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## CAUSES OF MORTALITY AMONG FREE-RANGING GYRFALCONS IN ICELAND

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**Abstract:** In an examination of the causes of death of 36 *Falco rusticolus islandus* and 2 *Falco rusticolus candicans* from Iceland it was found that 12 birds had been shot, while 10 had died from various other injuries. Thirteen had died of infection with *Capillaria contorta* in the upper alimentary tract, and one of alkyl phosphate poisoning. The cause of death of two birds could not be determined.

### INTRODUCTION

The resident population of gyrfalcons (*Falco rusticolus islandus*) in Iceland occasionally is supplemented with gyrfalcons (*Falco rusticolus candicans*) migrating from Greenland (Gudmundsson, unpubl.)

Great fluctuations occur in the Icelandic population of gyrfalcons. These fluctuations follow the fluctuation of the ptarmigan (*Lagopus mutus*), the main prey of the gyrfalcons<sup>1</sup>. In general, however, the population of gyrfalcons in Iceland does not seem to be declining (Gudmundsson, unpubl.).

While very little literature exists on diseases and mortality among free-ranging gyrfalcons, diseases of captive falcons have been studied for centuries.<sup>1</sup>

"Inflammation of the crop" and "frounce" have been mentioned among the more serious diseases of falcons,<sup>15</sup> and "frounce" has been known to be caused by *Trichomonas gallinae*.<sup>16</sup> In extensive surveys Cooper<sup>6</sup> and Keymer<sup>12</sup> found aspergillosis to be the main cause of death in captive birds of prey, while parasites were of very little importance. However, *Capillaria contorta* in captive gyrfalcons and peregrine falcons (*Falco peregrinus peregrinus*) has been described as a serious, often fatal disease, especially in newly captured birds.<sup>19</sup> Cooper<sup>7</sup> found a fatal infection of *C. contorta* in the upper digestive tract of a

peregrine falcon and a red-headed merlin (*Falco chicquera rusticolis*) and suggested that "frounce" sometimes might be identical to capillariasis.

A similar statement was made by Trainer<sup>17</sup> who found a "caseous growth" caused by *C. contorta* or *C. annulata* in the throat of two free-ranging gyrfalcons from Iceland. "Caseous growth" also has been described in a peregrine falcon by Brüll<sup>2</sup> who found that the lesions were caused by *C. dispar*.

Diphtheritic membranes have been seen in the throat of newly captured gyrfalcons from Iceland, and the same kind of lesion has been observed in their unfledged young in Iceland.<sup>3</sup> This disease seems to be identical with "frounce" or "caseous growth," and is a fatal disease among gyrfalcons in Iceland.

The purpose of the present study was to determine the causes of death among gyrfalcons, and to examine the cause of the diphtheritic inflammation of the pharynx known as "caseous growth," "frounce" or "inflammation of the crop."

### MATERIAL AND METHODS

A total of 38 gyrfalcons, 36 *F. r. islandus* and 2 *F. r. candicans*, found diseased or dead in Iceland during the years 1966-1973, were sent to the Museum of Natural History in Reykjavik, where as much information as possible was collected; they were then sent to

Copenhagen for further examination. Thirty-two (84%) birds were less than one year old. Twenty were males, 17 were females, and the sex was not determined for one bird. The birds were skinned and obvious lesions noted.

During necropsy, nutritional condition of the birds was judged by the amount of fat in the body cavity and the volume of the pectoral muscle.

Giemsa-stained smears were made from birds with lesions grossly compatible with ornithosis, and material from the air sacs of such birds was inoculated into mice. Cultivation for fungi was made on Sabouraud's agar plates, incubated at 37 C for 48 h, and the tissue stained with Grocott technique for histopathology, smears from gross lesions were Gram stained and cultured on Loewenstein-Jensen media for demonstration of possible mycobacteria. Material from intestinal contents and spleen from all birds was cultured in potassium tetrathionate medium (37 C 24 h) and then subcultured on brilliant-green agar plates (37 C 24 h) for isolation of *Salmonella*.

The alimentary canal was examined for parasites and the faeces was examined for eggs. Parasites isolated from the throat and oesophagus were identified after the guidelines given by Madsen.<sup>1,4</sup>

Intestinal contents from one bird were examined for insecticides,<sup>11</sup> and by thin layer chromatography for the presence of alkyl-phosphates. Determinations were made for PCB (polychlorinated biphenyls), DDE, and mercury in organs from all the falcons. The results of the chemical analyses have been published in another article.<sup>9</sup>

## RESULTS

Twelve of the 38 gyrfalcons had lesions obviously caused by small calibre rifles or shotguns, pellets often being found in the carcasses. Eight of the 38 died as a result of trauma. Fracture of the wing or sternum had occurred in six birds, four of

which were found under telephone wires, and one was captured alive, entangled in a net. One bird had died from ingesting a femur that had penetrated the gizzard and damaged the liver. The bone was compatible in size with the femur from ptarmigan, the normal prey of gyrfalcons. Two of the 38 gyrfalcons died from oil, one landed on a ship 45 km from shore, very weak, and covered with oil. The other was captured on land, covered with train oil.

All the 36 gyrfalcons except the two originating from Greenland were infected with *C. contorta*. In most of the birds the nematodes and their eggs were found in the pharynx and oesophagus, while in others characteristic eggs were found in the faeces. In lightly infected cases only a few nematodes were found embedded in the apparently normal mucous membrane. In some cases the mucosa was edematous, and dozens of nematodes and hundreds of eggs were found on the surface and embedded in the mucous membrane. In 13 gyrfalcons heavy deposits of a thick, grainy, yellow exudate was present, especially around the root of the tongue (Fig. 1) and in the pharynx. *C. contorta* and their eggs were numerous in these deposits. The lesions were most pronounced in the pharynx but also were seen in the oesophagus. The lesions were superficial and never penetrated the wall of the oesophagus. On histologic examination the lamina propria was found to be partly exfoliated. Large numbers of *Capillaria* and eggs were located in the lamina propria, and in some areas the mucosa was completely destroyed. The lesions caused by *Capillaria* were so pronounced that they were considered to be the cause of death for 13 birds; those were all in a very poor state of nutrition and capillariasis considered to be fatal was recorded in both sexes of falcons under one year of age as well as in older birds.

In addition to capillariasis, eight of the 13 gyrfalcons had lesions in the respiratory organs. One had an acute



FIGURE 1. Gyrfalcon with pronounced capillariasis.

pneumonia and a fibrinous pericarditis. *Corynebacterium murium* was isolated from the pericardium and liver of this bird. The other seven birds had pneumonia with caseation of the lung tissue and inflammation of the air sacs. The air sacs were covered with thick cheese-like membranes often nearly 1 mm in thickness. One of these birds also had a subperitoneal abscess under the right kidney, from which *Corynebacterium pyogenes* was isolated. Various Gram negative bacteria, together with  $\alpha$ -streptococci, were isolated from the pharynx, lungs, air sacs, and livers of the diseased birds.

Examinations for ornithosis, fungi and acidfast bacteria proved negative, and no salmonellae were found in the intestinal content of any of the falcons.

Small numbers of parasites other than *Capillaria* were found in the intestines of

12 gyrfalcons. *Plagiorchis elegans* was found in two birds, *Cladotaenia cylindracea* in two birds, *Hymenolepis* in seven birds, and *Mesocestoides* in one bird.

A green-stained gizzard together with an acute haemorrhagic enteritis in one falcon was suggestive of a toxic substance; an extract of the small intestine revealed the insecticide dimethoate.

No diagnosis could be made in two birds. Both were emaciated. No changes were seen in one, while the other had pulmonary edema and an acute haemorrhagic enteritis.

Seventeen of the birds were in a good state of nutrition; all these birds had been shot or otherwise injured. Thirteen of the emaciated birds had severe capillariasis, two had old injuries of unknown origin, one was covered with oil, and one was poisoned. Only two of the birds which had been shot were emaciated; both had capillariasis.

## DISCUSSION

Although the gyrfalcon is a protected species, an alarming 32% had been shot. Unfortunately, however, this is not unusual; 62% of the bald eagles (*Haliaeetus leucocephalus*) found dead in the USA between 1960 and 1965 had been shot.<sup>5</sup> The percentage of gyrfalcons shot corresponds very well with findings in similar surveys of birds of prey in Europe: sparrow hawk (*Accipiter nisus*) 40% and kestrel (*Falco tinnunculus*) 16%;<sup>8</sup> hawks 27%;<sup>10</sup> and buzzard (*Buteo buteo*) 41%.<sup>14</sup> Because this mortality factor is attributable entirely to man, it certainly is the mortality factor most easily changed.

Injuries other than gunshot were found in only six gyrfalcons (16%). This percentage is lower than is found in birds of prey in Europe.<sup>18</sup> But in Iceland the risk of collision with cars, telephone wires, etc. is also less than in Europe.

The recovery of dimethoate from the bird with haemorrhagic enteritis in-

dicates it probably died of alkyl-phosphate poisoning. Dimethoate is used mainly against flies in the stable; it is not known how the falcon came into contact with it. Alkyl phosphate poisoning occasionally is seen in Danish birds of prey when the insecticide is put in baits illegally to kill seagulls and crows.<sup>4</sup>

In deep frozen material, no trichomonads would be detectable, but nothing in the present investigation gave evidence of infection with *Trichomonas*. Thus none of the elevated well-delineated, deep caseous lesions which are characteristic of this infection, were

ever found in the pharynx or oesophagus, and liver lesions were never seen. Further it should be noted that pigeons, which are the main carriers of *Trichomonas gallinae*, are not found in Iceland except around a few larger cities, where they are occasionally taken by gyrfalcons during winter time.

## RESULTS

The results of the present study indicate that the lesions in the pharynx listed as a mortality factor for gyrfalcons from Iceland (frounce, caseous growth etc.) are identical with capillariasis.

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