

Salmonellosis in songbirds in the Canadian Atlantic provinces during winter-summer 1997–98

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Abstract — From winter 1997 to summer 1998, an epizootic of salmonellosis affected several species of songbirds over a large area of the eastern North American continent. This article describes the details of this epizootic in the Canadian Atlantic provinces, based on laboratory examination of dead affected birds and on suspected but unconfirmed cases of salmonellosis reported by members of the public. The common redpoll (*Carduelis flammea*) was the species most often affected, followed by pine siskins (*C. pinus*), purple finches (*Carpodacus purpureus*), evening grosbeaks (*Coccothraustes vespertinus*), and American goldfinches (*Carduelis tristis*). A poor body condition and necrotizing and fibrinopurulent esophagitis and ingluvitis were the most common gross lesions in these birds. Thirty-four of 35 isolates of *Salmonella* recovered from these birds were identified as phage type 40. Despite the magnitude of this and previous epizootics of salmonellosis among North American songbirds, the sources of these epizootics and the precise influence of environmental factors on their occurrence remain poorly understood.

Résumé — De l'hiver 1997 à l'été 1998, une épizootie de salmonellose affecta plusieurs espèces d'oiseaux chanteurs sur une grande étendue de l'est du continent nord américain. Cet article décrit les détails de cette épizootie dans les provinces atlantiques canadiennes, d'après l'examen d'oiseaux morts soumis en laboratoire et d'après les cas suspectés mais non confirmés de salmonellose rapportés par la population. Le sizerin flammé (*Carduelis flammea*) était l'espèce la plus fréquemment affectée, suivie du tarin des pins (*C. pinus*), du roselin pourpré (*Carpodacus purpureus*), du gros-bec errant (*Coccothraustes vespertinus*), et du chardonneret jaune (*Carduelis tristis*). Les lésions macroscopiques les plus fréquentes chez ces oiseaux incluaient un état d'amaigrissement et une œsophagite et ingluvite nécrosantes et fibrinopurulentes. Trente-quatre des 35 souches de *Salmonella* isolées de ces oiseaux appartenaient au lysotype 40. Malgré la sévérité de cette épizootie de salmonellose et d'autres épizooties similaires précédentes qui sont survenues parmi les oiseaux chanteurs sur le continent nord américain, les sources de ces épizooties et l'influence précise des facteurs environnementaux sur leur développement demeurent obscures.

(Traduit par les auteurs)

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Introduction

Systemic salmonellosis has been recognized for many years as a common cause of mortality in various species of songbirds, occurring particularly around bird feeders in winter. This mortality typically happens in a sporadic manner, notably among house sparrows (*Passer domesticus*) in the North American and European continents (1,2). However, in the past decade, outbreaks covering large geographic areas have been observed

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in North America. In spring 1988, large numbers of deaths attributed to salmonellosis, affecting mainly pine siskins (*Carduelis pinus*), occurred in the north-eastern United States. This was accompanied by several cases of salmonellosis in domestic cats, which preyed on sick birds or frequented areas around bird feeders (3). In winter 1992–93, high mortality caused by salmonellosis was reported among pine siskins and, to a lesser extent, evening grosbeaks (*Coccothraustes vespertinus*), house sparrows, and purple finches (*Carpodacus purpureus*), in western North America (British Columbia and the states of Washington, Idaho and California in the United States) (4,5). Heavy snow and rain on the west coast during that period may have been very stressful to the birds and also may have forced them to concentrate at feeders, thus favoring transmission of the disease (4). Alternatively, a mild winter and early spring during the previous year may have contributed to a large increase in the population of susceptible juvenile birds (5). In winter-spring 1994, a similar outbreak occurred along the eastern border of the Rocky Mountains, particularly in Colorado (6). In winter 1997–98, another epizootic of salmonellosis among songbirds (mainly goldfinches [*Carduelis* spp.], pine siskins, and common redpolls [*Carduelis flammea*]) swept through vast

areas of eastern and midwestern United States, as well as eastern and Atlantic Canada (7,8). This report provides details on this epizootic, as it affected the Canadian Atlantic provinces.

Materials and methods

Avian carcasses were submitted for necropsy to veterinary diagnostic laboratories in each of the 4 Atlantic provinces (Newfoundland/Labrador, Nova Scotia, New Brunswick, Prince Edward Island). Laboratory analyses were similar for all carcasses and included gross examination and collection of representative tissue samples for bacteriological examination. In a few cases, tissues were also collected for light microscopic examination. These tissues were fixed in 10% neutral buffered formalin, dehydrated in graded alcohol and xylene, and embedded in paraffin blocks; 5 µm-thick sections were stained with hematoxylin and eosin (9). Tissue samples collected for bacteriological examination were cultured at 35–37°C in 5% CO₂ on 5% sheep blood and MacConkey agars (Oxoid, Nepean, Ontario). Nonlactose-fermenting colonies were tested with automated identification systems (Autoscan 4, Dade International, Mississauga, Ontario, or API20E, Biomérieux Canada, Montréal, Québec) for identification of *Salmonella* spp., and these isolates were confirmed by slide agglutination with “Seiken” *Salmonella* polyO antisera (Oxoid, Nepean, Ontario). Serological identification of *Salmonella* spp. was performed as described by Ewing (10), and the serovars were named on the basis of the antigenic formulae of Le Minor and Popoff (11). The standard phage typing technique described by Anderson and Williams (12) was used. The phage typing scheme for *S. Typhimurium* (13–15), together with its phages and type strains, was obtained from the Central Public Health Laboratories, Colindale, United Kingdom.

Instances of probable salmonellosis for which specimens could not be obtained were also recorded. These records were the result of phone calls by concerned citizens to the office of the Canadian Wildlife Service (CWS) in Sackville, New Brunswick, and of inquiries by CWS biologists to birdwatching and naturalist groups. Details of the date, location, number of birds affected, species identification, proximity to bird feeders, behavior, and external lesions were recorded. Few observers were able to provide the sex of affected birds. Records determined to be probable cases of salmonellosis included observations of birds that were “fluffed up” or “puffy looking”, showed a reluctance to fly away when approached, and were found in the immediate vicinity of a bird feeding operation. Birds found directly under windows (which could have been the result of collisions) or that had visible signs of physical injury (which could have been the result of predation by domestic cats) were excluded from these records.

Results

Between December 1997 and August 1998, salmonellosis was confirmed in a total of 73 songbirds (49 common redpolls, 12 pine siskins, 7 purple finches, 4 evening

grosbeaks, and 1 American goldfinch [*Carduelis tristis*]). Such cases had been diagnosed very rarely or not at all in any of the 4 Atlantic provincial veterinary laboratories in the previous 10 y. All cases for which a proper history was available indicated that these carcasses had been found in proximity to a bird feeder or in the backyard of a private home. The first case was in a pine siskin from the Annapolis Valley of Nova Scotia in early December 1997. From late January to July 1998, cases of salmonellosis were diagnosed in several regions of Nova Scotia, southeastern New Brunswick, and Prince Edward Island (Figure 1). During the winter months, the common redpoll was the species most commonly affected in these 3 Maritime provinces (Table 1). In southern Labrador, the first confirmed cases of salmonellosis in this species occurred in late April, presumably as these birds were returning north for the breeding season. During the spring and summer months, cases continued to occur in the Maritime provinces in species other than common redpolls, including pine siskins, purple finches, evening grosbeaks, and American goldfinches (Table 1) and were first reported in insular Newfoundland in June.

During winter, the sex and relative age (immature versus adult) of the dead birds were difficult to determine, because their plumage was drab and matted, their gonads were inactive, and various degrees of autolysis prevented detection of the gonads and, in immature birds, the bursa of Fabricius. During spring and summer, the sex could be easily recognized in most birds, based on the bright color of the plumage or the prominence of the gonads. Of 43 birds of all species for which the age was determined, 12 were identified as immature and 31 as adult. Of these latter 31, 19 were male and 12 were female. In a large proportion of affected birds, the most striking gross lesions consisted of ingluvitis or esophagitis characterized by multifocal to confluent areas of caseous necrosis of, and fibrinopurulent exudation in, the crop or esophagus (Figure 2). A few seeds were often still present in the lumina of these organs. Small nodular areas of necrosis and exudation were occasionally seen in other organs and tissues, such as the liver, spleen, and pectoral muscles. In a few birds, necrosis of the mucosal surface of the large intestine and cloaca was also evident. Hemorrhage within the air spaces of the skull, attributed to impairment of blood coagulation caused by septicemia, was a common finding. Most birds were in poor body condition, with complete absence of fat reserves and at least some degree of atrophy of the pectoral muscles. Microscopic lesions in various organs consisted of multifocal, often very large, aggregates of mononuclear leukocytes and heterophils that were mixed with fibrin and numerous bacterial colonies and surrounded masses of necrotic inflammatory and parenchymal cells. Occasionally, more acute lesions, in the form of small bacterial colonies associated with only a few inflammatory cells, were found in organs such as the myocardium, lungs, and liver.

Salmonella spp. were isolated in moderate to large numbers, and most often in pure culture, from all organs submitted from affected birds, including crop, intestine, lungs, liver, and spleen. Thirty-five isolates were identified as to species, and their serotype and phage type

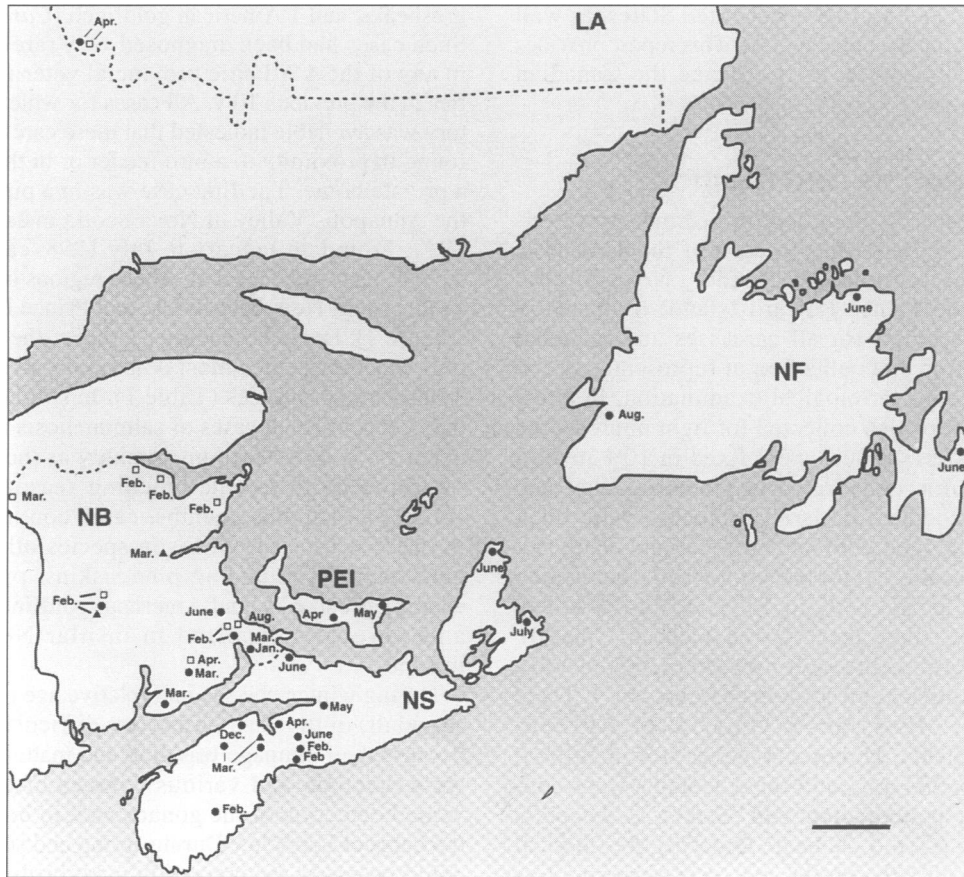


Figure 1. Map of the Canadian maritime provinces (New Brunswick [NB], Nova Scotia [NS], Prince Edward Island [PEI]), insular Newfoundland (NF) and southern Labrador (LA), showing the locations of cases of salmonellosis in songbirds during winter-summer 1997-98; confirmed cases, ●; single reports of suspected but unconfirmed cases, ▲; multiple reports of suspected but unconfirmed cases, □; and, for each location, the first month when the disease was diagnosed or reported; bar = 100 km.

Table 1. Distribution by month, region, and species of confirmed cases of salmonellosis in songbirds from the Canadian Atlantic provinces during winter-summer 1997-98

	Common redpoll	Pine siskin	Purple finch	Evening grosbeak	American goldfinch	Total
December		1 ^b				1
January	1 ^a					1
February	20 ^a , 7 ^b	1 ^b				28
March	4 ^b , 3 ^a	1 ^a	1 ^b	1 ^b		10
April	9 ^e , 2 ^b , 1 ^a , 1 ^c					13
May	1 ^e	3 ^b , 1 ^c	1 ^b , 1 ^a		1 ^a	8
June		1 ^b , 1 ^d	1 ^b , 1 ^a	2 ^b , 1 ^d		7
July		2 ^a	1 ^a , 1 ^b			4
August		1 ^d				1
Total	49	12	7	4	1	73

^aNew Brunswick

^bNova Scotia

^cPrince Edward Island

^dInsular Newfoundland

^eSouthern Labrador

determined. There was no clear pattern in the distribution of the different serovars and antigenic properties of the *Salmonella* isolates as they related to avian species, region of the Atlantic provinces, or month of the year (Table 2). All isolates tested were susceptible to most common antibacterials (including, but not limited to, amikacin, ampicillin, cephalixin, chloramphenicol, doxycycline, enrofloxacin, gentamicin, penicillin, and trimethoprim/sulfamethoxazole).

Forty-eight reports of suspected but unconfirmed salmonellosis, consisting of 263 individual birds, were received between February and August 1998, 35 of them in March. By comparison, not more than 2 to 3 phone calls per year regarding potential disease-related mortality among songbirds had been received by the CWS office in the previous decade. Forty-five of the 48 reports were from New Brunswick and included most areas of the province, except the central west and extreme

Table 2. Distribution of 35 isolates of *Salmonella* spp. by avian species, region of the Canadian Atlantic provinces, and month during winter-summer 1997–98

<i>Salmonella</i> spp. (total no. of isolates)	Avian species (No. of isolates)	Region (No. of isolates)	Month
Typhimurium PT 40 (20)	Common redpoll (9)	NB (5)	December to
	Pine siskin (6)	NS (11)	
	Purple finch (2)	LA (3)	August
	Evening grosbeak (2)	NF (1)	
	American goldfinch (1)		
Typhimurium var. Copenhagen PT 40 ^a (8)	Common redpoll (1)	PEI (1)	April to
	Pine siskin (3)	NB (2)	
	Purple finch (2)	NS (2)	June
	Evening grosbeak (2)	NF (2)	
		LA (1)	
Sbsp. I:4,5:i:- ^b (6)	Common redpoll (5)	NB (6)	February to April
	Pine siskin (1)		
<i>idikan</i> (1)	Common redpoll (1)	PEI (1)	April

LA — Labrador; NB — New Brunswick; NF — Newfoundland; NS — Nova Scotia; PEI — Prince Edward Island; PT — phage type

^aThese were identified as strains of *S. Typhimurium* var. Copenhagen, because, unlike strains of *S. Typhimurium*, they lacked the O:5 antigen

^bThese typed as subspecies I strains, but the second phase of the flagellar antigens could not be identified. Although, based on serotyping alone, these strains could not be called *S. Typhimurium*, they were identified as *S. Typhimurium* strains because they typed with the *S. Typhimurium* typing phages as *S. Typhimurium* PT 40



Figure 2. The esophagus of this common redpoll contains multifocal areas of caseous necrosis of variable size (arrowheads). *Salmonella* Typhimurium was isolated in large numbers from this organ; bar = 4 mm.

southeast regions (Figure 1). The common redpoll was the species most frequently reported (242 individuals). Other species included: American goldfinch ($n = 6$), evening grosbeak ($n = 5$), house sparrow ($n = 4$), pine siskin ($n = 1$), black-capped chickadee (*Poecile atricapillus*) ($n = 1$), snow bunting (*Plectrophenax nivalis*) ($n = 1$), brown-headed cowbird (*Molothrus ater*) ($n = 1$), pine grosbeak (*Pinicola enucleator*) ($n = 1$), and hoary redpoll (*Carduelis hornemanni*) ($n = 1$).

Discussion

The consistent isolation of *Salmonella* species from all organs submitted from individual birds indicated that septicemia was the cause of death. However, in most birds, the prominence of some of the gross lesions, particularly those involving the crop and esophagus, and, microscopically, the abundance of debris of inflammatory and parenchymal cells in affected organs suggested a sub-

acute disease process. Most birds were also in poor body condition. Although it was not possible to determine whether this poor body condition had been a predisposing factor for, or a result of, the disease, food sources for finches in the maritime provinces seemed adequate during winter 1997–98, thus suggesting that starvation was not a contributing factor. For example, although seed crops from birch (*Betula* species) were low, seed sources from other woody plants, such as alder (*Alnus* species) and willow (*Salix* species), were good (Busby, unpublished observations). Inguvitis and esophagitis have long been recognized as characteristic lesions associated with salmonellosis in songbirds (2,16,17), but the reason for the predilection of *Salmonella* species for the crop and esophagus is not known. It would be useful to determine whether these organs represent sites where the bacterium can reside in a latent form and subsequently cause lesions following depression of the defense mechanisms of the host, whether they are affected first because they are the first sites of prolonged contact with contaminated food, or whether they are preferred sites for bacterial growth following bacteremia originating from somewhere else in the body.

Opportunistic observations of mortality in wildlife are relatively rare and usually represent only a small fraction of the total mortality, particularly when involving small animals whose carcasses disappear rapidly after death (18). Therefore, the unprecedented increase in numbers of confirmed and suspected cases of salmonellosis in songbirds throughout the Atlantic provinces during winter 1997–98, together with similar reports in the provinces of Québec and Ontario and in several American states (7,8), constitute, in our view, sufficient evidence that an epizootic was occurring among these birds at the time. There is currently insufficient information to understand the epidemiology of large epizootics of salmonellosis in songbirds. Most reports of

mortality in our region were associated with bird feeders, even during the summer months. Although feeders may promote the occurrence of sporadic outbreaks of infectious diseases (19,20), the geographic magnitude of this epizootic suggests that mortality was widespread among songbirds throughout their range, rather than being confined to the vicinity of feeders. Since feeders increase the local density of birds and, therefore, the opportunities for transmission of infectious diseases, and because there is a good probability that carcasses will be found by bird watchers around these feeders (19), the latter may not provide an accurate measure of the level of mortality in the general population of songbirds. Conversely, the likelihood of finding carcasses of small birds in areas with infrequent human activity is very low, since a large proportion of these carcasses likely disappear within a few days (18). Bacterial contamination of seeds prior to their use at feeders might explain some local outbreaks of diseases, but not epizootics, unless such contamination were on an extremely large scale. During the outbreak of salmonellosis that affected songbirds in British Columbia in 1993, no *Salmonella* species was isolated following culture of several unopened packages of bird seeds (5).

A carrier state for *Salmonella* species has been shown in several avian species in various parts of the world, for example, 15% in house sparrows (21), 8.7% in ring-billed gulls (*Larus delawarensis*) (22), 22.2% in herring gulls (*L. argentatus*) (23), and 4.2% in adult and 19.2% in non-flying young black-headed gulls (*L. ridibundus*) (24). The results of several studies also suggest a positive correlation between the prevalence of carriers in some avian populations and their degree of association with livestock or human activity (either in the form of waste disposal sites or of contamination of water by sewage) (21,23,24–26). Such a correlation might explain regional outbreaks of disease but not an epizootic on a semi-continental scale.

Thirty-four of the 35 *Salmonella* isolates in our region were phage type 40. This type was also associated with the concurrent outbreaks of salmonellosis in songbirds in Québec (Dr. Robert Claveau, personal communication) and Ontario (27), and it has been isolated from songbirds in the United Kingdom (20) and from house sparrows in Ontario (21). As suggested by Prescott et al (27), *S. Typhimurium* phage type 40 may have become adapted to songbirds, may reside in their populations in an endemic form, and may cause epizootics under appropriate conditions. By comparison, sporadic winter mortalities among house sparrows at feeders in Ontario most often involve *S. Typhimurium* phage type 160 (27).

The common redpoll was, by far, the species most commonly affected during the epizootic in Atlantic Canada in winter-summer 1997–98, among both confirmed and suspected cases. Of all songbirds affected during this epizootic, it also is the most northerly species, breeding across northern Canada from the Northwest Territories to northeastern Newfoundland. It winters in the southern part of its breeding range and further south, and its presence in the maritime provinces during winter may vary annually from common to rare, or absent, with peak numbers usually occurring biennially (28,29). During winter, this bird migrates as far south as

is needed to find an adequate food supply, its relative abundance in southern regions being influenced by the availability of seeds in the northern part of its winter range (29). Reviews of Christmas bird counts and discussions with experienced bird watchers indicated that common redpolls were abundant in the Maritime provinces in winter 1997–98, but no more so than in any previous peak year (Busby, unpublished observations). There also was no indication of a severe shortage of food or of a particularly heavy snowfall in their northern range that might have forced larger numbers of them to migrate further south (Busby, unpublished observations). Nonetheless, the extra distance travelled by these migrants combined with winter conditions could have reduced their energy reserves and made them more susceptible to infection and disease. Winter typically has been associated with a higher incidence of salmonellosis and other infectious diseases in songbirds (19,30). Amplification of the disease in common redpolls, in turn, could have led to disease in birds of other species sharing their habitat, and the disease could have been maintained in these other species throughout spring and summer, once common redpolls returned north. Except for the common redpoll, there was little similarity between the confirmed and suspected cases of salmonellosis with regard to the avian species most often affected. However, caution should be used in comparing these 2 groups in detail because of the small number of individuals included in some of these species. The confirmed cases, which are more reliable, suggest that, after the common redpoll, pine siskins and purple finches were the species that suffered most from the disease. Finches readily feed on the ground and on feeders for prolonged periods of time. This behavior may increase the likelihood of these birds coming in contact with seeds contaminated by fecal material. Conversely, other species, like the black-capped chickadee, tend to dart to a bird feeder, grab seeds, and leave. Therefore, they may be less likely to become infected via contaminated seeds, or, if they do, they may be less likely to become sick and die in the vicinity of a feeder. This and other behavioral differences might explain variations in susceptibility to infection among species. A study of the carrier rate of *Salmonella* species in songbirds of different species at different times of year could help to determine the relative contribution of these species to the initiation and maintenance of large epizootics.

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