GREAT WESTERN EXOTIC VETS

BECAUSE EXOTIC PETS NEED EXOTIC VETS

DISEASE CONTROL AND REHABILITATION IN A COLLECTION OF RAPTORS

NEIL A FORBES BVETMED RFP DIPECAMS FRCVS
Great Western Exotic Vets
Unit 10 Berkshire House, County Park,
Shrivenham Road, Swindon, SN1 2NR
www.gwexotics.com

When dealing with the welfare of a larger collection of birds, either in a private collection, in a breeding centre, in a zoological garden or in a falconry centre, disease control is of particular importance.

In most facilities birds are kept in large numbers closely together in a limited space. Particularly if the collection maintains numerous birds of the same breed, the birds represent a flock with a similar gene pool, which means that the total of the birds is equally susceptible to disease and a disease outbreak is facilitated. The natural gene pool of a population contains a wide variety of hereditary characteristics and enables the population to adapt to different selective forces such as climate conditions, predators, food competitors, and diseases. For populations in aviculture, where the number of individuals can be very limited, especially in endangered species, the variability of hereditary characteristics can become very low. As with inbreeding recessive characteristics will occur more often, there will be a higher frequency of hereditary abnormalities, decline of viability, and decrease of reproduction. Birds in captivity will become more adapted to the protective environment with consequences such as degeneration and domestication. These issues make it a difficult challenge to ensure that populations in captivity can be used for reintroduction and to prevent the extinction of endangered species in nature and within aviculture (HOIIMEIJER, 2000).

There will also be movements of birds within the collection and between collections. Furthermore, the public cares increasingly for wild injured birds, which are anxiously brought to zoos or falconry centres for help. It is important to realise and address those factors of risking to spreading disease in a collection to provide good flock health.

IDENTIFICATION, MANAGEMENT PLAN, AND RECORD KEEPING SYSTEM

Breed, sex and age should be clarified for each individual in a collection. Each bird should be permanently identified. If the bird has not already been fitted with a closed or open band a microchip transponder can be placed into the pectoral muscles. The disadvantage of relying on bands as a mean of identification is that the numbers can become unreadable with time and that birds can destroy bands, with the potential risk

of self-trauma. Furthermore, metal bands left on legs of birds exposed to sub-freezing temperatures can contribute to frostbite (CLUBB and FLAMMER, 1994).

A management plan should consider following services: resident and new bird examinations, maintaining detailed records about all birds in the collections, establishing a preventive care program where necessary, considering husbandry aspects, providing emergency care, preparing an action plan in face of a disease outbreak, and evaluation of reproductive failure. In order to manage a collection and to permit disease control, but also prevent problems such as cage mate aggression, the management plan must be tailored to each species, to include the following: enclosure(s); current and desired numbers of birds; breeding priority and preferred rearing method; proposed disposition of surplus individuals; co-operative programmes; and specific exhibition, conservation, and research objectives (DERRICKSON and PICKETT, 1991).

An accurate record keeping system about birds entering the facilities, remaining in the facilities and leaving the facilities is of fundamental importance. A computer programme such as the 'Animal Record Keeping System (ARKS)' (ISIS; Apple Valley, Minnesota, USA) (DERRICKSON and PICKETT, 1991) allows individual birds to be located; it records where birds have previously been housed; maps the movement of diseased birds within the collection; facilitates identification of potential problem areas; prepares preventative medicine protocols; and establishes emergency disaster relief plans. Disease occurrence is generally not random; patterns of disease may suggest that endemic disease is associated with underlying geographic features. Post release records such as BTO ringing allow tracking and identifying the rehabilitated birds. That may provide valuable information about movements of the birds and successful rehabilitation. MEDARKS (ISIS; Apple Valley, Minnesota, USA) the software, which interfaces with ARKS, may also be useful. Other popular geographical Information systems are ArcView, ARC/INFO (Environmental Systems Research Institute, Inc., Redlands, CA, USA), and MapInfo (MapInfo Corporation, Troy, NY, USA) (BRIGHT, 2000).

QUARANTINE

The role of quarantine as the first line of defence against diseases must be emphasised. New birds must undergo thorough screening at the beginning of quarantine. Quarantine facilities should be isolated roofed buildings with their own water supply and drainage. Hygiene practices should include foot-baths, the regular disinfection of equipment, which is specific to the quarantine area and weekly power hosing and cleaning. If possible, each unit should have access to a separate outdoor pen. This area would have to be enclosed by a solid roof and side netting to prevent access of pest species or free flying birds or contact with their droppings. Outdoor units could be separated by using double layered side netting with a distance of at least 20 cm. There should be no sharing of air space with other birds of the collection. Length of quarantine period and preventive techniques vary according to the resources of the collection, the species and source of the birds being added and the type of collection. As a general role new birds should be housed in quarantine for a minimum of 35 days (**FORBES**) or 60 days (CLUBB and FLAMMER, 1994). The number of birds managed within this system, and their distribution within the facility should be determined in advance and should be adhered to strictly. The same strict

regulations are valid for the nursery of a collection. Neonates that leave the nursery and come into contact with other birds should not re-enter the nursery.

Quarantine time can simultaneously be used for gradually acclimatising birds to new climatic conditions. Not only colder weather conditions need to be considered, but also exposure to direct sunlight can cause burns on the unfeathered portions of the face if there is a lack of melanisation or deposition of other protective pigmentation (CLUBB and FLAMMER, 1994). It is important to monitor water and food intake as birds sometimes refuse feeding in a strange environment. Weight loss of approximately 15% of the initial weight in an originally healthy bird indicates the need to force feeding (CLUBB and FLAMMER, 1994).

In theory a ‘closed aviary system’ in a collection minimises the risk of introducing diseases with new birds. Each collection needs to clarify if they are tolerating and hospitalising wild injured birds, which represent a significant threat as a source of infection. A survey analysing the health status of birds presented for rehabilitation revealed infection with ecto- and endoparasites, Salmonella, Trichomonas, Paramyxovirus and Adenovirus (LIERZ, 2000). Falcon herpesvirus and owl herpesvirus has been isolated from wild raptors, owls, and pigeons (**FORBES_HERPESVIRUS**; LIERZ, 2000). Mycobacteria infection has been frequently diagnosed in hawks and owls (PIECHOCKI et al., 1981) and other free-ranging birds. If wild birds are hospitalised a special rehabilitation area should be declared, situated separately from all the other facilities and operated completely independent from the rest of the collection. Any interaction or traffic between that area and the rest of the collection should be strictly prohibited. Obviously an independent third unit, reserved solemnly for sick resident birds of the collection, should be provided as a hospital area. The same hygiene standards as for the quarantine facility apply for both the rehabilitation area and the hospital area.

SCREENING

All new birds should undergo screening in order to minimise the risk of infection for the inhabitants of the collection. But also all the other birds in a collection should be examined on an annual basis to obtain an overview over the health status of the collection and to detect underlying problems. Screening tests should be chosen in light of financial constrains and the birds to be tested. The value of the bird, the susceptibility to disease, and the physical examination findings should, according to a pre-determined protocol, determine which tests are most appropriate. Screening programs may include physical examination, haematology and blood chemistry, faecal examination including acid-fast staining, evaluation of a blood smear, and radiographic and laparoscopic examination if necessary. Blood plasma can be tested for antibodies against paramyxovirus 1 and falcon herpesvirus. Air sacs biopsies and tracheal swabs can be taken to detect mycoplasma. Cloacal swabs can be tested for *Chlamydia psittaci* using an antigen-enzyme linked immunosorbent assay or PCR DNA testing. Birds should be examined at the beginning of quarantine to detect any existing problems and again at the end of quarantine to detect any clinical changes. By performing a CBC, biochemical profile and radiographs on each individual bird it is possible to establish ‘normal values’ for a particular bird. Those ‘normal values’ may prove extremely useful when interpreting ‘pathological values’ at a later point. Ideally those haematologic and biochemistry examinations should be part of an annual routine preventive medicine program, including regular examinations of pooled faecal

samples. Those faecal samples should be collected over three to five days to increase accuracy. In that way organisms that are not constantly excreted such as coccidia are also detected. Necropsy should be performed on any bird that dies within the collection to be able to recognise infectious diseases at an early stage.

Screening should not only be performed when birds are entering the facilities but equally important when birds leave the facilities. Moving birds from one collection to another carries the risk of transferring disease. Particularly rehabilitation centres can be described as 'bottle necks' with a large number of birds being introduced to the facilities. In these facilities all the birds are kept in a high concentration on limited space with potential direct or indirect contact with each other. Those are ideal conditions for the accumulation of pathogens and infection of individuals. With releasing those birds, the infection can be spread into the environment, risking infecting further wild birds. An example is the infection of day-old-chicks with a certain strain of Adenovirus that due to its species-specific nature is not causing disease in chickens. Carnivorous birds fed on that diet again may not necessarily develop disease but are likely to become carriers. Once released those birds may well infect some other susceptible species with that strain of Adenovirus and that may be spread through the entire local population of those species (**FORBES**).

Aviculturists need to be well trained in recognising signs of illness and providing emergency care. They should assess each bird daily during routine feeding procedures. Attention needs to be paid to noting normal behaviour, so that abnormalities are noted as soon as possible. In addition to health, behaviour and attitude of the bird, the aviculturist should also evaluate the enclosure for signs of bleeding, feather loss or other signs of a traumatic episode. Fresh droppings should be observed for colour, consistency and amount of faeces, urine and urates. Sick birds should be immediately removed from the collection and a thorough diagnostic evaluation should be performed.

HYGIENE OF ACCOMMODATIONS

Maximal standards of hygiene with consideration to husbandry aspects are essential to maintain good flock health. The facility itself with its inhabitants must not become a source of infection for future residents, hospitalised birds for rehabilitation or free-ranging birds.

Disinfection

Disinfection and sanitation play a major role in disease control. All equipment, particularly that used in the hospital facilities, should be regularly, preferably daily, disinfected. However, the level of hygiene must be balanced with the level of disturbance that it creates. Disinfectants commonly used and effective against most bacteria and viruses are sodium hypochlorite, quaternary ammonium, phenol, chlorhexine, cresols and organic acids (CLUBB and FLAMMWER, 1994). Material should always be cleaned before disinfection, because few disinfectants are effective in the presence of organic debris. Disinfectants should always be used according to the manufacturer's recommendations as stronger solutions are not necessarily more effective and may be toxic. Birds should not come into contact with disinfectants, and it is best if they are not exposed to disinfectant fumes as well.

Sanitation
Each pen should undergo cleaning and sanitation according to a strict rotation. Sanitation should include removing the ground substrate and creating sub-optimal environmental conditions for most bacteria by reducing organic matter. Nesting materials and nesting boxes should be cleaned out annually. Plant material, soil or mud removed from one pen should not be used in another pen. It should be burnt and buried to prevent the spread of potentially contaminated material.

Compartmentalisation
In addition to improved screening and sanitation protocols, reduction of the size and diversity of the collection is crucial to disease control. Disease spread can be limited by compartmentalisation of operations and procedures. Each compartment (pen) should be operated independently with minimal interaction. No cleaning tools should be transferred between compartments. High standards of hygiene have to be maintained among staff. Warden's footwear, barrows, buckets or other cleaning equipment, and feed boxes are potential serious sources of contaminated material. Education of staff in the principles of hygiene and disease control is crucial. Aviculturists need to be aware of people serving as mechanical vectors for disease transmission between individual birds or different collections. 'Back scene visitors' such as veterinarians should visit only one avicultural facility a day, preferably early in the morning prior to entering other collections of birds or hospitals. Additionally, each facility should provide coveralls, scrubs and shoes, which remain at the facility for cleaning. Obviously such precautions are not feasible for the public, but should be considered when people are entering areas of particular risk such as quarantine buildings, nurseries or closed breeding flocks.

Design of aviaries
Housing should be designed according to the demands of the different species. An aviary should be designed to be easy to maintain and clean while providing safety, security and sanitary conditions for its inhabitants. Factors in providing a secure environment include having visual barriers to separate the nesting areas of secretive birds and keeping louder, more boisterous birds widely separated from quieter, more timid birds (HOOIMEIJER, 2000; CLUBB and FLAMMER, 1994). Observation holes discretely placed into the side walls of the aviary provide proper observation of the birds without disturbing them. The wire mesh of the side walls should be covered on the inside with some soft nylon netting as this acts as an inner softer protective lining and more importantly as a visual barrier to prevent trauma to head and cere. Alternatively vertical bars or battens (wood, bamboo, or plastic conduit piping) can be placed at suitable distances apart from each other so that the bird can get the head in-between but not the body. A sloped concrete floor, with precaution to avoid drainage into adjacent aviaries, should be covered with soil or pea gravel. In that way the ground substrate can be easily removed and substrate and concrete floor cleaned and disinfected. Perches should be secure and non-movable, apart from particularly designed swing perches. Offering perches and blocks of varying diameter and covering all perching sites with Astroturf contributes in preventing 'bumble foot'. Exposing as many perches as possible to direct sunlight helps control residual bacterial contamination (**FORBES**). Escape proofing is suggested and may be accomplished by safety aisles or suspended safety netting around the exits of an aviary. This is also recommended when multiple aviaries are jointed to each other. Day light has an important input on Vitamin D_3 synthesis and calcium metabolism.

Photoperiod also influences the regulation of reproduction and moulting (RYAN, 2000). Therefore, offering natural daylight in outdoor aviaries is recommended.

Pest control

Pest control is necessary to prevent the spread of potential avian pathogens and parasites. Insects and rodents may also disturb and irritate the birds. Barred traps and poisons will help to control rodents and pesticides, with consideration of all necessary precautions. Feeding the amount of food that will be consumed by the birds in total during daytime will discourage rodents. The bottom of the aviary walls should be solid to keep rodents and vermin from entering and by that transferring disease and parasites.

Interaction with other birds

It is important to minimise the contact to other birds within the collection and to wild birds including wildfowl, gulls, sparrows, blackbirds, and pigeons through placement of physical barriers, such as plastic or wire mesh screening around enclosures. Contact to wild birds and their faeces exposes the inhabitants of a collection to infectious agents and carries the risk of disease transfer (CLUBB and FLAMMER, 1994) Species that are particularly susceptible to certain diseases should be housed separately. Covering those aviaries would prevent contact with the faeces of wild birds.

Wild birds brought into the facility by the public need to be examined carefully. Often these birds are weakened due to an underlying illness and therefore, are excluded from the flock, possibly treated aggressively by their flock mates and are often the victims of predators (MONTALI et al., 1983). Those birds are predisposed to be involved in accidents (HATT et al., 1996). A study on 84 free-ranging raptors presented for rehabilitation in Germany 59.5% of all presented raptors showed signs of an infectious disease. The most common complaint was trauma (63.1%) and in 83% of those traumatised birds further disease or pathological findings were detected (LIERZ, 2000). Birds with a large ectoparasite infestation often suffer from an underlying disease. Healthy birds carry and cope with a certain parasitic burden, but when weakened the host-parasite balance may be upset in favour of the parasite. All incoming birds should be treated against endo- and ectoparasites.

Stress

Reducing stress contributes to a well-functioning immune system. Stressors include recent importation, and the associated change of diet, possible differences in humidity and climatic conditions (CROMIE, 1991; CROMIE et al., 2000). Therefore, birds should be introduced to the exhibit gradually. Compatibility with birds sharing the exhibit has to be considered when selecting species and individuals for display. Less aggressive birds should be introduced first to allow them to establish territories (BEEHLER, 1990). Overcrowding is a primary reason for a higher stress level that results in a higher susceptibility of contagious diseases and behavioural problems (HOOIMEIJER, 2000). The unnaturally high stocking densities found in captive collections and the permanent presence of birds on the same ground allow the accumulation of high levels of contamination (DERRICKSON and PICKETT, 1991). Neglect of social structures and incorrect nutrition must be avoided. When planning exhibits, consideration must be given to such matters as the ecology and social structures of the birds, whether or not the birds are social, and whether males are usually found with the females and the approximate ratio of males to females. There

are individual preferences whether male and female develop courtship behaviour or aggressive behaviour. Aggression between male and female can be influenced by sexual activity, as in goshawks, or by different condition of the birds. Birds need space to retreat in such situations (HEIDENREICH, 1995a). The presence of visitors in close proximity to nesting sites, during the breeding season may exacerbate stress at this time of year. Certain raptor species are particularly susceptible to stress induced infections such as aspergillosis and should receive preventative treatment.

Diet and food hygiene

Good food hygiene is vital to prevent the spread of food-borne pathogens or the spoilage of food within an enclosure. Excess food may not only lead to hepatic lipidosis, arteriosclerosis, and other health problems, but it also increases the risk of vermin infestation. Food that remains on the floor of an enclosure can be a source of bacterial and fungal pathogens and should be removed daily, especially in warm climate. Ideally the daily ration of meat should be defrosted in the morning and then stored in the fridge until fed. Food should be purchased from a reputable source, which ensure that day-old-chicks are blast frozen separately prior to packing. Prolonged freezing times, thawing and subsequent re-freezing encourage the proliferation of surface bacterial contaminants, toxin, or spore formation. Food should not be frozen for more than three months (FORBES and REES DAVIES, 2000). Supplying food in a drawer system enables the aviculturist to easily remove excess food and daily without disturbing the birds. The food drawer should not be positioned in direct sunlight and access of vermin should be avoided. Offering daily fresh water provided in a clean bowl is a matter of course. If using a hose or stand pipe for filling up water/bathing bowls, the water should be left to run for several unites before it is used as the first water will have a significantly higher bacterial loading (**FORBES**). Food and water/bathing bowls should be made of stainless steel, hard plastic or crockery (CLUBB and FLAMMER, 1994). In hot weather, it may be necessary to sanitise the drinking/bathing water with a diluted disinfectant such as chlorhexidine to control Pseudomonas infections (FORBES and REES DAVIS, 2000).

In feeding raptors it is important to offer them as much variety as possible to ensure a balanced diet. Feeding just one food type contributes to Ca:P ratio imbalances, excessive fat intake, and the lack of vitamins and minerals. Those deficiencies can lead to management related diseases such as arteriosclerosis, metabolic bone disease, ‘angel wing’, inward curling of the toes or opistotonus (‘star gazing’) (FORBES and REES DAVIES, 2000). It is not advisable to feed a pure beef diet. If due to public demands and practicality in case of display performance beef is fed, supplementing with minerals and vitamins is essential. Attention should be paid to offering those birds a different diet in-between being flown. In general the entire carcass should be offered so that the birds are eating casting (feather and fur), bones, muscle, viscera and the prey’s gut content. When feeding larger carcasses to smaller or young birds the bones must be broken. Otherwise the birds will eat only the meat, which is easier to consume.

Any wild source of food can be harbouring pathogens such as Mycobacteria, Salmonella, Campylobacter, E.coli, Trichomonas, Paramyxovirus, Adenovirus, Falcon herpsvirus, or Rotavirus. They can be also infested with internal (Caryospora, Syngamus) or external (lice) parasites. Often viruses are pathogenic only to one species. One example is *Adenovirideae*- this apathogenic poultry virus will not be detected in poultry food species, but can cause severe diseases in raptors being fed

on that food source. Similar sources have been reported as responsible for adenovirus outbreaks in Mauritius kestrels (*Falco punctatus*) (FORBES et al., 1997). Columbiformes form a particular risk to raptors due to their high subclinical incidence of Trichomoniasis. Discarding head, crop and oesophagus is not sufficient, but the pigeons could be frozen and thawed prior to feeding. However, pigeons carry also pathogens such as Falcon herpesvirus and owl herpesvirus, Paramyxovirus, Poxvirus, Adenovirus, and Circovirus, which will not be killed by freezing (HOOIMEIJER, 1999; **FORBES_HERPESVIRUS**). Therefore, it is advisable to refrain from feeding free-ranging pigeons. Infectious diseases are less likely if mammalian rather than avian derived food is used, as few pathogens cross between classes (FORBES and REES DAVIES, 2000). It should be considered that some wild birds will not be familiar with some readily available commercial food sources such as day-old-chicks.

REHABILITATION

Rehabilitation success can be evaluated at two stages. Firstly medical success of repairing injuries, curing diseases, or manipulating the behaviour. Secondly the successful integration of the animal back into the population after release. Some people argue that a bird has only been successfully released if it becomes integrated into the breeding population. However, in natural populations not all adults contribute to reproduction and there is constantly a non-breeding surplus of birds (CSERMEY, 2000). The author believes that a bird must not be released if there is any concern that its injuries prevent possibility of survival in the wild. Equally it must be considered very critically if it is fair to a wild bird without any influence of domestication to scrape a living in an aviary for the rest of its life. Obviously there are extraordinary circumstances such as birds of species existing as numerically small, localised populations or at the edge of extinctions. Following injuries prohibit the release of wild bird as they interfere with the bird's ability to fly, hunt, kill and eat: loss of any limb, loss of eye/sight, loss of a hind talon, permanent loss of any part of the beak, and inability to waterproof the plumage. Furthermore, the effect of loosing any primaries or deck tail feathers is different in buzzards or short wings compared to falcons that require greatest acrobatic skills when hunting (HEIDENREICH, 1995b; **FORBES**). It is likely that fitness will play a more important role in attackers than in searcher or birds that consume a significant quantity of carrion (FOX, 1995).

An analysis looking at 84 raptors and owls presented for rehabilitation showed that 45.2% of the birds could be released back into the wild. Fifty-one point nine percent of the injured birds could be released while only 33.3% of debilitated raptors could be reintroduced to the wild. Illness appears to have a greater impact on release rates than traumatic injury (LIERZ, 2000). A survey in Italy in a rehabilitation centre over the last 30 years showed that only 30% to 40% of the birds could be released back into the wild (CSERMELY, 2000). Prolonged captivity can reduce release success in some species, as it promotes habituation to humans, and reduces flight ability and responsiveness to natural prey. Close contact to staff can induce some form of socialisation or lack of fear, particularly in juveniles. The released bird might not choose the optimal habitat and may stay in areas with human presence (CSERMELY, 2000). An imprinted bird is unlikely to breed in the wild, but may well occupy a nest site, thereby preventing a further potentially fertile pair from using it. Birds cannot only become imprinted on men, but also on unsuitable prey/food (**FORBES**). A further study analysing data from 1550 rehabilitated birds

demonstrated no interaction between survival time and injury upon admission or the amount of time spent in the rehabilitation centre (MARTELL et al., 2000). The range of survival time was one to 458 weeks with 50% of the reports coming more than 24 weeks after release and 14.4% of birds, which survived less than six weeks.

Birds should be released in their own territories (most often the place where they have been found) to ensure a familiar environment and to avoid conspecific competition and aggression (CSERMELEY, 2000). Other authors recommend to releasing the bird back into its initial territory if recovery occurs within 14 days of the initial injury. In case of a delay the bird is usually better released in another area with suitable geographical position, vegetation type, and prey species availability. There should not be a particularly high density of the species already present. Migratory birds should not be released immediately prior to a potential migration time. Summer and autumn represent good months for release due to good weather conditions, long days, and plenty of prey (**FORBES**).

Traditional falconry techniques, such as hack broad, hack flight, hack to the lure and, in the case of fledglings, (cross-) fostering, were shown to be efficient when training raptors to survive after release (CSERMELEY, 2000; HEIDENREICH, 1995b). Alternatively birds are kept in large aviaries and regularly stimulated to multiple flights back and forth through the aviary. Following criteria should be monitored: symmetry and strength of the wing beats; balance during flying; position of the legs; height and speed of the flight; and the way of landing (HEIDENREICH, 1995b). A study compared those two techniques with the help of blood lactate concentration measurements and weight checks of recaptured birds after approximately ten days. Although there were no statistically significant differences, the results suggest that falconry techniques are superior to conditioning a bird in an aviary (HOLZ and NAISBITT, 2000). Assessing the bird's mobility or manoeuvrability even in a very large aviary proves to be difficult. Furthermore, the ability to successfully catching prey can be inspected by using falconry methods. Formerly wild birds tend to grow wild again very quickly after having been released (HEIDENREICH, 1995b).

References

BEEHLER, B.A. (1990): Management of *Mycobacterium avium* in a mixed species aviary. Annual Conference Proceedings of the American Association of Zoo Veterinarians, October 21st-236th, Padre Island, Texas, USA, 125-129

BRIGHT, P.R. (2000): GIS: A tool for protecting the health of wild bird populations. Annual Conference Proceedings of the Association of Avian Veterinarians, August 30th-September 1st, Portland, Oregon, USA, 181-185

CSERMELEY, D. (2000): Rehabilitation of birds of prey and their survival after release. A review. In: Lumeij J.T., Remple D., Redig P.T., Lierz M. and Cooper J.E. (eds.): Raptor Biomedicine III, including bibliography of diseases of birds of prey. Zoological Education Network, Inc., Lake Worth, Florida, USA, 303-311

CLUBB, S.L. and K. FLAMMER (1994): The avian flock. In: Ritchie B.W., G.J. Harrison and L.R. Harrison (eds.): Avian Medicine: Principles and Application. Wingers Publishing, Inc., Lake Worth, Florida, 45-62

CROMIE, R.L. (1991): Development of an avian tuberculosis vaccine for captive wildfowl. PH.D. thesis, University of London

CROMIE, R.L., N.J. ASH, M.J. BROWN and J.L. STANFORD (2000): Avian immune responses to *Mycobacterium avium*: the wildfowl example. Avian Pathology 22(3), 617-630

DERRICKSON, S.R and C.PICKETT (1991): History of avian tuberculosis at the National Zoological Park: gaining control through management and husbandry. Annual Conference Proceedings of the American Association of Zoological Parks and Aquariums, Autumn meeting, St. Augustine, Florida, USA, 476-484

FORBES, N.A. and R. REES DAVIES (2000): Practical Raptor Nutrition. Annual Conference Proceedings of the Association of Avian Veterinarians, August 30th-September 1st, Portland, Oregon, USA, 165-171

FORBES-Herpesvirus
FORBES

FOX, N. (1995): Understanding the bird of prey. Surrey: Hancock House, Publishers Ltd.

HATT, J.M., R. BAUMGARTNER, and E. ISENBUEGEL (1996): Diagnostik und medizinische Betreuung von Greifvögeln in einer Zusammenstellung der Fälle 1985-1994. Schweizer Archiev der Tierheilkunde, 138, 434-440

HEIDENREICH, M. (1995): Greifvogelzucht. In: Heidenreich M.(ed.): Greifvögel: Krankheiten-Haltung-Zucht. Blackwell Wissenschaftsverlag, Berlin, Germany, 35-61

HEIDENREICH, M. (1995): Rehabilitation von Wildvögeln. In: Heidenreich M.(ed.): Greifvögel: Krankheiten-Haltung-Zucht. Blackwell Wissenschaftsverlag, Berlin, Germany, 227-230

HOLZ, P. and R. NAISBITT (2000): Fitness level as a determining factor in the survival of rehabilitated raptors releases back into the wild – preliminary results. In: Lumeij J.T., Remple D., Redig P.T., Lierz M. and Cooper J.E. (eds.): Raptor Biomedicine III, including bibliography of diseases of birds of prey. Zoological Education Network, Inc., Lake Worth, Florida, USA, 321-325

HOOIMEIJER, J. (1999): Medical problems because of management failures in aviculture. Annual Conference Proceedings of the Association of Avian Veterinarians, September 1st-September 3rd, New Orleans, Louisiana, USA, 171-177

LIERZ, M. (2000): Investigation of free-ranging raptors discovered injured of debilitated in Germany. Annual Conference Proceedings of the Association of Avian Veterinarians, August 30th-September 1st, Portland, Oregon, USA, 139-141

MARTELL, M.S., J. GOGGIN and P.T. REDIG (2000): Assessing rehabilitation success of raptors through band returns. In: Lumeij J.T., Remple D., Redig P.T., Lierz M. and Cooper J.E. (eds.): Raptor Biomedicine III, including bibliography of diseases of birds of prey. Zoological Education Network, Inc., Lake Worth, Florida, USA, 327-334

MONTALI, R.J., M. BUSH and R.A. FREEMEN (1983): Effect of sanitation and antemortem screening on the incidence of tuberculosis in a zoo aviary. Proceedings of the 25th International Symposium on Diseases in Zoo Animals, 95-99

PIECHOCKI, R., R. IPPEN and H.D. SCHRÖDER (1981):

Tuberculosis in free-living hawks (*Falconiformes*) and owls (*Strigiformes*). Erkrankungen der Zootiere, Verhandlungsbericht der XXIII. Internationalen Symposiums über die Erkrankungen der Zootiere, 24.-28. Juni, Halle-Saale, Germany, 55-66

RYAN, T. (1999): Use of light in aviculture and avian medicine. Annual Conference Proceedings of the Association of Avian Veterinarians, September 1st-September 3rd, New Orleans, Louisiana, USA, 179-185