# ORAL PRESENTATIONS

## DEAD LOSSES OF FALCONS CAUSED BY ASPERGILLOSIS

**Schulz, J.[1], Sanchez, A.[2], Lierz, M.[3] and Hartung, J.[1]**

*[1] Institute of Animal Hygiene, Animal Welfare and Behaviour of Farm Animals, University of Veterinary Medicine Hannover, Germany; [2] Falcon Center Helvesiek, Germany*
*[3]Institute of Poultry Diseases, Free University of Berlin, Germany*

### SUMMARY

An increasing mortality of falcons was observed in a falcon breeder centre in Germany. 22 falcons which died in 2005 and 2006 were dissected and *Aspergillus fumigatus* was isolated in all cases from the lungs or air sacks. The origin of the fungi was unclear. Therefore air samples were taken in and around the premises under different meteorological conditions. *A. fumigatus* was only sporadically found in background samples, up to 400 cfu/m$^3$ were detected when the wind blew from a nearby mushroom factory. It was assumed that massive emission of *A. fumigatus* from this plant caused morbidity and mortality in the falcons.

**Keywords:** falcons, aspergillosis, *Aspergillus fumigatus,* aerial transmission, emission

### INTRODUCTION

Aspergillosis is a fungal disease caused by *Aspergillus* spp. which can affect birds of prey both in freedom and in captivity. *A. fumigatus* is the predominant species isolated from infected birds of prey (1). The spores of this thermophilic mould are relatively small (2 to 4 μm), can travel and survive for longer periods in an airborne state and are deposited in lungs and air sacks birds after inhalation (2). Median concentrations in ambient air vary largely around 10 colony-forming units per cubic-meter (cfu/m$^3$) (3, 4). Higher concentrations in ambient air (> 100 cfu/m$^3$) are usually caused by emissions from sources which harbour large amounts of spores such as mouldy grains, composting materials, litter or sawdust (1, 3, 5). Birds of prey, particularly young birds, which are exposed to ambient air containing high numbers of spores from such sources, can develop an acute or chronic aspergillosis depending on the number of inhaled spores and the responsiveness of their immune system (1, 6). However, often a clear definition of the source of the spores is difficult because also naturally decomposing organic materials have to be taken into account.

This paper reports on measurements of airborne micro-organisms and spores in and around Germany's biggest falcon breeder centre in order to identify the source responsible for high fungi concentrations in the airspace of the centre and to understand the increasing mortality rates particularly of young falcons due to acute aspergillosis.

## MATERIAL AND METHODS

The investigated falcon breeder centre is located in a rural region in north-west Germany housing about 500 falcons, Peregrine-, Saker- and Gyrfalcons, Red Saheen and hybrids in 189 aviaries. North of the area loosely grouped detached residential houses are situated about 100 m away. In westerly and south-westerly directions there is open field (some horses grazing) and a forest area. Close to the southern and eastern border of the falcon centre a mushroom factory was erected a few years ago.

Twenty two of 180 frozen falcons which died in 2005 and 2006 due to aspergillosis were randomly selected and dissected aseptically. Moulds were isolated with swabs from the infected lungs, air sacks and sliced aspergillomas. The isolates were incubated on Malt-agar and Czapek Dox Agar at 37 °C for 48 h. Moulds were identified by their typical growth on agar and by microscopic examination of hyphae, conidiophores and spores.

Air samples were taken simultaneously at 24 sampling days in two aviaries and at two sampling sites in the ambient air of the falcon centre from the end of March to September 2006. The outdoor sampling sites were situated close to the western and eastern border of the centre. Indoor samplings were done in aviaries close to these areas, where the lowest respectively the highest rates of morbidity were observed. At nineteen sampling days a filtration method was used and at five days the sampling was performed by means of an impactor. Fungi were sampled on polycarbonate filters as described by Saleh et al. (7) three m above the ground or with a SAS impactor (Bioscince International, Rockville, MD) in two metres height. The impactor was used for 40 seconds (flow rate 3 l/s**).** Sampled moulds were cultivated on DG-18-agar (Oxoid LTD, Basingstoke, Hampshire, England) at 37 °C for 48 h and identified as described above. Measurements were conducted at 21 different wind directions. Wind speed, wind direction, air temperature and further meteorological data were continuously measured by means of a weather station (UNIKLIMA 7, TOSS Potsdam, Germany) positioned on the top of the main building of the falcon centre 10 m above the ground.

## RESULTS

Table 1 summarises the data of the dissected 22 falcons which died of aspergillosis. Only two birds were older than one year (8 and 9 years of age) belonging to pedigree birds. 19 birds (86%) five months old or younger, six females and 13 males died of acute aspergillosis. *A. fumigatus* was isolated in all cases from the respiratory tract. Pedigree species and hybrids were affected.

**Table 1.** Dissection results of falcons that died in 2005 and 2006 due to Aspergillosis

| species, hybrids | sex* | age (month) at death | isolated pathogen | species, hybrids | sex* | age (month) at death | isolated pathogen |
|---|---|---|---|---|---|---|---|
| *Falco peregrinus x Falco rusticolus* | m | 3 | *Aspergillus fumigatus* | *Falco cherrug-rusticolus x Falco rusticolus* | f | 2 | *Aspergillus fumigatus* |
| *Falco cherrug x Falco rusticolus* | f | 3 | *Aspergillus fumigatus* | *Falco cherrug-rusticolus x Falco rusticolus* | m | 2 | *Aspergillus fumigatus* |
| *Falco cherrug-rusticolus-rusticolus* | m | 3 | *Aspergillus fumigatus* | *Falco rusticolus* | m | 2 | *Aspergillus fumigatus* |

| species, hybrids | sex* | age (month) at death | isolated pathogen | species, hybrids | sex* | age (month) at death | isolated pathogen |
|---|---|---|---|---|---|---|---|
| *Falco peregrinus babylonicus* | f | 3 | *Aspergillus fumigatus* | *Falco peregrinus* | m | 96 | *Aspergillus fumigatus* |
| *Falco cherrug-rusticolus x Falco rusticolus* | m | 3 | *Aspergillus fumigatus* | *Falco cherrug-rusticolus x Falco rusticolus* | m | 2 | *Aspergillus fumigatus* |
| *Falco cherrug x Falco rusticolus* | f | 4 | *Aspergillus fumigatus* | *Falco cherrug x Falco rusticolus* | m | 3 | *Aspergillus fumigatus* |
| *Falco cherrug x Falco rusticolus* | m | 4 | *Aspergillus fumigatus* | *Falco rusticolus* | f | 108 | *Aspergillus fumigatus* |
| *Falco cherrug-rusticolus-rusticolus x F.rusticolus* | m | 3 | *Aspergillus fumigatus* | *Falco cherrug x Falco rusticolus* | m | 2 | *Aspergillus fumigatus* |
| *Falco cherrug-rusticolus-rusticolus* | f | 3 | *Aspergillus fumigatus* | *Falco cherrug-rusticolus x Falco rusticolus* | m | 5 | *Aspergillus fumigatus* |
| *Falco rusticolus* | f | 9 | *Aspergillus fumigatus* | *Falco cherrug-rusticolus x Falco rusticolus* | m | 5 | *Aspergillus fumigatus* |
| *Falco cherrug-rusticolus x Falco rusticolus* | f | 2 | *Aspergillus fumigatus* | *Falco cherrug-rusticolus x Falco rusticolus* | m | 3 | *Aspergillus fumigatus* |

* m = male, f = female

Figure 1 presents the relationship between the wind direction and the amounts of *A. fumigatus* found at the outdoor sampling sites. Wind speed varied between 1 and 2.5 m/s during the measurements.

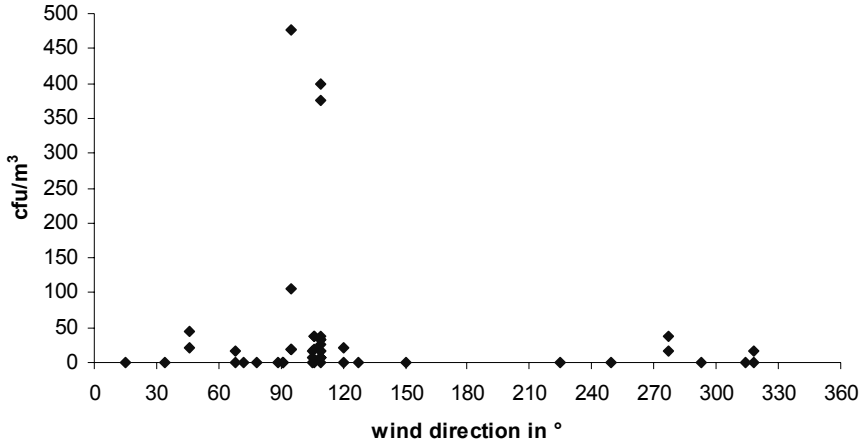


**Figure 1.** *Aspergillus fumigatus* concentrations in the ambient air of the falcon centre at two sampling places in relation to the wind direction. 0° = North, 90° = East, 180 = South, 270° = West

Highest concentrations of *A. fumigatus* are observed when the wind comes from east-southeast directions. At all other wind directions the concentrations do not exceed 45 cfu/m$^3$. No data are available when the wind came (very rarely) from the south. The results indicate that there is a potential emission source of *A. fumigatus* located in east south-east directions of the falcon centre.

The measurements inside the aviaries revealed *A. fumigatus* concentrations between 15 and 42 cfu/m$^3$. However, no fungi could be detected at 17 sampling days out of 24.

## DISCUSSION

The results of this study show that the heavy losses in the falcon breeding centre are mainly caused by acute and chronic aspergillosis. *A. fumigatus* which is seen as the predominant causative agent of aspergillosis in falcons (1, 8) was found in all fallen birds. 86% of the 22 out of 180 randomly selected birds were only 2 to 5 months old. This is typical for acute aspergillosis which particularly affects young birds when an overwhelming number of spores are inhaled (1, 6). The highest concentrations of *A. fumigatus* were regulatory found in the air space of the falcon breeder centre when the wind blew from eastern to south-eastern directions. In all other wind directions the airborne concentration of fungi was not detectable or below 45 cfu/m³. Although there is no clear definition of the infective dose for *A. fumigatus* to cause aspergillosis it seems likely that the periodically occurring massive emissions from the mushroom factory may have triggered the disease. The periodical character of the emissions (due to the wind direction) is supported by the results from the measurements inside the aviaries. Although the shelter walls of the aviaries reduce the number of fungi penetrating into the air space of the aviaries in some cases up to 45 cfu/m³ of *A. fumigatus* could be found inside.

The conditions of a captive environment may stress birds in general and can make them more susceptible to disease (8). Also poor husbandry, management and hygiene can increase the likelihood of infection (6). This may be in general terms also true for this holding. However, during inspections of all bird shelters regularly over a period of nearly a year no indication of poor management conditions and hygiene could be found. The managers made every effort to minimize the environmental stressors. The aviaries were regularly cleaned and experienced permanently employed staff was taking care of the animals. The good status of the aviaries is also confirmed by the low concentrations of fungi in the indoor air space when the wind is not coming from eastern directions.

The fact that the heavy losses of falcons caused by *A. fumigatus* infections began after the erection of the mushroom factory and increased steadily with the expansion of the mushroom production also supports the hypothesis that the mushroom factory may be the main contributor to the aspergillosis in the falcon centre. Mushroom plants use wood chips, peat and sawdust and other biological materials as growing substrate. Such materials regularly contain high amounts of *A. fumigatus* spores and also mycotoxins (10, 11). When the material is mixed high amounts of these compounds are emitted into the air and can travel easily 100m and more because of there minute dimensions. Windy and dry conditions support a far reaching distribution.

## CONCLUSION

It is assumed that the dead losses due to aspergillosis observed in a falcon breeder centre were caused by strong emissions of *A. fumigatus* from a mushroom factory situated about 100 m upwind. It is recommended that planning authorities should carefully consider "safe distances" between mushroom factories to sensitive animal holding facilities such as falcon farms. This may be also useful in respect to residential areas.

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