Lead poisoning in the Slimbridge wildfowl collection

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Summary

Rather surprisingly, lead poisoning, following the ingestion of spent shot gun pellets, has been found to be an important cause of death among captive wildfowl at Slimbridge, Gloucestershire. Thirty-two species have been affected and the post-mortem findings are described. The source of the pellets has been investigated. The differential mortality among the various wildfowl tribes is possibly related to differences in feeding habits, diet and gritting as well as to susceptibility. Methods of prevention are discussed. Lead poisoning casualties have also been found in other collections in England.

Introduction

Lead poisoning, caused by the ingestion of spent shot gun pellets, has long been recognised as an important mortality factor in free-living wildfowl. Olney (1960) has given a comprehensive review of the situation. In 1959 and 1960 a series of deaths occurred in the Magpie Geese *Anseranas semipalmata* at Slimbridge, and some form of poisoning was suspected. Then one case showed all the classic signs of lead poisoning and lead pellets were found in the gizzard. Subsequently a close watch has been kept for signs of lead poisoning in all post-mortems and, in all, 74 primary cases have been detected. These have occurred in the 32 species listed in the Appendix.

Post-mortem findings

The pellets found in the gizzard varied from the large BB pellet down to pellets the size of No. 6 shot and fragments. Some still showed signs of denting, others were spherical, while some were eroded to discs or tiny fragments. The surface of the pellets was a dark grey metallic sheen produced by the chemical and grinding action of the gizzard. 47 (63%) of the cases contained one pellet or fragment of lead while the remainder contained between two and seven. This amount of lead is similar to that found by Jordan and Bellrose (1950) to be sufficient to kill Mallard *Anas platyrhynchos* fed on a diet of mixed grain.

As in the case of birds poisoned in the wild, most of the corpses were emaciated. This was quantified by grading the pectoral muscles from 1 (very atrophied) to 4 (normal) and the subcutaneous and visceral fat each, from 0 (no fat) to 4 (massive

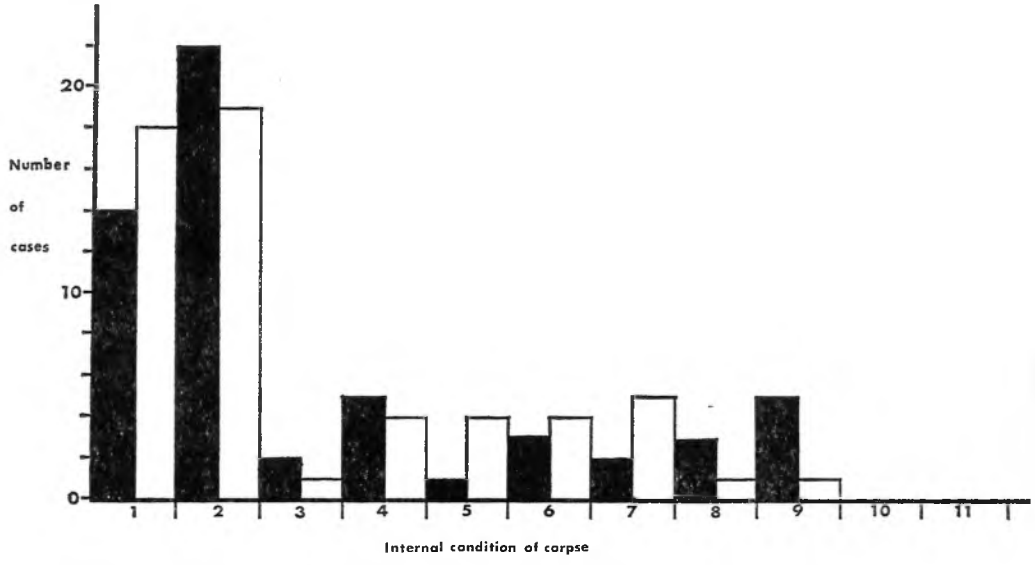

Figure 1. Condition of wildfowl poisoned by lead.

deposits). Adding the three grades gives values ranging from 1 (extremely emaciated) to 9 (healthy) to 12 (obese). Figure 1 shows that two-thirds of the Slimbridge cases were emaciated.

Many of the birds had nevertheless eaten shortly before death. The accumulation of food in their oesophagi was not always a direct result of impaction but was probably caused by a weakening or paralysis of the gizzard muscles. Actual gizzard impaction was noted in 24 (32%) cases. The impaction, sometimes extending to the proventriculus and duodenum, was formed of tough fibrous grass and other vegetable material which could not be broken down by the weakened gizzard. Jordan and Bellrose (1951) found proventricular impaction in 44% of their penned lead-poisoned Mallard. The horny pads of the gizzard were eroded and ulcerated in 9 (12%) of the Slimbridge cases.

Anaemia is a common finding in lead poisoning and was noticeable in 45 (61%) of the post-mortems. One Red-billed Whistling Duck *Dendrocygna autumnalis* was markedly anaemic before death, the bill and legs being almost white. An enlarged gall-bladder was present in 61 (82%) cases and the excess bile usually stained the gizzard, and also the cloacal and tail feathers, bright green. The liver was atrophied in 15 (20%) cases and some deterioration was noted in 24 (32%) cases.

In addition to the above post-mortem findings which, coupled with the presence of lead pellets in the gizzard, are pathognomic of lead poisoning, congestive heart failure was noted in 20 (27%), kidney impairment in 27 (36%) and pneumonia in 8 (11%) cases. The parasites *Echinuria* sp. and *Amidostomum* sp. were only found in 7 and 3 cases respectively, whereas Hansen, McNeil and Priebe (1957) considered that infections of the latter parasite contributed substantially to the death of wild Canada Geese *Branta canadensis* suffering from lead poisoning.

Source of the pellets

There has been little or no shooting in the immediate vicinity of the 35 acres of enclosures at Slimbridge since the Trust was founded in 1946. Controlled goose shoots are still held three or four times a year but well away from the pens. In any case the heavy shot used figures relatively seldom among the pellets found in gizzards. It seems, therefore, that the pellets now finding their way into the captive birds are two or more decades old, deriving from the time when the area was used for more general (but always strictly controlled) shooting.

One hundred soil samples each comprising 100 ml. of the top six inches were taken at random throughout the largest pen (6 acres). Not a single lead pellet was found, showing that the general level of contamination is not high. Similarly no pellets were found in fifty samples of deep, soft mud well out in the ponds. Fifty samples taken from along the marginal shelf of the ponds, however, yielded four pellets. The enclosures are on alluvial soil reclaimed from the river some three centuries ago. The edges of newly dug ponds are therefore unstable and prone to crumble into the water as birds dibble and tread along the margins. It is here that any lead pellets in the soil would most likely to be exposed within reach of the birds.

Erosion of the pond margins has been a major maintenance headache, for the ponds rapidly increase beyond the desired size, and fill with mud, while the circulation channels become choked with silt. To combat these effects it has been the practice to line the banks, two or three feet above and below the water line, with rough cast concrete coloured to simulate earth. This is a slow and expensive business so that a range of ponds with and without 'anti-erosion' linings has been available throughout the enclosures. In ponds with no anti-erosion linings twenty-six samples yielded 10 pellets; 21 cases of lead poisoning had occurred in these ponds. In ponds where the edges were mostly protected by concrete twenty-one samples yielded no pellets and there had been only 3 cases of lead poisoning. There have been clear instances where a species, such as the Magpie Goose, suffered from lead poisoning when kept with access to ponds with natural banks but not when kept in concrete-edged ponds.

The pellets found in the gravel on the marginal shelf were mainly No. 4 and No. 6 shot. No BB shot was found. All the pellets were pale buff or off-white due to a coating of lead hydroxide and salts which had prevented extensive corrosion over the years. Most of the pellets showed the characteristic denting which is produced during firing, but a few were very small and rounded and had possibly already been ingested and defaecated by a bird.

Differential mortality

It is clear that lead poisoning occurs, under captive conditions at least, much more frequently in some groups of wildfowl than in others. The known occurrences and the total number of post-mortems made in the six-year period 1959–64 are compared in Table I, using the taxonomic grouping into tribes proposed by Delacour (1954–64).

Table I. Frequency of occurrence of lead poisoning in post-mortem examinations of Anatidae kept at Slimbridge, 1959–64

Tribe	*Post-mortems undertaken*	*Lead poisoning cases*	
		number	%
Anseranatini	28	6	21
Aythyini	163	22	13
Cairinini	260	17	7
Dendrocygnini	159	7	4
Anatini	530	15	3
Oxyurini	47	1	2
Somateriini	44	1	2
Mergini	99	1	1
Anserini	302	2	<1
Tadornini	149	1	<1
	1781	74	4

It is suggestive that the Anseranatini are root eaters with powerful digging bills; that the Aythyini are diving bottom feeders; and that the Cairinini concerned (most cases were in the genus *Aix*) obtain their food by picking up individual seeds rather in the manner of poultry. All these methods of feeding are likely to bring them into contact with pellets more readily than, say, are the grazing habits of most of the Anserini. But for a number of reasons considerable caution must be exercised in relating differences in incidence of poisoning to the feeding habits. Experimental work in America (see Bellrose, 1964) has stressed the importance of the actual diet taken. After a bird has ingested a certain number of pellets, lead poisoning is much more likely to develop on a diet of whole grain than if the bird is fed grain meal or green stuffs. It is thought that the greater abrasion against the cereal grains leads to quicker erosion and solution of the lead. In the densely populated enclosures at Slimbridge natural foods are rapidly used up and the birds of many species subsist on an artificial diet rich in cereal grains. In these conditions the incidence of lead poisoning may reflect specific susceptibility as well as the likelihood or otherwise of the birds ingesting lead. To test the latter thoroughly it would be necessary to make X-ray investigation of the living birds in the collection. The disturbance this would entail is not justified.

Another reason why feeding habits may not be closely linked with the incidence of lead poisoning is that the pellets may be ingested in mistake for grit rather than for food seeds. The birds may well obtain their grit in places other than those in which they feed. Moreover, where grit is short, as in an alluvial soil, not only are lead pellets more likely to be taken in, but they are retained for longer in the gizzard. Excess grit passes rapidly through the birds, taking any pellets with it.

It is probable also that both the feeding and gritting habits are different in young birds from those of adults; they may also be more susceptible to poisoning. A combination of these factors, together with the necessity for keeping young birds on temporary, unconcreted ponds, probably accounts for the much greater incidence of lead poisoning in birds of less than one year old. These produced 39 cases (14%) in 269 post-mortems; 768 comparable adult post-mortems produced only 23 cases (3%). No case has been found in a downy bird over the six years, but their chances of coming into contact with lead pellets in the rearing pens are small.

Prevention of lead poisoning in collection birds

The situation at Slimbridge is by no means unique as the disease has been found recently in birds from collections in Lancashire, Norfolk, Surrey, Hampshire and Dorset. The general level of incidence (4%) indicated by Table I probably underestimates the seriousness of the position at Slimbridge owing to diagnostic difficulties in the earlier years. In 1963 and 1964, by when the condition was clearly recognised, the general level was 7% (52 cases in 702 post-mortems) making it one of the more important single causes of mortality.

Lead poisoning is difficult to diagnose and cure in the living bird, so that methods of prevention are most important.

When a potential collection site is being

considered, the extent of any shooting in the past should be ascertained and taken into account. Ideally the site should be entirely free of lead but, if not, precautions can be taken to keep the incidence of lead poisoning low. The banks of the ponds should be protected by concrete from erosion, while marginal shelves in shallow water can be covered with a uniform large gravel. However, if there is an appreciable amount of water-weed this should not be disturbed. New pens and ponds are best populated with animal feeders and grazing species. The Anseranatini, Aythyini and the Cairinini should be kept in old pens that have had the pond banks protected against erosion. Any soil or mud that has been removed from a pen or pond should be removed entirely or allowed to grass over before birds are put back in the pen. A plentiful supply of grit should be made available and the diet should contain as much green food as possible.

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Appendix. Species that have died of lead poisoning in the Slimbridge wildfowl collection.

	Post-mortems undertaken	*Lead poisoning cases*
Magpie Goose *Anseranas semipalmata*	28	6
Fulvous Whistling Duck *Dendrocygna bicolor*	61	4
Red-billed Whistling Duck *D.autumnalis*	33	3
Bewick's Swan *Cygnus columbianus bewickii*	2	1
Greylag Goose *Anser anser*	31	1
Falkland Island Steamer Duck *Tachyeres brachypterus*	6	1
Salvadori's Duck *Anas waigiuensis*	13	1
Versicolor Teal *A.versicolor*	18	1
Northern Pintail *A.acuta*	18	1
Chestnut-breasted Teal *A.castanea*	26	2
Mallard *A.platyrhynchos*	65	3
Laysan Teal *A.laysanensis*	11	1
Chinese Spotbill *A.poecilorhyncha zonorhyncha*	9	1
New Zealand Grey Duck *A.superciliosa*	7	1
Philippine Duck *A.luzonica*	15	1
African Yellowbill *A.undulata*	7	1
Cinnamon Teal *A.cyanoptera*	13	1
New Zealand Shoveler *A.rhynchotis variegata*	6	1
Steller's Eider *Polysticta stelleri*	26	1
Rosy-bill *Netta peposaca*	4	1
South American Pochard *N.erythrophthalma*	12	2
European Pochard *Aythya ferina*	7	1
Redhead *A.americana*	25	9
Common-White-eye *A.nyroca*	3	2
Australian White-eye *A.australis*	13	1
Tufted Duck *A.fuligula*	6	1
Lesser Scaup *A.affinis*	12	1
European Greater Scaup *A.marila*	14	3
Brazilian Teal *Amazonetta brasiliensis*	27	3
Mandarin Duck *Aix galericulata*	30	2
North American Wood Duck *A.sponsa*	106	13 + 1 pull.
European Goldeneye *Bucephala clangula*	11	1
North American Ruddy Duck *Oxyura jamaicensis*	7	1

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Breeding success of White-fronted Geese from the Nenets National Area

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Summary

The breeding success of White-fronted Geese has been inferred from the age composition of flocks wintering at Slimbridge, Gloucestershire, since 1947. These Whitefronts breed in the north east of European Russia. Annual variations in brood-size (average 3·24) have been comparatively slight, though there were unusual numbers of small broods in 1950 and 1958 and of large broods in 1951 and 1956. The proportion of first-winter geese has varied widely about a mean of 33·3%. The fluctuations seem to have reflected changes in output rather than in adult mortality. Attempts to relate production to the limited weather data from the breeding areas by means of correlation methods suggest that wet weather in July has markedly reduced production. Snow in late May and early June has been less important, while low temperatures without snow have had no perceptible effect. Marked geese breeding for the first time, at nearly three years old, have had smaller families than parents four to six years old. So have those more than seven years old.

Introduction

The best way of studying the fertility of geese and the factors affecting it is by direct observations on breeding groups continued over many years. For species nesting in the Arctic such investigations are very rarely practicable but much of the pertinent statistical information can be obtained by studying flocks in winter (Lynch and Singleton, 1964). The White fronted Geese *Anser albifrons albifrons* that visit Slimbridge, Gloucestershire, have been studied in this way since 1947 (Lebret 1948, Boyd 1954, 1957). The present paper adds data collected since 1956 and examines three factors likely to affect the output of young. First, attempts are made to use published weather records to investigate the effects of weather conditions on the breeding grounds upon reproductive success. Second, records of the family-sizes of marked geese are used to illustrate variation in output with age. Third, the proportion of young geese is compared with annual variations in the losses of full-grown birds. The results of all three lines of inquiry are tentative. Their thorough exploration would require a great increase in efforts to catch and mark geese, as well as access to detailed weather records not available outside the U.S.S.R.

Recoveries of ringed birds have shown that nearly all the Whitefronts visiting Slimbridge breed at the western end of the range of *A.a.albifrons*, on the south island of Novaya Zemlya and on Vaygach and Kolguev Islands and on the tundra of the Nenets mainland from the Kanin peninsula east to about 55°E (Shevareva 1959, Boyd 1961). The Slimbridge-visiting Whitefronts do not form a simple closed group. They are part of a much larger stock wintering chiefly in east Germany and the Netherlands with a breeding range extending as far as 70°E. (Philippona and Mulder, 1960). The consistent reappearance of