SERRATOSPICULIASIS, MYCOSIS, AND HAEMOSIDEROSIS IN WILD PEREGRINE FALCON FROM POLAND. A CASE REPORT

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Abstract

In 2006, an emaciated female peregrine falcon (Falco peregrinus) was found in Szczecin (North-West Poland). Parasitological, microbiological, and ecotoxicological (including determination of concentrations Mn, Fe, Cu, Zn, Ni, V, Pb, and Cd) examinations involved the digestive tract, kidneys, liver, brain, breast muscle, and bone. The presence of nematode Serratospiculum tendo (in air sacs), trematodes Strigea falconi and Conodiplostomum spathula, and cestode Cladotaenia cylindracea (in the digestive tract) were demonstrated. Two species of fungi (Aspergillus nidulans and Cladophialophora boppi), responsible for mycosis, were isolated from the skin of breast region. Escherichia coli (rough type) was isolated from the liver, kidneys, lung, small intestine, and heart. Moreover, Micrococcus luteus and Proteus mirabilis were found in the lungs. Worrisome high concentrations of Fe and Mn were denoted, especially in the liver (over 6 000 and 22 mg/kg d.w., respectively).

Key words: peregrine falcon, helminths, microbiological analysis, trace metals.

The peregrine falcon (Falco p. peregrinus) is bred in Poland only sporadically. The population consisting of 5 to 8 pairs and the species is deemed rare and critically endangered, CR (27, 37). This falcon is protected by the law in Poland, by Council Directive on the Conservation of Wild Birds (Bird Directive, 79/409/EEC; annex I) in European Union, and by CITES (appendix I) in the world. On the World Red List, it has lower category called least concern, LC (IUCN Red List 2004). Between 1960 and 1980, a dramatic decrease in the number of birds of prey was observed, including the peregrine falcon. It was mainly due to global pollution with pesticides, PCBs, and to a certain extent with toxic metals, which has been well documented (23, 25). A ban on the use of DDT and other pollutants has helped to increase the number of peregrine falcon in Europe and North America for ten years (3, 23, 40). Yet many pollutants, including heavy metals, still affect the life of raptors, decreasing their fitness and condition and weakening their immune systems, which in turn leads to many diseases caused, amongst others, by microorganisms and parasites (19, 29). In the case of European peregrine falcons, there have been few papers referring only to 2-4 metals in the liver and kidneys of these birds (1, 8, 40).

The aim of this paper was to determine the size of body and internal organs, the condition and health, as well as concentration of some trace elements in the peregrine falcon nesting in North-West Poland.

Material and Methods

In April 2006, in Szczecin (North-West Poland), a live but much weakened female peregrine falcon (F. peregrinus) was found near its nest. Unfortunately, the bird died soon after it was transported to the animal clinic. Then the dead falcon was given to the Department of Zoology at the Agricultural University in Szczecin, and where the bird was measured and necropsied (28). The gonads and highly enlarged oviduct indicated that it was an adult female, which had laid an egg shortly before death. The body condition index (BC) was calculated as follows: BC = (OBM – PBM) x 100/PBM, where OBM is observed body mass, and PBM – predicted body mass (22). According to Starck and Ricklefs (36), the body mass of an average adult female peregrine falcon (n=232) is 925 g. This value was accepted by us as the PBM.

During dissection, fragments of the following organs were taken for microbiological studies: the liver, kidneys, lung, small intestine, heart, and scrapings from the pathologically altered skin from the breast. The fragments were inoculated on various diagnostic media: Brain Heart Infusion Agar, Blood Agar, Baird Parker Agar Base, and MacConkey Agar (Oxoid, Poland). The cultures were incubated for 24 h at 37°C. Fragments of the skin were inoculated on Czapek Agar and Malt...
Extract Agar (Oxoid, Poland). The culture was incubated for 2 weeks at room temperature. The identification of fungi was carried out under microscope and through the observation of the mycelium growth. During further dissection, nematodes were found in the thoracic and abdominal air sacs (left side of the body), and other parasitic worms in the intestines, which were then preserved in 70% ethyl alcohol.

The concentrations of Fe, Zn, Mn, Cu, V, Ni, Pb, and Cd were determined in the kidneys, liver, brain, breast muscle, and bone (tarsus). The first four elements are thought to be essential for vertebrates, and the rest non-essential. Until the analyses, the falcon organs and tissues were kept in plastic bags at -20°C. The biological materials to be analysed were dried at 105°C to constant weight (for more details of the analytical procedure see 16). Concentrations of the metals were determined using induction coupled argon plasma atomic emission spectrometry (ICP AES) in a Perkin-Elmer Optima 2000 DV apparatus in the Department of Poultry and Ornamental Birds, Agricultural University of Szczecin. Detection limits (mg/L) for Fe, Zn, Mn, Cu, V, Ni, Pb, and Cd of the apparatus are 0.1, 0.2, 0.1, 0.4, 0.5, 0.5, 1, and 0.1 respectively. To crosscheck the analytical procedures applied, a Standard Reference (SRM) 1577b Bovine Liver (National Institute of Standards and Technology, USA) was used. The reference levels of the elements, specified for the SRM 1577b Bovine Liver and the corresponding values measured in our laboratory are reported in Table 1. Recoveries of the 6 metals assayed were good (from 94.3% to 103.3%), with the exception of Ni and V. The reference concentration of V was only approximate, while that of Ni was not provided at all.

**Results**

The examined peregrine falcon weighed 630 g and the calculated body condition index was low (BC = -31.89). It definitely signalled the bad condition of the bird. Other body size parameters were as follows: length of body, wing, tarsus, and culmen were 45 cm, 33.2 cm, 59 mm, and 23.8 mm, respectively. The internal organs achieved the following masses (g): brain 6.30, heart 7.32, liver 15.72, kidneys 4.67, spleen 0.19, gallbladder 0.89, left ovary 0.24, and right ovary 0.12.

**Table 1**
Trace metal concentrations (mg/kg d.w.) according to the certified reference material 1577b – Lyophilised Bovine Liver (CR) and the present authors’ data (OR)

<table>
<thead>
<tr>
<th>Material</th>
<th>Fe</th>
<th>Zn</th>
<th>Mn</th>
<th>Cu</th>
<th>V</th>
<th>Ni</th>
<th>Pb</th>
<th>Cd</th>
</tr>
</thead>
<tbody>
<tr>
<td>CR</td>
<td>184±15</td>
<td>127±16</td>
<td>10.5±1.7</td>
<td>160±8</td>
<td>(0.123)</td>
<td>-</td>
<td>0.129±</td>
<td>0.50±0.03</td>
</tr>
<tr>
<td>OR (n=4)</td>
<td>190±15</td>
<td>122±2</td>
<td>9.9±0.1</td>
<td>158±4</td>
<td>0.113±</td>
<td>0.212±</td>
<td>0.128±</td>
<td>0.49±0.02</td>
</tr>
<tr>
<td>OR/CR (%)</td>
<td>103.3</td>
<td>96.1</td>
<td>94.3</td>
<td>98.7</td>
<td>91.9</td>
<td>-</td>
<td>99.2</td>
<td>98.0</td>
</tr>
</tbody>
</table>

**Table 2**
Metal concentrations (mg/kg) in European peregrine falcons

<table>
<thead>
<tr>
<th>Metal</th>
<th>Liver</th>
<th>Kidneys</th>
<th>Breast muscle</th>
<th>Brain</th>
<th>Bone</th>
</tr>
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<tr>
<td>Mn</td>
<td>22.49</td>
<td>10.44</td>
<td>2.86</td>
<td>1.46</td>
<td>2.38</td>
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<tr>
<td>Fe</td>
<td>6.149</td>
<td>787.0</td>
<td>739.8</td>
<td>110.7</td>
<td>82.7</td>
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<tr>
<td>Zn</td>
<td>188.5</td>
<td>256.1</td>
<td>160.8</td>
<td>55.30</td>
<td>185.6</td>
</tr>
<tr>
<td>Cu</td>
<td>13.24</td>
<td>19.3</td>
<td>67.15</td>
<td>16.50</td>
<td>0.391</td>
</tr>
<tr>
<td>V</td>
<td>0.135</td>
<td>0.810</td>
<td>0.283</td>
<td>0.316</td>
<td>0.636</td>
</tr>
<tr>
<td>Ni</td>
<td>0.107</td>
<td>1.155</td>
<td>0.067</td>
<td>0.324</td>
<td>0.027</td>
</tr>
<tr>
<td>Pb</td>
<td>0.225</td>
<td>2.221</td>
<td>0.054</td>
<td>0.555</td>
<td>4.47</td>
</tr>
<tr>
<td>Cd</td>
<td>0.164</td>
<td>5.247</td>
<td>0.101</td>
<td>0.059</td>
<td>0.135</td>
</tr>
</tbody>
</table>

1this study; 2Ek et al. (8); 3Pain and Amiard-Triquet (26); 4Alleva et al. (1); n – number of birds; d.w. – dry weight; w.w. – wet weight
The flatworms were only found in the intestines. These were two species of trematodes: Strigea falconis (Szidat, 1928) (n=113) and Conodiplostomum spatula (Creplin, 1829) (n=18), and one cestode species Cladotaenia cylindracea (Bloch, 1782) (n=1). Two 20 cm long nematodes (male and female), belonging to the species Serratospiculum tendo (Nitzsch, 1857) were observed in the air sacks.

Mycological examination of the skin scrapings showed the presence of two pathogens responsible for mycosis: Aspergillus nidulans and Cladophialaphora boppi. Escherichia coli (rough, R type) was isolated from all parenchymatous organs. Moreover, Micrococcus luteus and Proteus mirabilis were isolated from the lungs.

The content of water in the breast muscle, liver, kidney, brain, and bone was as follows: 76.8%, 75.8%, 82.0%, 81.2%, and 33.1%, respectively. The concentrations of the examined trace elements are presented in Table 2. As seen from the Table, the falcon showed very high concentrations of Fe, Zn, and Mn in the liver (>6.100, 188, and 22 mg/kg d.w., respectively) and Cd in the kidneys (>5 mg/kg d.w.).

**Discussion**

As it was demonstrated, the intensity of helminthiasis in Polish peregrine falcon, excepting trematodiasis, was low. The trematode S. falconis (syn. S. falconispalumbi) is a common parasite in Eurasian falconiformes and strigiformes (18, 35). Sometimes, a massive invasion of this parasite may be the cause of serious health problems experienced by the peregrine falcon (31). Recently, parasitological researches were carried out on individual specimens (1-6) of peregrine falcons in Spain, Netherlands, and Germany (4, 21, 32). Generally, parasitofauna of the Polish peregrine falcon and F. peregrinus from other European countries are similar.

The air sack nematodes from the genus Serratospiculum cause a dangerous and sometimes lethal disease (serratospiculiasis) reported in falcons from various parts of the world (39). In Poland, in the 1950s, S. tendo was found in F. peregrinus and F. cherrug by Furmaga (10). Recently, this nematode was isolated from wild peregrine falcons from various European countries (4, 21, 32).

Aspergillosis is considered the most common mycosis in different bird species, including raptors (14). This mycosis is a very important cause of morbidity and mortality in captive falcons, and may develop into dermatosis or fungal infection of internal organs, especially of the respiratory system. Aspergillus fumigatus is the most often isolated in wild raptor species, and A. flavus, A. niger, A. glaucus, and A. nidulans are also found in birds of prey (14). Fungi from the lung of the Polish peregrine falcon were not investigated, but it may not be excluded that the bird also had lung aspergillosis, because that disease often accompanies serratospiculiasis in falcons (31). According to our knowledge, the second mycete - C. boppi found in the examined peregrine falcon has not yet been reported in these birds. This species is thought to be a potentially dangerous human pathogen, which is a relatively common cause of chromoblastomycosis, other skin lesions, and cauliflower-like tumours (5, 7).

Escherichia coli were found in all the examined organs of the falcon. M. luteus and P. mirabilis were isolated only from the lungs. This may indicate the airborne infection of the respiratory system. Such a way of infection with P. mirabilis in birds is also suggested by other studies (30). Probably, the lungs of the peregrine falcon examined in this study were the first impaired by the nematode S. tendo and P. mirabilis, and then underwent the secondary infection by the non-pathogenic M. luteus.

In Table 2, the concentration data concerning trace metals studied in European peregrine falcon were given. Contrary to our investigations, Fe and Mn were not analysed in this species. In ecotoxicological studies, Fe and Mn in the liver ofalconiform birds are only sporadically examined, and the common view is that hepatic Fe and Mn concentrations vary within a wide range. For example, white-tailed eagle Haliaeetus albicilla from Poland and common buzzard Buteo buteo from the Netherlands usually have in their liver from about 430 to 2 300 mg/kg of Fe and from 2.8 to 11 mg/kg d.w. of Mn (13, 15). In comparison to these values, the peregrine falcon has much higher concentrations of Fe and Mn in the liver (over 6 000 and almost 22.5 mg/kg d.w., respectively). A concentration of Fe reaching many thousands of mg/kg d.w. is a pathological phenomenon and is called iron storage disease or haemosiderosis (6). Sometimes haemosiderosis in birds accompanies increased levels of Pb in tissues and organs (20). Recently, haemosiderosis has been described in relation to the liver and spleen of mute swan; the disease was caused by trematodes Trichobilharzia sp. (38). In mammals, the increased absorption of Fe from the intestine, and the subsequent accumulation of Fe in the liver, may be the result of inflammations in the digestive tract due to bacterial infections and/or helminthiasis, or other diseases (2, 41). This aspect of haemosiderosis in wild birds is very poorly investigated (34). In the case of the peregrine falcon examined in this study, the accumulation of Fe in the liver should be associated with serious bacterial and helminthological infections, rather than with Pb toxicity, because this metal was found in small amounts in all analysed materials (Table 2). Such small concentrations of Pb in the bird body probably reflect rather the geochemical background (8, 13). Zinc and Cu were determined in the liver and kidneys of Swedish peregrine falcons (8). In comparison with them, the Polish falcon had from 2.6 to 3.6 times more Zn in the mentioned organs, but no such distinct differences were observed in the concentration of Cu (Table 2). Nickel and V belong to the elements that are very rarely determined in birds. It is an open question if Ni and V are essential metals for warm-blooded vertebrates, or potentially toxic pollutants from the environment (24). Vanadium was analysed in white-tailed eagles in Poland.
by Falandysz et al. (9). The concentrations of V in the liver and kidney of these birds achieved 0.077 and 0.350 mg/kg d.w. In comparison with white-tailed eagle, our falcon had similar concentrations of V, but much lower Ni level in the both mentioned organs (eagle: 13 and 6.5 mg/kg d.w. of Ni in liver and kidney, respectively). Cd is a non-essential element and due to its high affinity to the kidney, it is called a nephrotoxin. In birds of prey, it is usually determined in the kidney and liver. Scheuhammer (33) gives background values for Cd concentrations in birds. Cadmium levels above 3 and 8 mg/kg d.w. in the liver and kidneys, respectively, may suggest an increased environmental exposure to that toxic metal. Our peregrine falcon had >5 mgCd/kg d.w. in the kidneys. This was over 10 times more than in birds of the same species from Sweden and many times more than was observed in the white-tailed eagle from Poland (9, 16), white-tailed eagle and goshawk Accipiter gentilis from neighbouring Germany, and diurnal and nocturnal raptors from Spain (11, 17).

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References