabbit fur stuck in its eyes), it will not be able to take the food from its parent's bill, and will eventually starve. This is even more likely to happen when chicks are being reared by single adults, because the adult prepares the food right beside the chick. For this reason, it is advisable to skin rabbits before giving them to the birds during the first three weeks of the chick's life.

During this period it is necessary to pay special attention to the chick's eyes. Nest checks should be undertaken every 2-4 days for the first two weeks of the chick's life, to ensure that the chick's eyes are clean and do not have fur stuck in them. Video cameras installed at the nest site make it possible to check on the chick without performing nest checks in person, which can disturb the adult birds.



During the first four weeks of its life, the chick is fed on 100% soft tissue. To prevent chick deaths caused by fur sticking in their eyes, feed on skinned rabbits during the first three weeks of the chick's life.

Summary:

- ☞ **Ensure that sufficient soft tissue is available every day. During the first four weeks of a chick's life, it is fed on 100% soft tissue. Thereafter, it is fed on 70% soft tissue.**
- ☞ **Rats, guinea pigs, and rabbits weighing up to three kilos, with the digestive tract removed, are the best foods to provide birds with during the chick-rearing period.**
- ☞ **Avoid offering rabbits with fur during the first three weeks of the chick's life. Fur can stick in the nestling's eyes and cause its death.**
- ☞ **Avoid feeding principally on frozen food during the chick-rearing period.**

¹ The main cause of death in Bearded vulture chicks is yolk sac infections. The second main cause of death is starvation caused by loss of vision due to rabbit fur in the chick's eyes. In inexperienced breeding pairs, another main cause of death is the parents' inability to feed the chick properly.

FEEDING RHYTHMS AND QUANTITY

A shortage of food leads to competition for food between the pair and causes unnecessary fights. This can result in the death of one of the pair, especially during the breeding season when birds are naturally more aggressive. This has been observed in Bearded vultures. The problem has been avoided by feeding the birds every day *ad libitum*. For breeding Bald eagles, it is advised that birds only be fed by centre staff (Carpenter et al., 1987) and always at the same time of the morning, without entering the aviary. The same is recommended for Bearded vultures. When always fed at the same time every morning, the birds become accustomed to the routine. They then don't change their behaviour when they become more nervous during the breeding season.

The way food is provided can also lead to unnecessary fights. As is the case with Peregrine falcons, it is recommended that the same number of pieces of food are provided as there are birds in the aviary, to minimise confrontations (Cade et al., 1977). If birds are provided with at least one piece of food each at the same time, they can start feeding simultaneously and there will be less competition between the pair.

As mentioned above, wild Bearded vultures will eat twice a day, even on rainy days when their flight ability is reduced. The same behaviour has been shown in captive birds. Fast days can have a negative impact on the pair bond. Dominant birds can become more aggressive and begin to mob their partner. Fighting is a possibility if the pair bond is not strong. Fast days should therefore be avoided. At breeding centres, food is provided every day and *ad libitum*.

If fights over food occur even when birds are being fed *ad libitum*, there is a possibility that food is being stolen by rats or wild corvids. Rats or corvids may steal the food from the Bearded vultures' aviary a short time after feeding. This means that the Bearded vultures will only be able to feed once, in the morning, since by the evening the remainder of the food will have been taken away by the rats or corvids. It can often be difficult to tell that this is happening.

Outside the breeding season, a pair of Bearded vultures will require between 500 and 700 g of food per day. During the chick-rearing period, it is necessary to gradually increase quantities (especially of soft tissue).

Summary:

- ☞ **One Bearded vulture required between 250 and 350 g of food per day (500-700g for a pair). When rearing chicks, the requirement for soft tissue increases.**
- ☞ **Food should be provided every day and *ad libitum*.**
- ☞ **Food should be provided every morning at the same time, thus giving the birds the option of eating twice a day.**
- ☞ **At least as many pieces of food as there are birds in the aviary should be provided, to minimise confrontations.**
- ☞ **Avoid fast days, as these can have a negative impact on the pair bond.**
- ☞ **Be careful to avoid losses of food due to robbery by other species. Food shortages lead to competition for food between the pair and cause unnecessary fights.**

1. Food quantity during the chick-rearing period

The average weight of a Bearded vulture chick on hatching is 155.4g (n= 164 chicks). As in other birds of prey, weight is lost on the second day. In Bearded vultures this weight loss amounts to 4.47% of total body weight and birth weight is not regained until the third or fourth day. On average, chicks put on around 10% of their own body weight every day during the first two months of their life. The daily soft tissue requirement increases rapidly from 10% to 25% of the chick's weight.

A one week-old chick weighing 200g will therefore consume 25% of their own body weight – roughly 50g – every day. This is equivalent to one weaned rat weighing 70-80g. Consumption increases rapidly and daily, so that by one week later, the two week-old chick's requirements have doubled. By the time the chick is three weeks old, it may be triple the weight of the two week-old chick. At three weeks, the chick weighs around 1 kg and consumes 250-300g of food per day. That is equivalent to an adult (reproductive age) rat, which weighs around 500g with skin and entrails. At 35 days old, the chick reaches its maximum food consumption of around 500g per day -around double that of an adult bird. This can be achieved by feeding at least one fresh rabbit per day. This level of food consumption is maintained until they leave the nest.

Table 1: Average weight of Bearded vulture chicks (in grams) and average daily food requirements (in % of body weight)

DAY	1	2	3	4	5	6	7	8	9	10	14	21	28	40	60	120
Weight	155	148	151	161	174	188	208	228	250	275	420	980	1500	2300	5000	5500
%	1	11	19	20	25	25	25	27	27	27	25	25	25	25	10	10

It is very important to gradually increase the quantity of food provided as the chick grows, bearing in mind that during its last months in the nest a chick can eat half a kilo of food per day. The only way of knowing exactly how much food to provide is by observing how much food is left every day or by increasing the quantity if all the food has been eaten. The quantity of food required by a pair rearing a chick that is more than a month old is therefore 1000-1200g per day (equivalent to around 1500-1800 gross weight).

Summary:

- ☞ Chicks up to 5 days old consume 25% of their body weight daily.
- ☞ Aged 35 days, chicks reach their maximum food consumption of 500g/day, which is maintained until they leave the nest.
- ☞ The quantity of food consumed by a pair with a chick that is more than one month old is 1000-1200g per day.

FEEDING PLACES

For birds to be relaxed in their aviaries, it is important that they are familiar with the working practices of the centre. It is therefore advisable to install a feeding place in each aviary. The feeding place should measure 90 x 90cm and be placed close to the door and away from the nest. It should be possible to place food in the feeding place from outside the aviary. This should be done every morning at the same time. Birds can become so familiarised to this routine that even parent-reared birds have been known to take food from the hand of the staff member, through the aviary mesh.

In aviaries housing a larger numbers of birds (juvenile aviaries), several feeding places made of wood or stone should be installed in various different places throughout the aviary, such that each bird can eat above the floor and at a distance from the other birds. This is essential for subordinate birds.



The feeding place should be installed near the door and as far as possible from the nest. Food should be placed every morning at the same time, from outside the aviary.

Summary:

- ☞ Feeding places should be installed near the door and as far as possible from the nest.
- ☞ Food should be provided at the same time every morning, from outside the aviary.
- ☞ **Never enter the aviary to feed the birds. They may react aggressively, especially during the breeding season.**

EXAMPLES OF FOOD

1. Eviscerated rabbits (large and small)



Large rabbits weighing 3-3.5kg will weigh 2.7-3kg when eviscerated.

Small rabbits weighing 1-1.2kg will weigh 0.8-1kg when eviscerated.



Left: Small, eviscerated rabbit divided into portions of adequate size for feeding adult birds outside the chick-rearing period. One rabbit of this size can be divided into three portions.

Right: Large, eviscerated rabbit divided into portions of adequate size for feeding a breeding pair with a chick. One rabbit of this size can be divided into seven portions, plus the head. **A breeding pair with a chick that is more than 35 days old will require around four pieces per day.** For the first three weeks of the chick's life, rabbits should only be provided skinned, as rabbit fur can stick in the chick's eyes, leading to its death.

2. Skinned mutton



Left: When feeding skinned mutton to adult birds outside the chick-rearing period, it is necessary to remove the excess meat from the bones. The diet of adult birds is 70% bone.

Right: When feeding skinned mutton to birds during the chick-rearing period, meat should not be removed from the bone, as the proportion of soft tissue required is higher.



Mutton prepared for adult birds. Because birds in captivity are not able to break bones, the food is prepared by chopping it up into pieces using an axe. The vertebrae of adult sheep are also too large for a Bearded vulture to swallow whole. The spines of adult sheep are therefore not suitable food and are not used by birds in the wild when rearing chicks. In captivity, however, as long as the spine is chopped up with an axe, breaking up the vertebrae, and leaving the meat on the bones, it can be a wonderful food for pairs rearing chicks. Above is an example of pieces suitable for one fully-grown bird (total weight of around 300-400g).

3. Food combinations



An excellent combined diet for a fully-grown Bearded vulture is the head of a small rabbit (~200g), with three sheep legs (~100g each = ~300g), or the head of a large rabbit (~400g,) with two sheep legs (~100 g each= ~200g).

BIBLIOGRAPHY

- ANONYM (1978): Lammergeier *Gypaetus barbatus*. Red data book of the Kazakh SSR. Part 1, Vertebrates, "Kainar", Alma-Ata, pp. 143-145. (Russian)
- BOUDOINT, Y. (1976): Techniques de vol et de cassage d'os chez le Gypaète barbu. *Alauda* **44**, 1-21.
- BROWN, C.J. (1988): A study of the Bearded Vulture *Gypaetus barbatus* in southern Africa. Diss., Zool. Inst. Univ. Natal, pp. 572.
- BROWN, L.H., URBAN, E.K., NEWMAN, K. (1982): *Gypaetus barbatus* (Linnaeus). Lammergeier; Bearded Vulture, Gypaète barbu. The birds of Africa. Vol. 1, Academic Press, London, pp. 318-321.
- CADE, T.J.; WEAVER, J.D.; PLATT, J.B. & BURNHAM, W.A (1977): The propagation of large falcons in captivity. *Raptor Research* **11**(1/2): 28-48.
- CARPENTER, J.W.; GABEL, R.R. & WIEMEYER, S.N. (1987): Captive Breeding. En: Pendleton, B.A.G.; Millsap, B.A.; Kline, K.W. & Bird, D.M. (Eds.): Raptor Management Techniques Manual. National Wildlife Federation, Washington, p. 349-370.
- DONAZAR, J.A. (1993): Los buitres Ibéricos. Biología y conservación. 1 ed., J.M. Reyero, Madrid.
- FENTZLOFF, C. (1983): Breeding, artificial incubation and release of White-tailed sea eagles *Haliaeetus albicilla*. *Int. Zoo Yb.* **23**: 18-35.
- GIRTANNER, A. (1879): Zur Pflege und Ernährung des Bartgeiers in der Gefangenschaft. *Mitt. orn. Ver. Wien* **3**, 112-115.
- GRUBAC, R.B. (1987): The biology of the Lammergeier (*Gypaetus barbatus aureus*). Technical document.
- HIRALDO, F., DELIBES, M., CALDERON, J. (1979): EL Quebrantahuesos: sistemática, taxonomía, biología, distribución y protección. Monografías 22, ICONA, Madrid.
- HOUSTON, D.C., COPSEY, J.A. (1994): Bone digestion and intestinal morphology of the Bearded Vulture. *J. Raptor Res.* **28**, 73-78.
- HUXLEY, J. (1963): Lammergeyer *Gypaetus barbatus* breaking bones. *Ibis* **105**, 106-107.
- KELLER, F.C. (1886): Der Bartgeier (*Gypaetus barbatus* Brisson.). In: DOMBROWSKI, R. (Ed.): Allgemeine Encyclopedie der gesamten Forst- und Jagdwissenschaften. M. Perles, Wien u. Leipzig, S. 1-12.
- LLOPIS, A. (1996): Untersuchung zur Ernährung freigesetzter Bartgeier (*Gypaetus barbatus*). Diss., Vet. Med. Uni. Wien, pp. 313.
- MENDELSSOHN, H. & MARDER, U. (1989): Reproduction of the Lappet-facet vulture *Torgos tracheliotus negevensis* at Tel Aviv University Research Zoo. *Int. Zoo Yb.* **28**: 229-234.
- MUNDY, P., BUCHART, D., LEDGER, J., PIPER, S. (1992): Bearded Vulture *Gypaetus barbatus*. The vultures of Africa. Academic Press, London, pp. 202-219.
- THALER, E. & PECHLANER, H. (1979): Volierenzucht und Handaufzucht beim Bartgeier (*Gypaetus barbatus aureus*): Beobachtungen aus dem Alpenzoo Innsbruck. *Gefiederte Welt* **2**: 21-25.
- THALER, E. & PECHLANER, H. (1980): Cainism in the Lammergeier or Bearded Vulture at the Alpenzoo Innsbruck. *Int. Zoo Yb.* **20**: 270-280.
- THIBAUT, J.C., VIGNE, J.D., TORRE, J. (1993): The diet of young Lammergeiers *Gypaetus barbatus* in Corsica: its dependance on extensive prazing. *Ibis* **135**, 42-48.
- VITOVICH, O. A., TKACHENKO, I. V., PISHVANOV, Yu. V., PRILUTSKAYA, L. I. (1988): Lammergeier. Resources of rare animals of the RSFSR, their conservation and reproduction. Moscow, Pp. 98-99. (Russian)
- WIEMEYER, S.N. (1981): Captive propagation of Bald eagles at Patuxent Wildlife Research Center and reintroductions into the wild, 1976-80. *J. Raptor Research* **15** (3): 68-82.