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Salmonellosis in wild birds feeding at sewage treatment works

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SUMMARY

Between June 1976 and August 1977 faeces were collected from 599 wild British birds caught during ringing operations at two sewage treatment works in south-east England. Samples were incubated with selenite-F broth to detect the presence of *Salmonella*. *Salm. anatum* was isolated from one bird, a Dunnock *Prunella modularis* an incidence of 0·17 % of the total birds examined and 3·23 % of the Dunnocks. Comparisons are drawn with previously reported studies and it is suggested that sewage treatment works play little part in the transmission of *Salmonella* infections to wild birds feeding there.

INTRODUCTION

Isolated cases of *Salmonella typhimurium* have been reported in Gannets *Sula bassana* (Macdonald, 1962), Tufted Duck *Aythya fuligula* (Keymer, 1958), gulls (laridae) (Macdonald, 1963, 1976; Macdonald & Brown 1974), Wood Pigeons *Columba palumbus* (Macdonald, 1965) and House Sparrows *Passer domesticus* (Macdonald, 1965), usually with an incidence of less than 1 %. Slightly higher rates of incidence occurred in feral Pigeons *C. livia* (Macdonald 1962), with a rate of, 26 % amongst those in the London Borough of Kensington (Farrant, Phillips & Rogers, 1964).

Wilson & Macdonald (1967) gave an account of four outbreaks of *Salm. typhimurium* infection in Greenfinches *Carduellis chloris* and House Sparrows, the first of them occuring in 1964, while in 1968 no less than 22 outbreaks were recorded (Macdonald & Cornelius, 1969). In this latter work it was suggested that the congregation of gregarious species such as those involved in the described outbreaks, at feeding tables in private gardens allowed for intraspecific spread of the infection, whilst their droppings falling to the ground below infected essentially solitary species such as the Dunnock *Prunella modularis*. The existence of the carrier state in Greenfinches and House Sparrows was also hypothesized.

Of the other serotypes of *Salmonella* little is published. *Salm. hessarek* caused an epidemic of salmonellosis amongst Blackbirds *Turdus merula* (Macdonald, Everett & Maule 1968), while a total of 22 different serotypes were isolated from 124 Herring Gulls *Larus argentatus* in Wales (Williams, Richards & Lewis, 1976).

The only mention in the literature of any relation between birds and sewage as a source of infection describes the isolation of *Salm. enteritidis* from 23 out of

32 Mute Swans *Cygnus olor* on the sewage polluted River Tame in Staffordshire (Clegg & Hunt, 1975).

This paper examines, therefore, the possibility that sewage may be a source of *Salmonella* infection amongst wild British birds, and looks specifically at the species using sewage treatment works as feeding sites by examination of their faeces.

CHOICE OF SITES

The two sewage treatment works chosen for this study were already in use as ringing sites. One, at Wanstead in East London, deals only with primary filtration solids and liquid sewage. These solids are dumped daily along a line across the centre of a lower lying area of ground where the flora is predominantly annual, comprising mainly Goosegrass *Galium aparine*, Chickweed *Stellaria* spp., and Scotch Thistle *Onopordum acanthium*. This area is used extensively by many birds for feeding, especially the finches (Fringillidae) and their allies, and particularly so during the winter months. The gravel filter beds are used extensively by Starlings *Sturnus vulgaris* and Pied Wagtails *Motacilla alba*, the numbers of the former exceeding a thousand in winter, when they are also joined by Redwing *Turdus iliacus* and Fieldfare *T. pilaris*. It may be expected therefore that any pathogenic bacteria present in these environments may easily be contracted by the birds whilst feeding.

The second site chosen, at Epping in Essex, comprised a quite large area of grassland and clumps of deciduous woodland of a variety of species. Full treatment of the sewage is performed at this site, employing gravel filters and sludge drying beds as well as lagoons to which excess semi-solids are pumped.

Owing to infrequent visits to the Epping site, however, no comparison was possible between there and Wanstead.

COLLECTION AND EXAMINATION OF FAECES

Birds were taken indiscriminately in flight between June 1976 and August 1977 using 'mist' nets during normal ringing operations. Birds were transported to base in cloth bags which had been previously sterilized by steam. Most birds readily defecated into the bags making collection easy, whilst those which did not were processed and ringed over a sheet of clean paper, when collection was made by cutting a square of the paper. The birds were examined thereafter for any signs of *Salmonella* infection, particularly pharyngeal ulcers, listlessness, loss of weight and diarrhoea. On each collecting trip samples were also taken from the sewage solids and the gravel filters to determine the serotypes of any *Salmonella* present in the environment.

All samples were transferred immediately to selenite F broth and incubated as soon as possible at 37 °C. As most collecting took place at weekends this was not always possible until the following Monday morning. After incubation for 24 h the broths were subcultured onto deoxycholate–citrate agar (DCA) and incubated for 16 h. Non lactose-fermenting colonies were then identified in the normal

Table 1. *Analysis of wild bird faeces for* Salmonella *at two sewage treatment works in south east England*

Species	A	B	C	D	E
Kestrel *Falco tinnunculus*	1	—	—	—	—
Red-legged Partridge *Alectoris rufa*	1	—	—	—	—
Wood Pigeon *Columba palumbus*	2	—	—	—	—
Kingfisher *Alcedo atthis*	2	—	—	—	—
L.S. Woodpecker *Dendrocopos minor*	1	—	—	—	—
Swallow *Hirundo rustica*	1	—	—	—	—
House Martin *Delichon urbica*	14	—	—	—	—
Sand martin *Riparia riparia*	2	—	—	—	—
Magpie *Pica pica*	1	—	—	—	—
Jay *Garrulus glandarius*	1	—	—	—	—
Great Tit *Parus major*	7	—	—	—	—
Blue Tit *P. caerulus*	26	—	—	1	—
Coal Tit *P. ater*	1	—	—	—	—
Willow Tit *P. montanus*	2	—	—	—	—
Wren *Troglodytes troglodytes*	8	—	—	—	—
Song Thrush *Turdus philomelos*	14	—	3	3	—
Blackbird *T. merula*	41	1	17	1	—
Robin *Erithacus rubecula*	13	—	—	—	—
Reed Warbler *Acroceph. scirpaceus*	10	—	—	—	—
Sedge Warbler *A. schoenobaenus*	3	—	—	—	—
Blackcap *Sylvia atricapilla*	11	—	—	—	—
Whitethroat *S. communis*	4	—	—	—	—
Lesser Whitethroat *S. curruca*	5	—	—	—	—
Willow Warbler *Phylloscopus trochilus*	4	—	—	—	—
Spotted Flycatcher *Muscicapa striata*	3	—	—	—	—
Dunnock *Prunella modularis*	31	—	3	—	1
Meadow Pipit *Anthus pratensis*	1	—	—	—	—
Pied Wagtail *Motacilla alba*	10	—	—	1	—
Starling *Sturnus vulgaris*	40	—	1	—	—
Greenfinch *Carduelis chloris*	20	—	—	—	—
Goldfinch *C. carduelis.*	61	—	—	—	—
Linnet *Acanthis cannabina*	3	—	—	—	—
Redpoll *A. flammea*	14	—	—	—	—
Bullfinch *Pyrrhula pyrrhula*	7	—	—	—	—
Chaffinch *Fringilla coelebs*	16	—	—	—	—
Yellowhammer *Emberiza citrinella*	5	—	—	—	—
Reed Bunting *E. schoeniclus*	5	—	—	—	—
House Sparrow *Passer domesticus*	153	1	31	1	—
Tree Sparrow *P. montanus*	43	—	1	—	—
Total	587	2	55	7	1

Key: A = number tested; B = number with pharyngeal ulcers; C = number with diarrhoea; D = number appearing listless; E = number from which *Salmonella* isolated.

manner by biochemical and serological tests. Further subculture was performed from the broths after 72 h incubation to detect slower-growing salmonellas (Chattopadhyay & Pilfold, 1976). The identification of the salmonellas was later confirmed or otherwise by the Salmonella–Shigella Reference Laboratory at Colindale, London.

Table 2. *Analysis of wild bird faeces collected away from the two sewage treatment works for* Salmonella

Species	A	B	C	D	E
Mallard *Anas platyrhynchos*	1	—	1	—	—
Mute Swan *Cygnus olor*	8	—	3	1	—
Tawny Owl (nestlings) *Strix aluco*	3	—	—	—	—

Key: as for Table 1.

Table 3. Salmonella *present in the environment at the two sewage treatment works*

Date of test (1976/77)	Organisms isolated: Wanstead site, Gravel filters	Wanstead site, Solids	Epping site, Gravel filters	Epping site, Solids
6 June	None	*S. newport*	—	—
12 June	None	None	—	—
18 July	None	*S. newport*	—	—
9 Aug.	—	—	None	*S. enteritidis* *S. typhimurium*
1 Sept.	None	None	—	—
4 Oct.	None	*S. hadar*	—	—
18 Oct.	*S. hadar*	None	—	—
22 Nov.	None	*S. montevideo*	—	—
5 Dec.	None	None	—	—
19 Jan.	None	*S. enteritidis*	—	—
20 Feb.	None	None	—	—
31 Mar.	None	None	—	—
11 Apr.	None	None	—	—
13 Apr.	None	*S. enteritidis* *S. typhimurium*	—	—
5 May	None	None	—	—
19 July	None	None	—	—
21 Aug.	None	*S. saintpaul*	—	—

—, Not examined.

RESULTS

A total of 587 birds were examined at the two sites representing 39 species. The findings are presented in Table 1. A further 12 birds caught away from the two sites but within 400 m of the Wanstead site boundary were also examined, and the results obtained from these birds are presented in Table 2. *Salmonella anatum* (serotype 3, 10: eh: 1, 6) was isolated from one Dunnock at the Wanstead site. The bird was a juvenile and was examined on 18 July 1976 when BTO ring number KP 53.690 was fitted.

To enable possible comparisons between *Salmonella* serotypes present in the environment and those which may have been isolated from individual birds, environmental samples were tested on each trip. The findings are presented in Table 3.

DISCUSSION

Of the total of 599 birds tested, only one, a Dunnock, was an active excretor of *Salmonella*, an incidence of 0·17 % of the total and 3·23 % of the Dunnocks tested. This incidence is somewhat lower than that obtained by other workers from smaller samples of birds, e.g. 1·61 % by Macdonald (1962), 1·05 % by Macdonald (1965), and 4·82 % by Macdonald & Brown (1974). The value of 3·23 % of Dunnocks obtained is probably erroneously high due to the low number (31) of this species tested. It would seem therefore that sewage treatment works do not play a role in transmission of *Salmonella* infections to wild birds feeding there, although it should be pointed out that birds which frequently feed by probing the sewage sludge in the large lagoons at the Epping site, such as the Snipe *Gallinago gallinago*, were not tested. Furthermore, the absence of *Salm. anatum* from the environment on the day that the infected bird was examined or indeed at any other time during the study period, would suggest that sewage was not responsible for this infection, although this is not conclusive evidence.

The susceptibility of birds to salmonellosis may increase during winter months when cold weather and possible reduced food supply may lower the birds' general resistance to infection (Macdonald & Cornelius, 1969). It is of interest then that the infected Dunnock in this survey was caught in July during the first year of its life. The general good health of the bird and its weight of 20·0 g at 09.00 GMT may suggest that the bird was in the very early stage of infection. It is not considered likely that a bird of this age could be a carrier. It was not legally possible to confine the bird for observation and in any case at the time of capture there was no reason to suspect that the bird would be infected.

Although 20 % of the Dunnocks ringed at the Wanstead site during 1976 were retrapped between January and September 1977, KP 53.690 has not so far been caught again.

Although more than 1000 Starlings often gather daily in winter on the gravel filters at the Wanstead site, no *Salmonella* were isolated from those caught. This reflects in part the small number of this species examined (about 16 % of the total Starlings present) but, together with the low isolation rate of *Salmonella* from these filters, may suggest that these filters are not important in the transmission of salmonellosis to the birds feeding on them.

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REFERENCES

CHATTOPADHYAY, B. & PILFOLD, J. N. (1976). The effect of prolonged incubation of selenite F broth on the rate of isolation of Salmonella from faeces. *Medical Laboratory Sciences* **33**, 191–4.

CLEGG, F. G. & HUNT, A. E. (1975). Salmonella infections in mute swans, *Cygnus olor*. *Veterinary Record* **97**, 373.

FARRANT, W. N., PHILLIPS, A. G. & ROGERS, S. M. (1964). *Salmonella typhimurium* in London pigeons. *Monthly Bulletin of the Ministry of Health and the Public Health Laboratory Service* **23**, 231–2.

KEYMER, I. F. (1958). A survey and review of the causes of mortality in British birds, and the significance of wild birds as disseminators of diseases. *Veterinary Record* **70**, 713.

MACDONALD, J. W. (1962). Mortality in wild birds with some observations on weights. *Bird Study* **9**, 147–67.

MACDONALD, J. W. (1963). Mortality in wild birds. *Bird Study* **10**, 91–108.

MACDONALD, J. W. (1965). Mortality in wild birds. *Bird Study* **12**, 181–95.

MACDONALD, J. W. (1976). Salmonellosis in gulls. *Veterinary Record* **99**, 344.

MACDONALD, J. W. & BROWN, D. D. (1974). Salmonella infection in wild birds in Britain. *Veterinary Record* **94**, 321–2.

MACDONALD, J. W. & CORNELIUS, L. W. (1969). Salmonellosis in wild birds. *British Birds* **62**, 28–30.

MACDONALD, J. W., EVERETT, M. J. & MAULE, M. (1968). Blackbirds with Salmonellosis. *British Birds* **61**, 85–7.

WILLIAMS, B. M., RICHARDS, D. W. & LEWIS, J. (1976). Salmonella infection in the herring gull (*Larus argentatus*). *Veterinary Record* **98**, 51.

WILSON, J. E. & MACDONALD, J. W. (1967). Salmonella infection in wild birds. *British Veterinary Journal* **123**, 212–18.