Mortality of the northern geese in captivity

NIGELLA HILLGARTH, JANET KEAR and KATHERINE HORKY

This is the sixth in a series of reports that analyse post-mortem findings of birds dying in the Wildfowl Trust collections since 1959. Detailed records have been kept by J. V. Beer (1959-69), by N. A. Wood (1970-1973), and by M. J. Brown subsequently.

Within the true geese we have included the following: Swan Goose *Anser cygnoides*, Bean Goose *A. fabalis*, Pink-footed Goose *A. brachyrhynchus*, White-fronted Goose *A. albifrons*, Lesser White-fronted Goose *A. erythropus*, Greylag Goose *A. anser*, Bar-headed Goose *A. indicus*, Emperor Goose *A. canagicus*, Snow Goose *A. caerulescens*, Ross's Goose *A. rossii*, Canada Goose *Branta canadensis*, Barnacle Goose *B. leucopsis*, Brent Goose *B. bernicla*, and Red-breasted Goose *B. ruficollis*. Post-mortem examinations of Hawaiian Geese *B. sandvicensis* dying at the Wildfowl Trust have already been analysed and the results published by Kear & Berger (1980). Reference to their findings will be made in this paper for the purpose of comparison, but the reader is referred to their book for details.

Geese are monogamous and both sexes rear the young; sexes are similar in appearance and have only one annual moult of body feathers. Most species are migratory and breed in northerly areas. Families remain together on migration and in winter, and many of their movements are 'traditional'. All true geese are found in the northern hemisphere and normally take two or three years to reach maturity. They primarily feed by grazing, even when young.

History in captivity

Geese have long been maintained in waterfowl collections, and about half the species had been bred by the time Sclater published his list of birds at the London Zoo in 1880.

The Swan Goose and the Greylag have been domesticated for centuries, the former for at least 2000 years, and its domesticated form (the Chinese Goose) was common in Europe from the 18th century. The first wild Swan Geese were bred by R. & N. Stevens, at Walcot, England, in 1937 (Delacour 1954). The Greenland race of the White-fronted Goose first hatched in 1950 at Cleres, France. Lesser Whitefronts nested at Scampston Hall in England in 1918 and Pink-footed Geese in Norfolk also about 1918. The first Ross's laid at Gooilust, Holland, in 1902 (Blaauw 1902) and the Emperor at the same place in 1914 (Blaauw 1916). The Red-breasted Goose hatched at Woburn in 1926 (Bedford 1927) and the Brent at Boston, Lincolnshire, in 1953. All other wild goose species had bred in captivity by 1900.

The greatest difficulty has been experienced in breeding the high latitude, arctic species, possibly because the day-lengths in temperate zoos do not reach the level typically required for laying to occur (Murton & Kear 1973).

Materials

Post-mortem data from 1503 geese dying between 1959-80 have been examined. These consist of 811 adults, 279 juveniles and 413 downies (Table 1).

An adult bird is defined as one that has survived to its first January. A juvenile is fully feathered, but dies before 1 January of the year after its death. A downy is any young bird that is not fully feathered.

Results

Longevity and seasonal mortality

The average age at death of all captive geese (adults only) was 5.4 years. This figure is based on the 442 geese examined whose age was known, and excludes wild-caught birds (Figure 1). Males died at an average age of 5.7 years and females at an average of 5.1 years, but there is no

Table 1 (a). The numbers of adult geese dying in Wildfowl Trust collections since 1959.

	Male	Female	Unsexed	Total
Swan Goose	14	17	0	31
Bean Geese	19	17	0	36
Pink-footed Goose	23	26	0	49
White-fronted Geese	19	15	0	34
Lesser White-fronted Goose	14	19	1	34
Greylag Geese	39	37	4	80
Emperor Goose	27	49	0	76
Snow Geese	34	26	0	60
Ross's Goose	34	47	0	81
Canada Geese	34	38	0	72
Barnacle Goose	40	46	2	88
Brent Geese	34	45	1	82
Red-breasted Goose	30	38	0	68
Bar-headed Goose	11	11	0	22
Totals	372	431	8	811

The word 'geese' has been used when more than one subspecies has been included within the totals; 'goose' implies that the species has no recognised races.

Table 1(b). The number of juvenile geese dying in Wildfowl Trust collections since 1959.

	Male	Female	Unsexed	Total
Swan Goose	13	9	0	22
Bean Geese	3	1	0	4
Pink-footed Goose	5	10	0	15
White-fronted Geese	9	6	0	15
Lesser White-fronted Goose	9	6	0	15
Greylag Geese	10	6	1	17
Emperor Goose	15	24	4	43
Snow Geese	22	9	0	31
Ross's Goose	2	3	0	5
Canada Geese	10	11	0	21
Barnacle Goose	18	36	1	55
Brent Geese	7	5	1	13
Red-breasted Goose	7	7	1	15
Bar-headed Goose	4	4	0	8
Totals	134	137	8	279

Table 1(c). The number of downy geese dying in Wildfowl Trust collections since 1959.

	Male	Female	Unsexed	Total
Swan Goose	11	13	1	25
Bean Geese	4	7	1	12
Pink-footed Goose	3	1	0	4
White-fronted Goose	4	5	0	9
Lesser White-fronted Goose	10	10	4	24
Greylag Geese	8	11	1	20
Emperor Goose	19	57	9	85
Snow Geese	21	32	5	58
Ross's Goose	5	7	6	18
Canada Geese	22	20	1	43
Barnacle Goose	21	36	3	60
Brent Geese	4	4	1	9
Red-breasted Goose	8	5	3	16
Bar-headed Goose	8	16	6	30
Totals	148	224	41	413

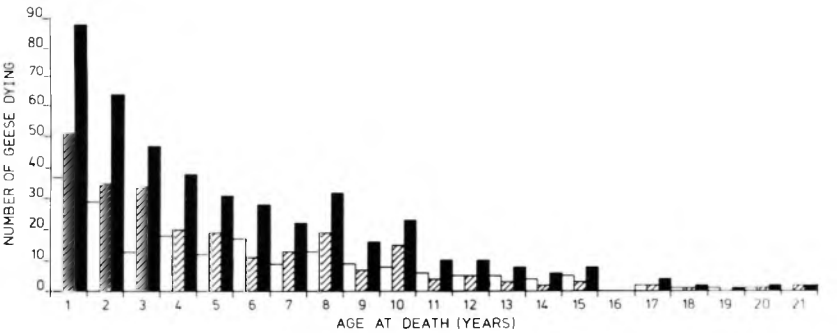

Figure 1. Age at death of 442 adult geese hatched at the Wildfowl Trust.

Table 2. Wildfowl Trust longevity records for geese hatched in captivity and wild-caught (age in years).

Species	Male	Female
Swan Goose	14	
Bean Geese		21
Pinkfoot		
Whitefronts	17; 20; 17*	17; 17; 15
Lesser Whitefront		15
Greylag Geese		20
Emperor Goose	15	
Snow Geese		21
Ross's Goose	18; 15*	15; 14
Canada Geese	15	
Barnacle Goose		15; 22*
Brent Geese	14	18
Red-breasted Goose	15	15*
Bar-headed Goose	17	15; 16*
Hawaiian Goose	17.6**	

* wild-caught birds, i.e. exact age not known but the figure given indicates that the individual was in captivity that long.
** Kear & Berger (1980).

statistically significant difference between the sexes in age at death. Table 2 shows the oldest recorded Wildfowl Trust birds, but it is likely that many more years of record-keeping are required before the full potential of these species is obvious. Kear & Berger (1980) gave the average age at death of 223 captive Hawaiian Geese at the Wildfowl Trust as 5.0 years for ganders and 4.6 years for females, slightly younger than the average age of dead geese of other species. Their figure, however, referred to all ringed birds, and some dead juveniles would have been included in the calculations.

There are records elsewhere for a captive Greylag of 26 years and a Canada Goose of 33 years (Johnsgard 1968) and two Red-breasted Geese lived at the London Zoo until they were 21 years old. There are also several longevity records for ringed wild birds available for comparison (Table 3).

Seasonal mortality

The seasonal mortality pattern of geese (in which most birds are found to die between March and June) is typical of temperate-breeding waterfowl in captivity (e.g. eiders, shelduck, mergansers, etc.), although the peak in male deaths in the spring is not normally so pronounced (Figure 2).

At post-mortem examination, a pri-

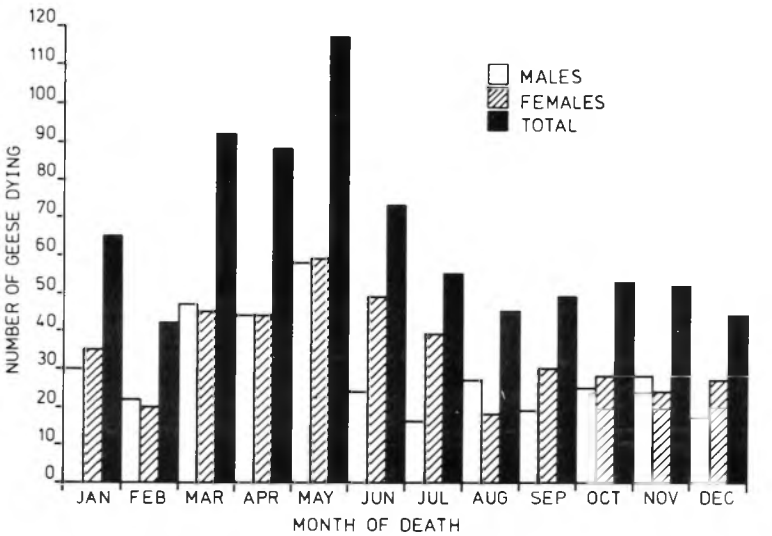

Figure 2. Seasonal mortality of 775 captive adult geese dying at the Wildfowl Trust.

Table 3. Longevity records for wild geese, obtained from ringing records (number of years that bird carried ring).*

Species	Age
Swan Goose	-
Bean Geese	7 yrs 10 mths
Pink-footed Goose	21 yrs 4 mths
White-fronted Geese	17 yrs 8 mths
Lesser White-fronted Goose	-
Greylag Geese	17 yrs 4 mths; 15 yrs 2 mths
Emperor Goose	-
Snow Geese	15 yrs 5 mths; 8 yrs 6 mths; 10 yrs 2 mths
Ross's Goose	-
Canada Geese	23 yrs 5 mths; 15 yrs 5½ mths
Barnacle Goose	14 yrs 1 mth; 7 yrs 9 mths
Brent Geese	5 yrs 5½ mths
Red-breasted Goose	-
Bar-headed Goose	-

* from: Kennard (1975),
Rydzewski (1971, 1973, 1974).

mary cause of death was assigned and it is these conditions that are discussed below. For information on treatment and prevention of disease the reader is referred to Beer (1959), Beer & Stanley (1965), the Game Conservancy (1974), Arnall & Keymer (1976), Hillgarth & Kear (1979a), and Wobester (1982).

Renal malfunction

Kidney failure was the major cause of death (27%) among adult geese at the Wildfowl Trust. There were high levels in Greylags (46%) especially males, Brents (43%) and Ross's Geese (38%). The renal failure rate in juveniles was considerably lower (7%), the highest levels occurring in Snow (26%) and Barnacle goslings (26%). Among dead downies, renal problems were relatively unimportant at 4%. The age at death of 121 adult geese suffering from renal malfunction was examined: 12% died at one year old and 19% died at two years

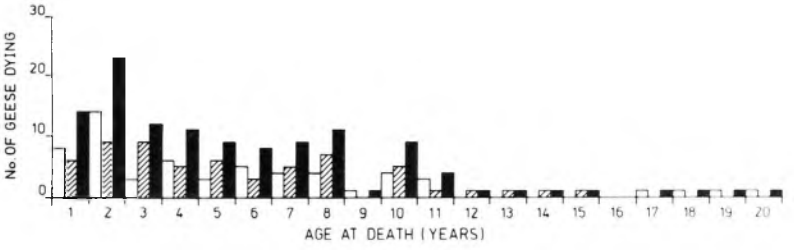

Figure 3. Age at death of 121 adult geese hatched at the Wildfowl Trust showing renal failure upon post-mortem examination.

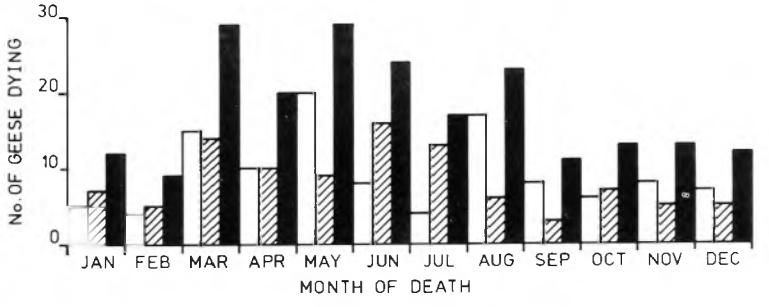

Figure 4. Seasonal mortality of 212 captive adult geese dying of renal failure at the Wildfowl Trust.

old, which contrasts with the 20% of adults who died at one year of all mortality causes and 14% at two years old (Figure 3).

The seasonal mortality pattern of 212 birds dying of renal failure (whose month of death was known) was also examined (Figure 4). Nearly 70% died between March and August, which includes the six-month period when they are most likely to be breeding or moulting flight feathers, and thus metabolising relatively large amounts of protein.

Tuberculosis

Avian TB was a serious problem for adult geese (18% died of the condition) but is less common than in other captive waterfowl, where the incidence varies on average from 20% in adult stifftails to 49% in adult perching duck (Kear & Hillgarth 1979a, b, 1980, 1982a, b). Rates were particularly high in Lesser Whitefronts (47%) and Canadas (35% in all races) and low in Emperors (3%) and Greylags (4%). There are only two recorded cases of TB among juveniles (a Barnacle and a Red-breasted gosling) and none in downies.

Amidostomum anseris and other parasitic conditions

Eight per cent of adults died of amidostomiasis or gizzard worm *Amidostomum* attack. The highest levels were among Pinkfeet (16%) and Ross's Geese (18%). There were, on the other hand, no cases recorded in White-fronted, Lesser White-fronted and Brent Geese, and low levels in Bar-headed Geese (2% of those examined), Canadas (4%), Barnacles (4%) and Red-breasted Geese (2%).

Among juveniles, gizzard worm was, at 17%, the primary cause of death. Young Swan Geese and Barnacles had the highest level (20%) while that in Greylags was 15% and in Snow Geese 13%. The parasite was not recorded as a cause of mortality among juvenile Bean Geese, Lesser Whitefronts, Brent and Red-breasted Geese, and was rare in Ross's (1%), Whitefronts (4%) and Barhead

goslings (4%).

In downies the level was generally low (4%) but was high in Snow Geese (37%) and in Barnacles (31%) the young of which tend to be parent-reared at Slimbridge where the level of infection in the lawns must be high.

Cyathostoma or gape worm infestations among juveniles (5%) were common only in Lesser Whitefronts (28%) and Emperor Geese (10%). Three per cent of downies had severe cyathostomiasis but there was only one recorded case of *Cyathostoma* as a primary cause of death in adults.

Other parasitic conditions included six cases of *Acuaria* infestations among adults, and one case in a juvenile. There was one recorded case only of a severe cestode infestation in a juvenile Barnacle Goose.

Pneumonia

Pneumonia was by far the major problem for downy geese (causing 35% of all mortality). It occurred at relatively high levels among Red-breasted Geese, Barnacles and Lesser Whitefronts (42-44% in all species), and at relatively low levels in Whitefronts, Pinkfeet and Bean Geese (22-25%) despite the latter species hatching earlier (and probably therefore while the weather is colder). The difference in mortality may be related to the size of the goslings and, therefore, only indirectly to their ability to keep warm (Table 4).

Our post-mortem records often do not state whether goslings were being parent-reared at the time of death or not. Red-breasted Geese and Lesser Whitefronts are much more likely to be hand-reared than not, while goslings of the other four species are usually left with their parents in a pen and, therefore, are more affected by adverse weather conditions.

Pneumonia was quite common (8%) among dead juveniles. Relatively high levels were recorded in Whitefronts (20%), Brent (15%), Redbreasts and Snow Geese (both 13%). There were no recorded cases in young Swan, Bean, Lesser Whitefronts, Bar-headed and Ross's Geese, and low levels among Greylags (3%).

Only 2% of adult geese, eight males and seven females, died of pneumonia.

Egg peritonitis

Of the geese that breed fairly readily in captivity in England, the Ross's and Hawaiian Goose lay the largest eggs relative to their own weight, and females of these species die of egg peritonitis or egg-binding not infrequently (these conditions are not caused necessarily by the same agent but are often associated). Brent produce larger eggs but fewer captive females lay and those that do, breed on average 15 days later than the Ross's, when the spring temperature may be higher. Cold weather is probably the complicating factor in the case of the Hawaiian Goose, which lays earlier than any other species (the median date of its first egg is 8 February). Climate may account also for the three cases in female Swan Geese which, although laying relatively small eggs (4.8%), lay early (Murton & Kear 1973) as does the Greylag (six cases) and Canada (two cases). Probably more significant is the fact that five species that neither lay very large eggs nor have an early laying season have never suffered egg peritonitis: Bean, Pinkfoot, Whitefront, Lesser Whitefront, and Barhead (Table 5).

Table 4. Percentage mortality of downy geese due to pneumonia in relation to weight.

	Av. weight (g) at one day old*	% mortality
Red-breasted Goose	48	44
Barnacle Goose	68	42
Lesser White-fronted Goose	70	42
White-fronted Goose	82	22
Pink-footed Goose	87	25

* Kear, unpublished data.

Table 5. The incidence of egg peritonitis and egg-binding in female geese.

	Females dying	% of all geese mortality (females only)	% of species mortality (females only)	Egg as % of ♀♀ weight*	Mean date of first egg **
Swan Goose	3	9.4	17.6	4.48	6 April
Bean Goose	0	-	-	5.73-6.69	25 April
Pinkfoot	0	-	-	5.64	26 April
Whitefront	0	-	-	5.86-6.69	30 April
Lesser Whitefront	0	-	-	6.76	29 April
Greylag	6	18.8	16.2	5.48-5.51	30 March
Bar-headed	0	-	-	6.29	18 April
Emperor	3	9.4	6.1	5.24	30 April
Snow Goose	2	6.3	7.6	5.38-6.10	27 April
Ross's Goose	11	34.4	23.4	7.23	6 May
Canada Goose	2	6.3	5.2	4.38-8.33	29 March-1 May
Barnacle	2	6.3	4.3	6.18	8 May
Brent Goose	1	3.1	2.2	7.50-8.00	21 May
Red-breasted	2	6.3	18.2	6.54	3 June
Hawaiian Goose ***	22			7.58	8 Feb.)

* from Owen (1980)
** from Murton & Kear (1973)
*** from Kear & Burger (1980)

Aspergillosis

Aspergillosis was rare among adults (4%), but commoner in juveniles (15%) and downies (15%). The condition was especially troublesome in adult Emperor Geese (13%) which, in the wild, are birds of the sea coast, and was fairly frequent in the Redbreasts (9%) and Whitefronts (12%). There were no records of the disease in adult Greylags, Barheads, Snow and Ross's Geese. Brent Geese are not particularly susceptible despite their natural tendency to a marine existence.

Among juveniles, nearly half the dead Red-breasted Geese were affected (47%), with Emperor, Bean, Brent, and Ross's recording levels of over 20%. The condition was rare among Barnacles, Canadas, Snow and Pink-footed Geese.

Aspergillosis was a serious problem for downy Whitefronts (44%), Brents (33%), Redbreasts (38%), Ross's and Canada Geese, and important as a cause of death in all goslings except Lesser Whitefronts and Beans.

Cardiac conditions

Six per cent of dead adults had cardiac disease and/or atherosclerosis. However, these conditions were common (10% or more) only among Emperors, Snows and Redbreasts; severe heart and circulatory problems were not reported in Lesser Whitefronts and were rare in all others. On the other hand, cardiac disease was extremely common in captive Hawaiian Geese, but only as a contributor to mortality, not as the main cause of death (Kear & Berger 1980).

Other conditions

Lead poisoning was rare (2% of dead adults were poisoned but no juveniles or downies were affected). Impactions of the gut were also unusual (occurring in only 1% of dead adults and 2% of juveniles and downies). Infected yolk was a problem for downy goslings (12%), particularly Emperor Geese (38%), and

Table 6(a). The cause of death among adult geese captive at the Wildfowl Trust.

	Male	Female	Unsexed	Total	%
Renal failure	116	105	2	223	28.0
Tuberculosis	54	90	1	145	18.0
Amidostomum infestation	35	32	1	68	8.0
Cardiac problems	26	21	0	47	6.0
Aspergillosis	17	17	1	35	4.0
Egg peritonitis	0	32	0	32	4.0
Enteritis	13	10	0	23	3.0
Pneumonia	8	7	0	15	2.0
Lead poisoning	6	6	0	12	2.0
Impactions	5	6	0	11	1.0
Amyloid disease	6	3	0	9	1.0
Hepatitis	2	4	0	6	0.7
Acuaria infestation	1	5	0	6	0.7
Other conditions	22	15	1	38	5.0
Trauma and K.B.O.*	35	53	0	88	11.0
No diagnosis	26	25	2	53	7.0
Totals	372	431	8	811	

* 'killed by order'.

Table 6(b). The cause of death among juvenile geese captive at the Wildfowl Trust.

	Male	Female	Unsexed	Total	%
Amidostomum infestation	18	27	1	46	17.0
Aspergillosis	22	17	2	41	15.0
Pneumonia	10	11	0	21	8.0
Renal failure	6	13	0	19	7.0
Cyathostoma infestation	7	8	0	15	5.0
Cardiac problems	7	7	0	14	5.0
Enteritis	6	2	0	8	3.0
Impactions	3	3	0	6	2.0
Other conditions	22	14	2	38	14.0
Trauma and K.B.O.	27	29	1	57	21.0
No diagnosis	6	6	2	14	5.0
Totals	134	137	8	279	

Table 6(c). The cause of death among downy geese captive at the Wildfowl Trust.

	Male	Female	Unsexed	Total	%
Pneumonia	52	83	10	145	35.0
Aspergillosis	21	27	16	64	16.0
Infected yolk	15	32	2	49	12.0
Amidostomum infestation	10	6	0	16	4.0
Renal failure	9	7	0	16	4.0
Cyathostoma infestation	4	10	0	14	3.0
Impactions	4	5	0	9	2.0
Cardiac problems	4	0	2	6	2.0
Other conditions	8	20	4	32	8.0
Trauma and K.B.O.	21	34	7	62	15.0
Totals	148	224	41	413	

was high among Canada Geese (13%), Barnacles (10%) and Snow Geese (8%). Enteritis was scarce throughout (3% of adults, 3% of juveniles and four cases only in downies). Other conditions found at post-mortem examination included a few cases of amyloidosis, hepatitis, gizzard malfunction, wet feather, air sacculitis, septicemia and anaemia.

Trauma

Injuries were an important cause of mortality in all age groups (7% of adults, 10% of juveniles and 13% of downies). Several birds were 'killed by order' (K.B.O.) because of injuries or deformities, nearly always to the legs (4% of adults, 10% of juveniles and 2% of downies).

Discussion (see also Tables 6a, b, c)

In general, captive geese die older than other waterfowl that we have examined, where age at death varies between 2.4 years among stifftails and 4.4 years among shelducks (with whistling ducks, perching ducks, sheldgeese and seaducks in between). Since longevity seems to be connected with body size, this finding is not surprising; it is likely that only captive swans will, on average, live longer than geese do.

It is supposed that the hazards of breeding and wing moult are the causes of the high levels of spring mortality. Kear & Berger (1980) showed that more female Hawaiian Geese at Slimbridge died in March than in any other month; this peak occurs two months later in the females of other goose species (Figure 3) as is appropriate to their later breeding seasons, which, in all geese and in many temperate waterfowl, are determined by changes in daylength (Murton & Kear 1973). Renal failure often seems to be a condition of birds old enough to breed, and was found to be so among geese. Disturbances of protein metabolism may be related to kidney disease, but the mechanism is not understood, nor is it clear why renal problems should be associated in geese with the seasons of breeding and moult. Egg peritonitis is a cause of death obviously linked to the breeding season and to the female only. Although it is quite common in two species in captivity (the Ross's Goose and Hawaiian Goose), the condition is not reported apparently from the wild.

Whether the lower incidence of TB in geese in general is due to some natural immunity or to the fact that, living on open lawns, they seldom come into contact with infection is uncertain. In some other waterfowl, tuberculosis is a disease that increases in incidence with age and, on that basis, captive geese ought to be particularly susceptible. Perhaps the fact that they spend less time on potentially contaminated water than ducks and swans may have significance.

Among sheldgeese – the southern hemisphere grazing waterfowl – 21% of captive adults and 23% of juveniles at Slimbridge died with severe gizzard worm infestations (Hillgarth & Kear 1979b), which is higher than even the highest levels found in true geese. The explanation for this comparative susceptibility is not obvious, but parasitic nematodes are a common cause of mortality even among wild sheldgeese in the Falkland Islands (Harradine 1982). We have already pointed out that the grazing Maned Goose *Chenonetta jubata* is unaffected by *Amidostomum,* and speculated that the structure of its gizzard differs from that of the true geese and sheldgeese (Hillgarth & Kear 1981). Herman & Wehr (1954) found *Amidostomum anseris* in 78% of 647 Canada Geese from several areas of the U.S.A. Erosion of the gizzard wall was severe when 150 or more worms were present but they concluded that *A. anseris* was not a usual cause of death among wild Canada Geese, although it might be a contributory factor.

Beer (1963) was able to obtain *Aspergillus fumigatus* from the throats of many healthy wild geese, although this fungal parasite is capable of causing epizootics. For instance, McDougle & Vaught (1968) reported over 2,000 deaths in wild Canada Geese from an outbreak of aspergillosis. *Aspergillus* is an opportunist, which may grow and spread rapidly in the bodies of young geese especially, if conditions are right.

Humphreys & Beer (1971) established that, of 110 captive dead geese and swans (Anserini) they examined, 58 were

affected by varying degrees of hardening of the arteries or atherosclerosis (53%). This was much higher than their overall figure for waterfowl (36%), and, out of 30 affected swans and geese whose ages were known, the severity of lesions increased with age. We also have found cardiac conditions commoner in dead adult geese than in other waterfowl so far examined; perhaps this is related to the greater age that many geese attain in captivity.

Acknowledgements

P. N. Humphreys, M.R.C.V.S., and subsequently M. Robinson, M.R.C.V.S., have provided veterinary supervision of the laboratories at Slimbridge. We thank Col. R. Hodgson, P. J. Olney and Dr. J. Baker for their help and advice. J. V. N. Turner kindly prepared the figures.

Summary

Results of post-mortem data from 1503 northern geese dying in Wildfowl Trust collections between 1959 and 1980 have been analysed. The main causes of death were renal failure and avian TB among adults, *Amidostomum anseris* infestations in juveniles and pneumonia in downies. Enteritis was low throughout.

References

Arnall, L. & Keymer, I. F. 1975. *Bird Diseases.* London: Bailliere Tindall.
Bedford, Duchess of. 1927. Red-breasted Geese *(Branta ruficollis)* breeding in captivity. *Avic. Mag.* (4) 5: 65-6.
Beer, J. V. 1963. The incidence of *Aspergillus fumigatus* in the throats of wild geese and gulls. *Sabouraudia* 2: 238.
Beer, J. V. 1959. The control of Aspergillosis in wildfowl collections. *Wildfowl Trust Ann. Rep.* 16: 41-42.
Beer, J. V. & Stanley, P. J. 1965. Lead poisoning in the Slimbridge wildfowl collection. *Wildfowl Trust Ann. Rep.* 16: 30-34.
Blaauw, F. E. 1903. Notes on the breeding of Ross's Snow-Goose in captivity. *Ibis* 45: 245-47.
Blaauw, F. E. 1916. On the breeding of the Emperor Goose at Geoilust, *Philacte canagica. Avic. Mag.* 7: 277-9.
Delacour, J. 1954. *The Waterfowl of the World.* Vol. 1. London: Country Life.
Game Conservancy. 1974. *Some diseases of gamebirds and wildfowl.* Game Conservancy Booklet No. 6.
Harradine, J. 1982. Some mortality patterns of Greater Magellan Geese on the Falkland Islands. *Wildfowl* 33: 7-11.
Herman, C. M. & Wehr, E. E. 1954. The occurrence of gizzard worms in Canada geese. *J. Wildl. Manage.* 18: 509-513.
Hillgarth, N. & Kear, J. 1979a. Diseases of seaducks in captivity. *Wildfowl* 30: 134-41.
Hillgarth, N. & Kear, J. 1979b. Diseases of shelducks and sheldgeese in captivity. *Wildfowl* 30: 142-6.
Hillgarth, N. & Kear, J. 1981. Diseases of perching duck in captivity. *Wildfowl* 32: 156-62.
Hillgarth, N. & Kear, J. 1982a. Causes of mortality among whistling ducks in captivity. *Wildfowl* 33: 133-39.
Hillgarth, N. & Kear, J. 1982b. Diseases of stiff-tailed ducks in captivity. *Wildfowl* 33: 140-44.
Humphries, P. N. & Beer, J. V. 1971. Atherosclerosis in a waterfowl collection. *Vet. Rec.* 88: 418-21.
Johnsgard, P. A. 1968. *Waterfowl.* Lincoln: University of Nebraska Press.
Kear, J. & Berger, A. J. 1980. *The Hawaiian Goose.* Calton: Poyser.
Kennard, J. H. 1975. Longevity records of North American Birds. *Bird Banding* 46: 55-73.
McDougle, H. C. & Vaught, W. 1968. An epizootic of Aspergillosis in Canada Geese. *J. Wildl. Manage.* 32: 415-17.
Murton, R. & Kear, J. 1973. The nature and evolution of the photoperiodic control of reproduction in wildfowl of the family Anatidae. *J. Reprod. Fert., Suppl.* 19: 67-84.
Owen, M. 1980. *Wild geese of the world.* London: Batsford.
Rydzewski, W. 1971. Longevity records. *The Ring.* 76: 64.
Rydzewski, W. 1973. Longevity records. *The Ring.* 77: 92.
Rydzewski, W. 1974. Longevity records. *The Ring.* 79: 142.
Wobester, G. A. 1982. *Diseases of wild waterfowl.* New York & London: Plenum Press.

Nigella Hillgarth, Dr. Janet Kear and **Katherine Horky,** Wildfowl Trust, Martin Mere, Burscough, Lancashire.