The Old School, Brewhouse Hill, Wheathampstead,
Hertfordshire AL4 8AN, UK

Animal Welfare 2007, 16: 369-374
ISSN 0962-7286

Effects of feeding enrichment on the behaviour and welfare of captive Waldrapps (Northern bald ibis) (Geronticus eremita)

HE Vargas-Ashby and SJ Pankhurst*

Environmental Sciences Research Centre, Anglia Ruskin University, East Road, Cambridge CB1 1PT, UK
* Contact for correspondence and requests for reprints: s.j.pankhurst@anglia.ac.uk

Abstract

*One of the contributing factors leading to the development of serious foot problems such as bumblefoot (pododermatitis) in captive birds is an abnormally sedentary lifestyle. This study investigated the effects of feeding enrichment on the activity levels of a captive colony of seven Waldrapps or Northern bald ibis (*Geronticus eremita*) at Tilgate Nature Centre in Sussex. After the introduction of a simple and inexpensive feeding enrichment device, the proportion of time the ibis spent inactive on perches was significantly reduced, with a corresponding increase in the proportion of time allocated to active behaviours such as walking, flying and foraging on the ground. Feeding enrichment, over the longer term, also resulted in a significant reduction in levels of aggression between individuals within the colony. The scope of this study is limited by the relatively small sample size, but nevertheless the findings suggest that the use of feeding enrichment for captive Waldrapp ibis has a number of beneficial effects.*

Keywords: *animal welfare, bumblefoot, feeding enrichment, Northern bald ibis, pododermatitis, Waldrapp ibis*

Introduction

One of the basic goals of animal welfare is to maintain animals in good physical health (Young 2003). Bumblefoot (pododermatitis) is a serious health problem affecting many species of captive birds (eg raptors, Rodriguez-Lainz *et al* 1997; penguins, Reidarson *et al* 1999; waterfowl, Bourne & Boardman 2000; falcons, Naldo & Samour 2004). If left untreated, it can become chronic, progressive, invasive and eventually disabling, resulting in death (Reidarson *et al* 1999).

The major contributing factors leading to the development of bumblefoot in birds in captivity are the bird's weight, trauma, lameness from other causes, generalised illness, the substrate surface type and, most commonly, an abnormally sedentary lifestyle (Reidarson *et al* 1999; Bourne & Boardman 2000). Due to abnormal weight-bearing on one portion of the foot (tarsal pads), the blood supply to these areas is compromised, leading to a reduction in the local skin defence system and allowing normal epithelial microbial inhabitants (such as *Staphylococcus aureus*) to penetrate these defences and enter the foot (Samour 2000).

Treatment of bumblefoot is complicated and protracted and the need for repeated capture and handling of birds in order to administer injections and change dressings is likely to be stressful (Rupley 1997). On welfare grounds, therefore, prevention rather than cure is desirable.

The Northern bald ibis, also known as the Waldrapp ibis, (*Geronticus eremita*), is one of the world's most critically endangered birds (Brindley *et al* 1995), with an estimated wild population of fewer than 250 birds in the Agadir region of Morocco (Boehm 2003; Bowden *et al* 2003, but see Serra *et al* 2004 for a report of the recent discovery of a relict breeding colony in Syria).

Due to the precarious situation of this bird in the wild, the success of long-term captive management is highly important. A mortality survey for this species in captivity, carried out between 1999 and 2003 (Quevedo 2003), showed that euthanasia was the most common cause of death (19.4%) and that, of the birds that were euthanased, bumblefoot and other foot problems accounted for 16.6% of cases.

Wild Waldrapps forage for six to eight hours every day, using their long bill to probe under stones, in crevices and in tufts of vegetation for prey such as earthworms, insects and small reptiles (Cramp & Simmons 1977; Kotrschal 2003). In captivity, however, these birds may spend only several tens of minutes once or twice a day foraging, depending on the feeding schedule, as clumped food sources provide few foraging opportunities. Enrichment regimes that increase overall activity have been shown to reduce the incidence of leg abnormalities and foot problems such as bumblefoot in other captive bird species (eg in Adelie penguins [*Pygoscelis adeliae*], Reidarson *et al* 1999; in falcons, Muller *et al* 2000; in domestic poultry, Bizeray *et al* 2002).

The aim of this study was to investigate the effects of feeding enrichment on activity levels of birds in a captive colony of Waldrapps, with the specific goal of reducing the

amount of time spent by the birds inactive and/or on perches.

Materials and methods

This study was carried out between 9th June and 24th September 2003 at Tilgate Nature Centre, Sussex (0.10ºW, 51.05ºN).

The study animals were a breeding colony of seven Waldrapp ibis, comprising two males and five females, aged between seven and fourteen years old. The Waldrapps were housed in a mixed-species exhibit in a large outdoor aviary, along with two Eurasian spoonbills (*Platalea leucorodia*), Gough Island moorhens (*Gallinula comeri*), one purple gallinule (*Porphyrio madagascariensis*), two red-billed choughs (*Pyrrhocorax pyrrhocorax*), and one Guinea pigeon (*Columba guinea*).

The birds were housed in a weld-mesh aviary measuring 20 × 15 m (length × breadth) and with a variable height (due to the sloping site) of between 5 and 7 m. For shelter, the two rear corners had timber-clad sides and translucent sheeting roofs.

At the front of the aviary, large public viewing windows offered uninterrupted views of the birds and provided additional shelter from wind. At the time of the study, the aviary had a natural-looking backdrop containing a dense stand of mature *Rhododendron ponticum*. In the central part of the enclosure, there were areas of grass, a small spring-fed pond, and two banks of large sandstone boulders. Wide plywood shelf-like perching was provided at different heights around the aviary's two central telegraph poles; long sections of natural tree branches offered additional perching. For nesting, banks of plywood open-fronted boxes were secured at the top of the back wall beneath the roofed sections in the two rear corners; here there were also further perching of lengths of half-round timber fixed curve-side up.

Management regime prior to study

The normal management regime for the birds prior to the start of the enrichment trial was feeding twice a day, at 0930h and again at 1730h. The morning feed consisted of Febo Professional Dog Biscuits, Spillers UK (SDS Diet A, Mazuri Zoofoods, Witham, England) soaked overnight; hard-boiled eggs (grated), whitebait, mealworms, and grated carrot and lettuce. This feed was presented in two large bowls, which were placed on pedestals 50 cm above the ground. A sufficient quantity was given to allow for a slight surplus and the bowls and any uneaten food were removed during the evening feed.

The early evening feed consisted of quartered day-old poultry chicks, which were scattered over the sandstone boulders. The dietary items given in the evening feed were favoured over those given in the morning and were generally consumed by the Waldrapps within a matter of several minutes. Cleaning of the aviary was carried out twice per week.

Design of feeding enrichment

In consultation with the keepers at Tilgate, it was decided that the morning feeding regime should not change, since this food was intended for all of the bird species within the aviary. The ibis's early evening feed, which was provided solely for them, provided the greatest potential for manipulation and enrichment. This feed was replaced by an afternoon feed, using a new enrichment device.

A simple but robust enrichment device was developed, consisting of a 40 cm long wire mesh triangular tube suspended from a branch and pegged into the ground. The holes in the wire mesh measured 25 × 12.5 mm (it was thought that holes of a smaller diameter might cause damage to the ibis's beaks). Twenty whole day-old dead poultry chicks were placed inside the tube (Figure 1).

Because a whole chick would not fit through the holes in the mesh tube, the ibis would have to pull/peck off small pieces at a time; the movement of the suspended tube posed an additional foraging challenge to the birds.

The enrichment device was provided at 1300h each day, as opposed to the evening, in order to allow the birds a longer period of time to manipulate and acquire the food. Strict hygiene controls were placed on the maintenance of the enrichment device as it has been suggested that day-old poultry chicks can be a source of poultry pathogens, such as *Salmonella enteritidis*, especially when left uneaten or partly uneaten for periods during which bacterial proliferation can occur (Kirkwood *et al* 1994). To reduce the risk of *Salmonella* infection, two feeders were constructed and used on alternate days, with one left soaking overnight in a strong antibacterial solution (DuPont's Antec® Farm Fluid S) diluted 1:200 whilst the other was in use. The enrichment device was removed in the evening, so that any uneaten chicks were not left overnight. To further reduce the risk of infection, all day-old chicks fed at Tilgate were obtained from a reputable supplier practicing routine *Salmonella* vaccinations of its breeding hens.

Experimental design and data collection

This was a three phase study, consisting of a two week pre-enrichment period (phase one) where baseline data were collected, followed by a two week enrichment trial (phase two) using the feeding device. Keepers at Tilgate continued to use the enrichment device on a daily basis after this period, but no further data were collected until an interval of eight weeks had elapsed, to allow the ibis time to adjust to the device and to permit any novelty effects to subside. The final phase of the study (phase three) was then carried out, comprising data collection over a further two weeks to investigate the long-term effects of the enrichment device on the behaviour of the birds.

Instantaneous scan sampling of focal animals was used to collect data (Martin & Bateson 1993), with a one-minute scan time interval (determined after a preliminary heuristic study comparing data from continuous recording and data from instantaneous measures). Each observation period

https://doi.org/10.1017/S0962728600027184 Published online by Cambridge University Press

lasted for one hour and observation periods were distributed evenly throughout the day, from 0530 to 2000h. At each scan, the behaviour of the focal bird and its position in the aviary (perch or ground) was recorded onto pre-printed check sheets. Individual birds were easily identifiable by unique numbered leg bands.

Potential sources of disturbance to the birds were also noted *ad libitum* during the study and the cause of the disturbance was categorised as either keeper disturbance or visitor disturbance (eg particularly loud or large groups of people and/or behaviours such as visitors banging on the glass window at the front of the exhibit).

Statistical analysis

Data from behavioural observations were entered onto the SPSS (version 11.0.0) statistical software package for analysis (Copyright© SPSS Inc, 1989-2001). Before any analysis was performed, data collected from focal follows of individual birds were aggregated, to ensure independence of data points. All data were then tested for normality using a Kolmogorov-Smirnov goodness of fit test (Sokal & Rohlf 1994).

Since the data were found not to be normally distributed and the sample size (n = 7) was small, non-parametric statistical tests such as the Kruskal-Wallis and Mann-Whitney *U* tests were used (Siegel & Castellan 1988; Sokal & Rohlf 1994). Except where otherwise stated, two-tailed tests were used to provide levels of significance, with rejection of the null hypothesis at $P < 0.05$.

The introduction of the feeding enrichment device had a significant effect on the behavioural time budgets of the birds, with a reduction in stationary behaviour and a corresponding increase in the proportion of time spent in active behaviours on the ground such as walking, probing, and food bowl use; there was also a notable increase in time spent flying (Table 1, Figure 2).

The resultant changes in the behavioural time budgets of the ibis after the addition of the enrichment device led to a significant decrease in the amount of time they spent up on perches ($P < 0.001$), and a corresponding increase in the amount of time they spent on the ground (Figure 3).

The increase in the proportion of time spent in active behaviours was still evident in phase three of the study, after the enrichment device had been in place in the enclosure for eight weeks (Table 1, Figure 2).

During the pre-enrichment phase, there was no significant difference in aggressive behaviour between individuals ($P = 0.44$, ns) but during phase two of the study, immediately after the introduction of the feeding device, there was a significant difference between individuals in the level of aggression displayed ($P = 0.035$). This increase in aggression was short-lived, however, and had disappeared by phase three of the study ($P = 0.66$, ns)

Despite these changes in individual levels of aggressive behaviour after the initial introduction of the feeding enrichment, there was no significant difference between individual birds in the use of the enrichment device during phases two and three of the study ($P = 0.88$, ns; $P = 0.93$, ns, respectively). In other words, dominant birds were unable to monopolise the enrichment device and prevent other birds from accessing the food.

Figure 1

Waldrapp ibis at feeding station.

Effects of disturbance on behaviour

Probing (foraging) behaviour decreased significantly both when keepers were present and when the ibis were disturbed by large or noisy groups of visitors ($P < 0.001$). Use of the feeding enrichment device, however, was not affected by visitor/keeper disturbance ($P = 0.32$, ns) nor did human disturbance influence the amount of time the birds spent on the ground rather than on the perches at the back of the enclosure $P = 0.18$, ns).

Discussion

Low levels of activity and a high proportion of time spent perching have been implicated as two key risk factors contributing to the development of bumblefoot in captive birds (Rupley 1997; Reidarson 1999; Bourne & Boardman 2000; Samour 2000; Tully *et al* 2000). One of the main recommended preventative measures for bumblefoot in captive birds is to promote blood circulation to the feet by encouraging adequate exercise. Of equal importance is a management regime that reduces the amount of time spent on perches, to prevent the development of pressure sores (Samour 2000; Tully *et al* 2000).

The results of this study suggest that the use of a simple feeding enrichment device for Waldrapp ibis is likely to reduce the chance of these birds developing bumblefoot, by promoting a more active lifestyle. In many enrichment studies, an increase in the time spent foraging by animals is equated with a general improvement in their welfare status (Young 1997, 2003) and similar beneficial results of feeding enrichment have been demonstrated for other bird species in

https://doi.org/10.1017/S0962728600027184 Published online by Cambridge University Press

Table 1 Median values for the proportion of time spent in different behaviours at each of the three phases of the study.

Behaviour	Phase one	Phase two	Phase three	Kruskal-Wallis χ^2 (df = 2)	*P*-value
Stationary	0.61 (0.18)	0.34 (0.22)	0.33 (0.20)	83.839	< 0.001
Preening	0.28 (0.20)	0.27 (0.25)	0.22 (0.21)	3.873	0.144, ns
Walking	0.05 (0.07)	0.21 (0.25)	0.22 (0.15)	74.773	< 0.001
Flying	0.00 (0.02)	0.02 (0.03)	0.02 (0.02)	47.223	< 0.001
Probing	0.00 (0.02)	0.03 (0.11)	0.05 (0.08)	43.094	< 0.001
Food bowl use	0.00 (0.00)	0.00 (0.00)	0.00 (0.09)	15.829	< 0.001
Enrichment use	-	0.00 (0.05)	0.00 (0.11)	*U* = 3,514.00*	0.002
Aggression	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	2.031	0.362, ns
Submission	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	2.961	0.228, ns
Other	0.00 (0.02)	0.00 (0.02)	0.00 (0.01)	2.335	0.311, ns
Perch use	1.00 (0.00)	0.87 (0.37)	0.73 (0.46)	56.531	< 0.001
Ground use	0.00 (0.00)	0.13 (0.37)	0.27 (0.46)	58.273	< 0.001

Interquartile ranges are given in parentheses. Data are from focal animal follows (n = 7 birds).
* Mann-Whitney *U* test.

captivity (eg raptors, Rodriguez-Lainz *et al* 1997; penguins, Reidarson *et al* 1999 and falcons, Müller *et al* 2000).

There are two further respects in which feeding enrichment may help to prevent the development of bumblefoot. Firstly, Tully *et al* (2000) has suggested that avoidance of captive birds becoming overweight is important; secondly, Hogan and Craig (1987) have suggested that foot injury from overgrown claws can be a contributing factor to the development of the disease. Any increase in the overall activity levels of Waldrapps in captivity is likely to help to ensure that these birds do not become overweight. The feeding device changed the way in which food was presented to the birds, but there was no overall change in the amount of food offered each day. An increase in time spent walking on the ground, demonstrated in this study after the enrichment was introduced, should also ensure that the claws of the ibis do not become overgrown.

Other behavioural and health benefits likely to arise from the provision of feeding enrichment, particularly where this substantially increases foraging time, are an increase in mental stimulation for the birds, by encouraging the cognitive processes involved in attaining a desired food source, and a change in behavioural time budgets to more closely reflect foraging behaviour by wild Waldrapps. Although there are no plans at present to reintroduce any of the birds in the Tilgate colony back into the wild, a key goal of any captive breeding initiative should be to maintain, as far as possible, the 'wild' behavioural repertoire of the species.

A welcome outcome of this study was the finding that the use of the feeding enrichment device by the birds did not decline as a consequence of long-term use and that, even after an extended period, enrichment was still having a positive influence on activity levels.

Aggressive interactions between birds

Before feeding enrichment, there was no significant difference in aggressive behaviour between individuals. The immediate effect of enrichment, however, was a temporary increase in aggression between individuals (in the form of beak motions towards other birds and increased vocalisation), raising concerns about the welfare of subordinate birds. The behaviour of the birds was monitored carefully at this stage of the study and, had there been any risk of harm to any individual bird, the feeding device would have been removed and the enrichment trial halted. The increase in aggression was short-lived, however, and was no longer evident in phase three of the trial.

Another factor that was closely monitored throughout the study was whether certain individuals were monopolising the enrichment device and preventing other birds from gaining access to the food. There was no evidence to suggest that this was the case. Indeed, this method of feeding day-old chicks (which are a highly desired food item for this species) appeared to result in a more equitable distribution of the resource; prior to the enrichment trial, quartered day-old chicks were simply scattered on the rocks in the enclosure, where they were quickly seized and eaten by the more dominant birds.

Animal welfare implications

This study demonstrates that the use of a simple feeding enrichment device can promote a significant increase in activity in captive Waldrapps or Northern bald ibis, thus reducing the likelihood of the development of bumblefoot (a serious and potentially debilitating disease) in these critically endangered birds.

The introduction of the enrichment device used in this study produced a short-term rise in aggression between individuals, although this was followed over the longer term by a

https://doi.org/10.1017/S0962728600027184 Published online by Cambridge University Press

Figure 2

The effect of the feeding enrichment device on the behavioural time budgets of the ibis, comparing phase 1 (pre-enrichment versus phases 2 and 3 (post-enrichment) of the study. Bars represent median values and vertical lines show interquartile ranges.

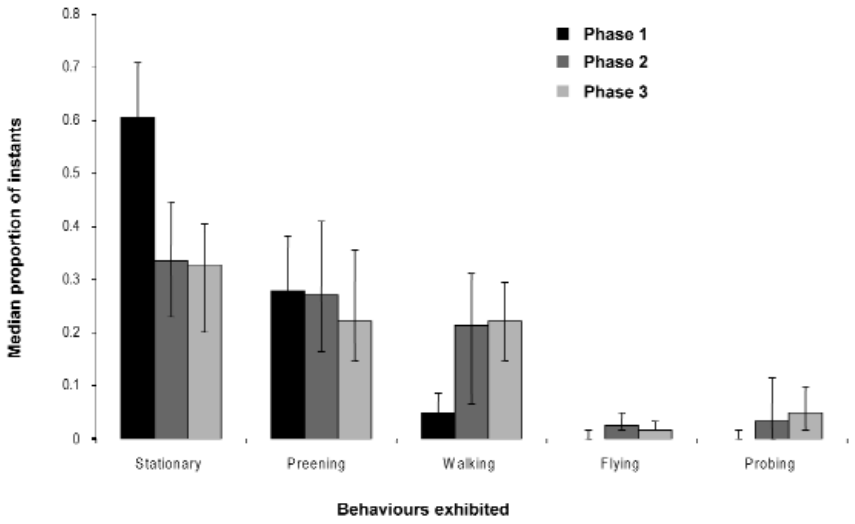
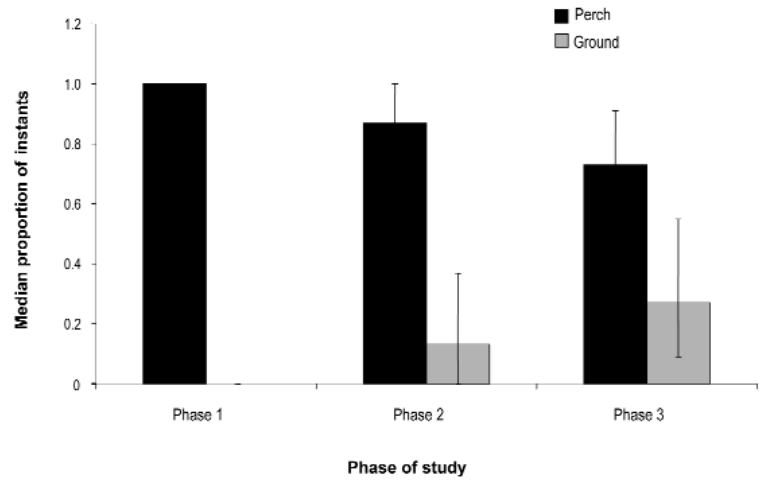


Figure 3

The proportion of time spent on perches versus time spent on the ground for each phase of the study. Bars show median values and vertical lines show interquartile ranges.



significant reduction in the overall incidence of aggression in the colony. It is recommended, however, that if a similar method of enrichment is employed in larger captive colonies of Waldrapps, more than one device should be installed, to reduce the potential for aggressive competition between conspecifics.

Some disturbance to the birds by visitors and by keepers is inevitable and difficult to avoid, especially during busy periods such as school holidays, but the provision of refuges within the enclosure could help to reduce the impact of large or noisy groups.

There is some scope for increased use of ornamental planting as a partial barrier in front of the enclosure, to increase the distance between birds and visitors without greatly compromising the visitors' view of the enclosure. This measure, together with additional explanatory signage, could help to mitigate disturbance of the birds whilst the enrichment device is in use.

Although the presence of visitors and staff did not significantly affect the birds' use of the enrichment device in this study, the positioning of the device should be carefully considered; this should be in an area where, if the birds

https://doi.org/10.1017/S0962728600027184 Published online by Cambridge University Press

become startled, they can fly up without danger of becoming caught in overhanging vegetation etc.

It became apparent during the course of the study that not all members of the public viewed the feeding of day-old chicks in a positive light. We suggest that the placement of an explanatory sign near the enclosure could help to mitigate any adverse reaction by visitors, by providing information about the use of feeding enrichment to improve the welfare of captive animals and also explaining that the cockerel chicks used in the feeding device are a by-product of the egg industry and are widely used as animal feed.

Recommendations for future studies

The authors acknowledge that this study would have benefited from the addition of an extra phase to observe the effects, if any, on Waldrapp behaviour of moving the early evening feed to the afternoon, but without the use of the enrichment device. Future studies would also benefit from access to a colony with a larger number of birds, to increase the sample size, and from veterinary inspection and some form of scoring of foot condition of each bird prior to the start of the study and again at the end of the study.

Author's note

Since this study was carried out in 2003, the feeding enrichment device has remained in regular use in the Waldrapp ibis enclosure at Tilgate Nature Centre. Keepers report that two ibis chicks which hatched in 2006 are also now feeding from the device. There have been no injuries to the birds from using the feeder and, gratifyingly, no foot problems among the ibis.

Acknowledgements

This work was supported by a vacation scholarship awarded by the Universities Federation for Animal Welfare and we are most grateful to UFAW for their support. We would also like to thank Gary Clarke, Simon Woodard and all the staff at Tilgate Nature Centre for their enthusiasm and co-operation throughout the study. Grateful thanks are also due to Christopher Bowden at RSPB International Research; to Mrs Ashby for support with transport and logistics; to Christiane Boehm, Alpenzoo Innsbruck-Tirol; to Miguel A Quevedo DVM, ZooBotánico Jerez, and to two anonymous referees for their helpful comments on this manuscript.

References

Altman JD 1998 Animal activity and visitor learning at the zoo. *Anthrozoös 11:* 12-21

Bitgood S, Patterson D and Benefield A 1988 Exhibit design and visitor behaviour: Empirical relationships. *Environment and Behaviour 20:* 474-491

Bizeray D, Estevez I, Leterrier C and Faure JM 2002 Effects of increasing environmental complexity on the physical activity of broiler chickens. *Applied Animal Behaviour Science 79:* 27-41

Boehm C 2003 The Northern Bald Ibis EEP – an overview. In: Boehm C, Bowden C and Jordan M (eds) *Proceedings of the International Advisory Group for the Northern Bald Ibis (IAGNBI) meeting Alpenzoo Innsbruk, Tirol, Austria* pp 33-35. IAGNBI, RSPB: Bedfordshire, UK

Bourne DC and Boardman SI 2000 *Waterfowl: Health and Management* (CD Rom) Wildlife Information Network. www.wildlifeinformation.org

Bowden CGR, Aghnaj A, Smith KW and Ribi M 2003. The status and recent breeding performance of the critically endangered Northern Bald Ibis *Geronticus eremita* population on the Atlantic coast of Morocco. *Ibis 145(3):* 419-431

Brindley E, Dimmick C, Bowden C, Ribi M, Hoffmann D and del Nevo A 1995 The Bald Ibis: a Species on the Brink? *RSPB Conservation Review 9:* 76-79

Cramp S and Simmons KEL 1977 *The Birds of the Western Palearctic 1*. Oxford University Press: Oxford, UK

Hogan LS and Craig LD 1987 Successful treatment of bumblefoot in canaries. *Modern Veterinary Practice 68:* 30-30

Kirkwood JK, Cunningham AA, Macgregor SK, Thornton SM and Duff JP 1994 *Salmonella enteritidis* excretion by carnivorous animals fed on day-old chicks. *Veterinary Record 134:* 683-683

Kotrschal K 2003 The Grünau Project: Establishing a non-migratory Northern Bald Ibis colony from zoo offspring. In: Bowden C (ed) *IAGNBI Newsletter 2: An update on current projects involving wild and captive Northern Bald Ibis* Geronticus eremita. IAGNBI, RSPB: Bedfordshire, UK

Martin P and Bateson P 1993 *Measuring Behaviour: An Introductory Guide, 2nd edition.* Cambridge University Press: Cambridge, UK

Müller MG, Wernery U and Kösters J 2000 Bumblefoot and lack of exercise among wild and captive-bred falcons tested in the United Arab Emirates. *Avian Diseases 44:* 676-680

Naldo JL and Samour JH 2004 Causes of morbidity and mortality in falcons in Saudi Arabia. *Journal of Avian Medicine and Surgery 18:* 229-241

Quevedo MA 2003 The diseases and health problems known for the Northern Bald Ibis in captivity. In: Boehm C, Bowden C and Jordan M (eds) *Proceedings of the International Advisory Group for the Northern Bald Ibis (IAGNBI) meeting Alpenzoo Innsbruk, Tirol, Austria* pp 46-50. IAGNBI, RSPB: Bedfordshire, UK

Reidarson H, McBain J and Burch L 1999 A novel approach to the treatment of bumblefoot in penguins. *Journal of Avian Medicine and Surgery 13:* 124-127

Rodriguez-Lainz AJ, Hird DW, Kass PH and Brooks DL 1997 Incidence and risk factors for bumblefoot (pododermatitis) in rehabilitated raptors. *Preventive Veterinary Medicine 31:* 175-184

Rupley AE 1997 *Manual of Avian Practice*. WB Saunders Company: Philadelphia, USA

Samour J 2000 *Avian Medicine*. Mosby: London, UK

Serra G, Abdallah M, Assaed A, Abdallah A, Al Qaim G, Fayad T and Williamson D 2004 Discovery of a relict breeding colony of northern bald ibis *Geronticus eremite* in Syria. *Oryx 38:* 106-108

Siegel S and Castellan NJ 1988 *Nonparametric Statistics for the Behavioural Sciences, 2nd edition.* McGraw-Hill International: Singapore

Sokal RR and Rohlf FJ 1994 *Biometry: The Principles and Practice of Statistics in Biological Research, 3rd edition.* WH Freeman & Co: New York, USA

Tully TN, Lawton MPC and Dorrestein GM 2000 *Avian Medicine.* Butterworth-Heinemann: Oxford, UK

Young RJ 1997 The importance of food presentation for animal welfare and conservation. *Proceedings of the Nutrition Society 56:* 1095-1104

Young RJ 2003 *Environmental Enrichment for Animals*. UFAW Animal Welfare Series. Blackwell Publishing: Oxford, UK

https://doi.org/10.1017/S0962728600027184 Published online by Cambridge University Press