

University of Sopron

PhD Thesis

Causes of morbidity and mortality in diurnal and nocturnal birds of
prey in Hungary

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Introduction

Until date, 37 species of diurnal and 12 species of nocturnal birds of prey have been recorded in Hungary, of which 18 raptor and 9 owl species nest on a regular basis, whilst the remainder are either winter visitors or pass through our country along their migration or as vagrants. Over the past two and a half decades, the Wildlife Rescue Center at the Budapest Zoo and Botanical Garden has taken in and treated over ten thousand protected and strictly protected individuals including many birds of prey. Therefore, the aim of this study was to examine all predatory birds that either died or were euthanized at the rescue facility in order to discover the leading non-infectious and infectious causes of morbidity and mortality. Additionally, levels of 12 essential elements and heavy metals were measured from tissue samples in order to determine their prevalence in the top avian predators of our country.

Materials and Methods

The individuals included in this study were brought into the Wildlife Rescue Center at the Budapest Zoo and Botanical Garden from all parts of Hungary between 2015 and 2017. All birds of prey that either died or were humanely euthanized owing to the severity of their injuries over the course of the study period were included. Biometric data (wing, tail, body, tarsometatarsal and beak length) was recorded from all individuals before necropsy was performed. *Post mortem* examinations were executed according to VETÉSI & MÉSZÁROS (1998) and samples were taken for various examinations. Tissue samples were utilized for histopathological and virological examinations, as well as the measurement of the concentration of various essential elements and heavy metals, whereas bacteria were cultured from cloacal swabs. Virological investigations and the detection of *Chlamydia psittaci* were performed through RT-PCR. Microsoft Excel (Fx: AVERAGE, STDEV) was employed for statistical analysis and a Mann-Whitney U test was implemented to establish statistical significance between heavy metal concentrations in the liver and bone tissues of Common kestrels (*Falco tinnunculus*).

The retrospective portion of this study included birds of prey on which necropsy had been performed at the University of Veterinary Medicine Department of Pathology between 2000 and 2013. In these instances, the species, age, sex and cause of death were recorded as part of our work.

Results and Discussion

During the study period, necropsy was performed on 70 birds of prey pertaining to 16 species at the Budapest Zoo and Botanical Garden of which 12 were raptors, whereas four were their nocturnal predatory counterparts. In the retrospective portion of our work, 15 individuals of 8 species were analyzed; six

raptors and two owl species. Between both institutions 85 individuals of 17 species were included, with 12 raptor and 5 owl species. On a whole, 75.0% were diurnal predatory birds, whereas 25.0% were owl species. A number of these birds were either protected, or strictly protected species (i.e. European honey buzzard, White-tailed eagle, Lesser spotted eagle, Eastern imperial eagle, Saker falcon, Peregrine falcon, Eurasian scops owl, Eurasian eagle-owl and Ural owl) of the Hungarian fauna. Until date, the largest study analyzing cause of death of birds of prey through necropsy was performed by GÁL *et al.* (2003) in Hungary, where the authors executed detailed *post mortem* examinations on 21 diurnal birds of prey.

Of the 17 species of birds of prey, Common kestrels, Common buzzards (*Buteo buteo*), Sparrowhawks (*Accipiter nisus*) and Northern goshawks (*Accipiter gentilis*) were represented in sufficient numbers to allow comparison of biometric parameters. Values obtained from Common kestrels and Northern goshawks were similar to those published by FARAGÓ (2015) for these species.

Through our results, we were able to establish that non-infectious disease accounted for 78.0% of morbidity and mortality, while the remaining 22.0% of individuals succumbed to infectious causes. In this portion of the study all birds were combined into one sample group. Of those raptors and owls where cause of death had non-infectious grounds, electrocution induced by contact with powerlines was implicated in 50.0% of cases. Furthermore, hepatic dystrophy was identified as the second more frequent cause of mortality in 12.0% of instances and third more common alteration was internal bleeding of traumatic etiology in 11.0% of individuals. Further non-infectious causes are depicted in **Figure 1**.

In species where a broader dataset was obtained owing to the increased number of individuals included in our work, non-infectious causes of morbidity and mortality were analyzed separately. In Common kestrels, 67.0% were found to have succumbed to electrocution, with acute renal failure in the form of tubulonephrosis proving to be the second most frequent alteration at 13.0%. On the other hand, cause of death was attributed to electrocution in merely 31.0% of the Common buzzards and hepatic dystrophy and internal hemorrhage was observed in 23.0% of cases apiece.

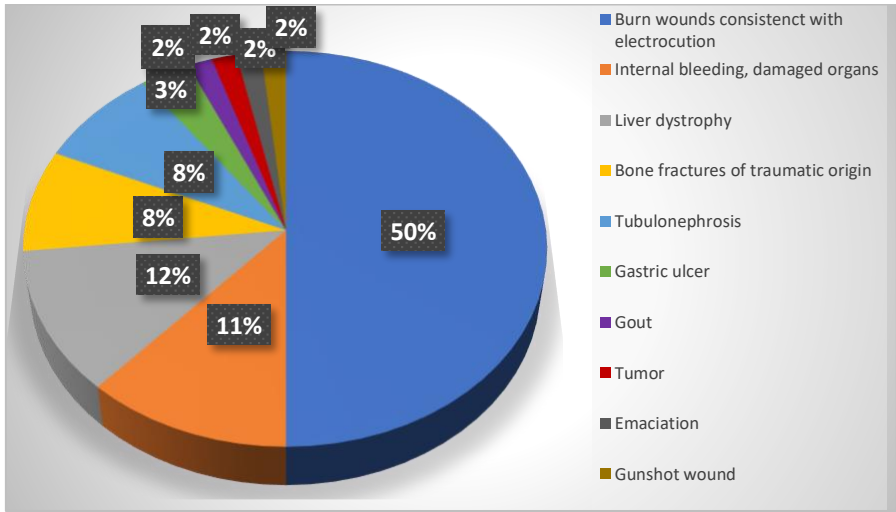


Figure 1: Non-infectious causes of morbidity and mortality (n = 64).

Analysis of 12 different essential elements and heavy metals was performed from liver and bone tissue samples (**Figure 2 & 3**). These elements were arsenic (As), barium (Ba), cadmium (Cd), cobalt (Co), chromium (Cr), copper (Cu), mercury (Hg), manganese (Mn), molybdenum (Mo), nickel (Ni), lead (Pb) and zinc (Zn).

Concentrations of arsenic and molybdenum were measured below the LOD (lower level of detection) in all instances from bone samples (LOD: 0.5 mg/kg for arsenic and 0.2 mg/kg for molybdenum). Moreover, in addition to arsenic, barium and nickel concentrations were also below the LOD from all liver samples (LOD: 0.5 mg/kg for barium and 0.2 mg/kg for nickel).

As compared to the literature, the values obtained through our work did not appear to be elevated, though average concentrations of copper and manganese were greater in liver samples as compared to those from bone tissue. Though elevations were not noted in mean values, individual samples did show marked deviations from the average, suggesting that these heavy metals were elevated regionally in the feedsource of some of the birds of prey in our study.

Moreover, Common kestrel samples were present in sufficient numbers to warrant further statistical analysis. Upon comparing concentrations of various elements, we found that barium, chromium, copper, manganese, nickel, lead and zinc levels were significantly greater in bone as compared to liver tissue ($p < 0,05$).

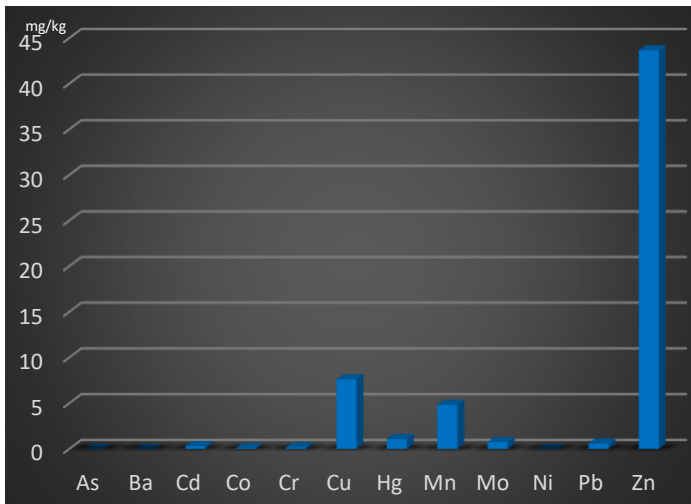


Figure 2: Examined liver samples from all birds of prey in the study (n = 42) and the average trace element values measured; As, Ba and Ni below the LOD.

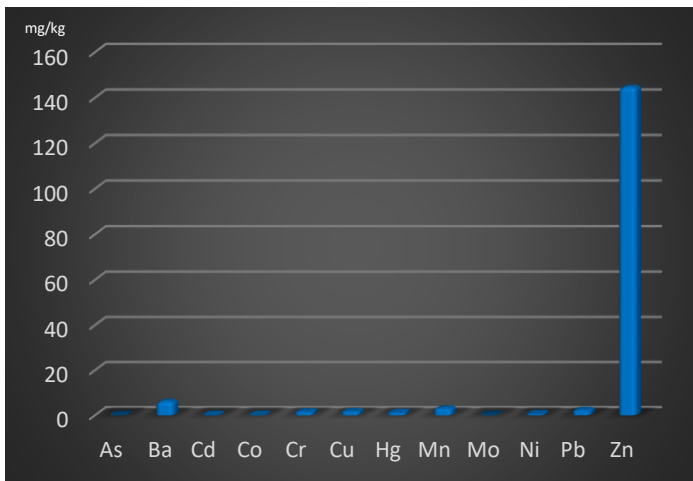


Figure 3: Examined liver samples from all birds of prey in the study (n = 28) and the average trace element values measured; As and Mo below the LOD.

Analysis of the infectious causes of morbidity and mortality are depicted in **Figure 4**. From the results, it was evident that various viral (i.e. poxdermatitis), bacterial (i.e. avian tuberculosis) as well as fungal (i.e. aspergillosis) diseases were recorded as part of our work. 47.0% of the individuals with an infectious etiology were attributed to pulmonary and air sac mycosis caused by *Aspergillus* sp.

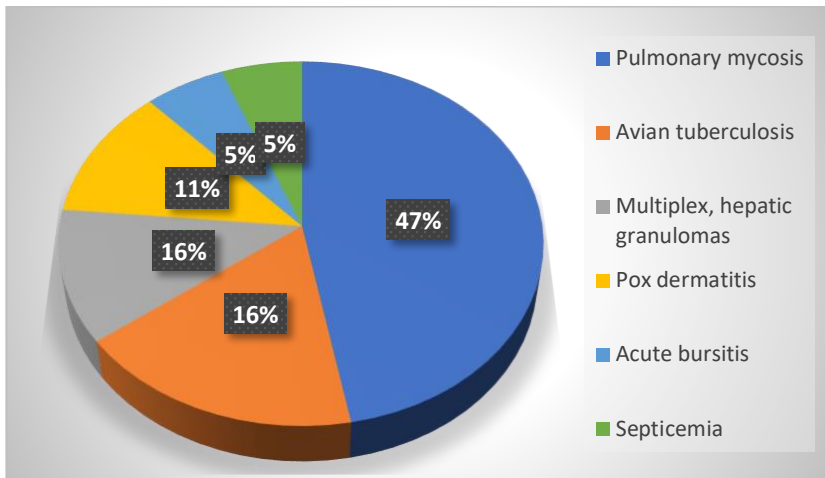


Figure 4. Infectious causes of morbidity and mortality (n = 19).

All the cloacal swabs taken on necropsy tested negative for *Salmonella* sp. through culture. However, *Pseudomonas aeruginosa* and *Escherichia coli* were identified from a number of the birds of prey, where *post mortem* alterations did not reflect the presence of these pathogens. Furthermore, RT-PCR testing yielded negative results for the presence of *Chlamydia psittaci* and West-Nile Encephalitis in all individuals.

Upon examining the birds of prey admitted to the Wildlife Rescue Center and the Budapest Zoo and Botanical Garden, we identified various infectious and non-infectious factors to have caused varying degrees of morbidity and mortality in these species. Non-infectious alterations were found to occur far more frequently than ailments of infectious origin, and electrocution was identified as the leading cause of mortality. Additionally, various pathogenic agents were identified for the first time in various birds of prey in Hungary through the course of our work. Furthermore, trends on a whole showed that, essential elements and heavy metals were not elevated in the birds sampled, however, some individuals had elevated levels of various elements and in Common kestrels, various heavy metals were found in significantly greater concentration in bone, as compared to liver tissues.

Though such an extensive *post mortem* examination has not yet been performed on deceased birds of prey at a wildlife rescue facility in Hungary, further work is still required to gain further information and to establish trends in the causes of mortality in these charismatic species. Moreover, evidence about the causes of morbidity and the monitoring of disease may aid in the active conservation of these species and possibly reduce anthropogenic factors.

New Scientific findings

1. To the best of our knowledge, we are the first to have performed such a detailed and broad-scale *post mortem* examination of free-living birds of prey admitted to a wildlife facility in Hungary and to identify the leading cause of morbidity of predatory avian species to be electrocution caused by powerlines with particular significance in Common kestrels.
2. In the scope of our work, we found acute renal failure (8%) to occur more commonly as a cause of morbidity and mortality in birds of prey than gout or chronic renal failure (2%). Whether or not this was due to chance we feel that owing to the size of the dataset and the broad number of species affected, we deemed it to be a significant finding.
3. Our work is the first record of the analysis of 12 different types of trace elements (including heavy metals) from liver and bone samples origination from 42 individuals of seven species of diurnal and two nocturnal birds of prey. Through this study, it was evident that several elements were below the lower limit of detection in all samples analyzed (Mo and As in bone, and As, Ni and Ba in liver) suggesting that in presumed levels of environmental contamination by these elements did not affect the birds included in this study. As various heavy metals were elevated in certain specimens, implications can be drawn about higher levels of these elements to be present in certain regions of our country (or the specific areas from where individuals originate), but the trends show that levels were not elevated everywhere. Levels of essential elements, such as Cu, Mo and Zn were present at elevated levels (particularly Zn) as compared to the other metals, however, values were within normal range as compared to data in the literature.
4. Identification of pulmonary and air sac mycosis caused by *Aspergillus* sp. was found to be the most frequently occurring infectious disease in the studied individuals and as these lesions lead to respiratory impairment, this finding can truly implicate this ailment to be a major cause of morbidity and indeed mortality in free-ranging birds of prey.
5. Several instances of septicemia and hepatic granulomas were recorded as part of this study suggesting that generalized bacterial infection caused by *Pasteurella multocida* can also pose a threat to free-living predatory birds of Hungary and lead to mortality in multiple species.
6. This was the first account of poxvirus infection in a Common kestrel (*Falco tinnunculus*) in Hungary.
7. Our cases reveal the first instance of avian mycobacteriosis in Common buzzard (*Buteo buteo*) in Hungary.
8. Finding that all our samples were negative for both WN and *Chlamydia psittaci* through RT-PCR and *Salmonella* sp. by culture, can also be significant, as the presumption would have been to find active infection

caused by these pathogens (even if only subclinically) in a number of the free-living population.

9. Through our work, we were able to establish that 76% of the birds in this study were carriers of *Escherichia coli* and 24% of *Pseudomonas* sp. indicating the presence and moderate prevalence of potentially pathogenic bacteria in the predatory avian populations of Hungary.

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Total number of publications:

- Impact factor journal articles relevant to the subject of the PhD: 1
- Original publications relevant to the subject of the PhD: 1
- Conference presentations relevant to the subject of the PhD: 4
- Conference posters relevant to the subject of the PhD: 1
- Further publications relevant to the subject of the PhD: 6

- Impact factor journal articles not relevant to the subject of the PhD: 3
- Conference presentations not relevant to the subject of the PhD: 22
- Conference posters not relevant to the subject of the PhD: 6
- Further publications not relevant to the subject of the PhD: 1

Total number of publications: 45

Citations: 8