

EFFECTS OF WEATHER ON REPRODUCTIVE SUCCESS OF BIRDS AT CHURCHILL, MANITOBA

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ABSTRACT. A study has been made of the effects on nesting birds of a severe wind and rain storm in the region of Churchill, Manitoba, in early July 1965, and the possible role of weather in determining the composition of the arctic avifauna is discussed.

RÉSUMÉ. *Effets du temps sur la reproduction des oiseaux à Churchill, Manitoba.* Les auteurs étudient les effets d'un vent violent et d'une forte pluie d'orage du début juillet 1965 sur les nichées d'oiseaux de la région de Churchill, Manitoba, et le rôle, peut-être déterminant, du temps dans la composition de l'avifaune arctique.

REZÜME. *Vliãanie pogody na vosproizvoditel'nost' pti fsv raõone Chërhillã, Manitoba.* Vliãanie sil'nogo vetra, livneï i bur' na gnezdufushchikh ptiï v nachale iulã 1965 g., v okrestnostãkh Chërhillã, Manitoba, bylo issledovano, i potentsial'naã rol' pogody v opredelenii sostava arkticheskof avifauny byla izuchena.

FROM late May to late July, 1965, we conducted ornithological field studies in the region immediately south and east of Churchill, Manitoba. Most of our studies were made in the coastal tundra bordering Hudson Bay and at the tree line, approximately 5 miles to the south. In this paper we describe the effects on nesting birds of the severe weather conditions that occurred in early July, and we comment on the possible role of weather in determining the composition of the arctic avifauna.

Weather Conditions

The period 6 to 10 July was cold and rainy, owing to a large low pressure system over Hudson Bay. The arrival of the low in the pre-dawn hours of 6 July was indicated by overcast skies, light rain, falling temperature, and strong southeasterly winds. The rain stopped shortly after noon and brief periods of sunshine followed, with diminishing winds shifting to the northeast. By 2200 hours (CST) the winds had shifted to the north and on the morning of 7 July they became northwesterly. At noon on that day a light rain began. It continued on 8 July and temperatures fell to the mid-thirties; shortly after 0800 hours the winds became strong and northerly, attaining maximum velocity between 1400 and 2000 hours. In this period wind speed averaged 37 m.p.h. and gusts of 54 m.p.h. were recorded. Winds of over 22 m.p.h. were recorded for the rest of the day, but they began to diminish early on 9 July, when it became cold and overcast with intermittent fog and rain. The rain ended on the morning of 10 July, and skies began to clear at noon. The temperature, which had not been higher than 40°F. between 2200 hours on 7 July and 0500 on 10 July, rose to the upper 40's by mid-afternoon. The normal mean temperature for this period is 51°F. A detailed summary of weather conditions is given in Table I.

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Table I. Weather at Churchill, Manitoba, 6-10 July 1965.

	Temp. (°F.)	Normal mean Temperature	Relative Humidity	Wind Direction	Wind Speed m.p.h.*	24 hour ppt. (in.)	Total sunshine hours
6 July	38-45(41)	51	63-90	SE-N	12-37(19)	0.1	4.1
7 July	37-52(45)	51	72-95	N-WNW	9-27(15)	0.1	0.3
8 July	34-40(37)	51	92-97	NNW-NNE	12-54(26)	0.56	0.0
0000-0600	36-38		92-95	N	12-20		
0600-1200	36-40		92-93	NNW-N	17-41		
1200-1800	36-40		92-95	NNW-N	28-54		
1800-2400	34-38		94-97	N-NNE	22-47		
9 July	33-39(36)	52	92-100	NNE-NNW	11-27(15)	0.08	0.0
10 July	37-54(46)	52	84-100	N-NNW	7-21(11)	Trace	5.0

*Means are in brackets.

Mortality of Passerine Birds

Before the storm, 62 nests of passerine birds were under observation; 57 of these contained young on 8 July and 5 contained only eggs. Many nests, particularly those of the longspurs (*Calcarius* spp.) and Savannah Sparrows (*Passerculus sandwichensis*) were checked daily. Because of the weather, no observations were made between noon on 8 July and 1000 hours on 9 July. When observations were resumed we found many young birds wet and dead in their nests. To determine the extent of the mortality we examined every nest known to us. Our findings are presented in Table II. Live young were present in only 3 of 57 nests, but birds were still incubating at each of the 5 nests containing eggs. Eighty-seven per cent of the nests under observation were destroyed, and 95 per cent of the nests containing young were lost.

In the Lapland Longspur (*Calcarius lapponicus*) nest that contained live young, 1 of the 4 young died and the remaining 3 were cold and lethargic on 9 July. Two of the 3 Horned Lark (*Eremophila alpestris*) young were weak and unable to hold up their heads on 10 July, but they had recovered by the next day. There seemed to be no deleterious effects on the surviving Savannah Sparrow young.

We infer that most of the mortality occurred between 1200 and 2200 hours on 8 July, the period of the most intense driving rain. Five nests of Lapland Longspur, 4 of Smith's Longspur (*Calcarius pictus*), and 1 of Savannah Sparrow were checked before noon on that day. All contained live young, but the young in one Smith's Longspur nest appeared to be in poor condition.

Death was caused by exposure. The nestlings were apparently drenched and chilled while the parents were gathering food, and the brooding adults were unable to dry them later. Weight data showed that the growth of 2 of the 3 surviving Lapland Longspur chicks was retarded during the storm period. Possibly this indicates that the adults at this nest were unable to find sufficient food during the storm. However, it is also possible that the young in this nest survived because the adults spent more time brooding than did adults at nests that were destroyed. We have no reason to attribute substantial mortality to starvation. One hundred stomachs of nestling birds were examined (Tree Sparrow, *Spizella arborea*, 3; White-crowned Sparrow, *Zonotrichia leucophrys*, 9; Harris's Sparrow, *Z. querula*,

Table II. Fates of 62 passerine nests containing young or eggs on 8 July 1965.

Species	Nests containing young			Condition on 9-10 July	Nests containing eggs		
	nests	young per nest	Age of young		nests	eggs	eggs hatch
Horned Lark (<i>Eremophila alpestris</i>)	1	3	5-6	All young alive.			
Gray-cheeked Thrush (<i>Hylocichla minima</i>)	1	4	2-3	All young dead.			
Common Redpoll (<i>Acanthis flammea</i>)	1	5	1-3	All young dead.			
Savannah Sparrow (<i>Passerculus sandwichensis</i>)	11	3-5	2-5	All young dead in eight nests; two nests empty; one with five 3-4 day young.	2	4,5	9
Tree Sparrow (<i>Spizella arborea</i>)	4	4-5	3-6	All young dead.			
Harris's Sparrow (<i>Zonotrichia querula</i>)	2	4	4-6	All young dead.	1	4	3
White-crowned Sparrow (<i>Zonotrichia leucophrys</i>)	4	5	5-6	All young dead.			
Lapland Longspur (<i>Calcarius lapponicus</i>)	15	1-6	2-11	All young dead in 14 nests; one nest with 1 dead, 3 live 2-3 day young on 9 July.	1	4	4
Smith's Longspur (<i>Calcarius pictus</i>)	18	2-4	1-5	All young dead.	1	4	3

3; Savannah Sparrow 14; Lapland Longspur 39; Smith's Longspur 32). Eighty-three were at least half-filled; only 10 were empty.

Differences in nest sites had no noticeable effect on survival. Lapland Longspur nests were usually built under low vegetation on the south side of hummocks. The nest with live young was similarly situated and appeared to be no better protected than the other nests. Many Savannah Sparrow nests were protected on the north by overhanging grasses, as was true of the nest with young, but others that appeared to be equally well protected were lost. The Horned Lark nest was one of most exposed, being on almost level ground on the south side of a small tuft of grass. Nests of Smith's Longspurs were in exposed situations on flat, open ground. Those of Tree, Harris's, and White-crowned sparrows were also on the ground, but they were always at the base of a small shrub or tree from which they gained some protection. Redpoll (*Acanthis spp.*) nests were usually

in thick willows or among the dense branches of small spruce trees. The nest observed during the storm period was approximately 12 inches above the ground in a dwarf birch on the south side of a small hummock. The Gray-checked Thrush (*Hylocichla minima*) nest was approximately 4 feet up on a dead spruce stump. Although it was exposed, it was protected to some degree by the surrounding spruce woods.

As noted above, there was a marked difference in survival between nests containing young and those containing only eggs. Of the latter, young subsequently hatched in each of the 5 nests; the combined hatching success was 91 per cent. On the morning of 9 July we noted that the linings of the Smith's Longspur and Harris's Sparrow nests were wet, which suggests that the higher survival rate of nests with eggs might be related to the ability of the eggs to withstand wetting, rather than to differences in protection afforded them by the adults.

We have no reason to think that the large mortality was confined to the nests that were being studied. Shortly after the storm birds stopped giving alarm calls, and small flocks of adult Smith's Longspurs were seen. These observations suggest that nesting had been disrupted. Moreover, between 9 and 20 July, we found no additional passerine nests that contained young, and, with the exception of a few young redpolls, we saw only one flying young: a Savannah Sparrow.

There was no unequivocal evidence of renesting. One White-crowned Sparrow nest with 4 eggs was found on 11 July, and 2 more, with 1 and 5 eggs, were found on 15 July. We have no other data on these nests; possibly some or all were renestings started before the storm period. We noted no resumption of territorial behavior in adult birds.

We conclude that most of the small passerine birds fledged in the Churchill region in 1965 were hatched in nests that contained eggs on 8 July, and that these represented no more than 10 per cent of the nests on that date. Whether young that fledged before 8 July escaped destruction is not known. Only the redpolls (*Acanthis flammea* and *A. hornemanni*), that began nesting in late May, and a few pairs of Horned Larks and Lapland Longspurs could have fledged young prior to 8 July.

Non-Passerine Mortality

It is not possible to make a detailed comparison of mortality in passerine and non-passerine species, because most non-passerine young leave the nest soon after hatching and are subsequently difficult to find. We have no reason to suspect unusual mortality among water birds. An Arctic Loon (*Gavia arctica*) that hatched on the morning of 8 July was seen daily until 20 July. Canada Geese (*Branta canadensis*) hatched between 21 June and 4 July, and many broods of normal size were seen later in July. Two Shoveler (*Spatulata clypeata*) and 2 Greater Scaup (*Aythya marila*) nests were incubated through the storm. Eggs in 3 of these nests hatched shortly afterward, and 1 scaup nest was still being incubated on 13 July.

Most nests of Herring Gull (*Larus argentatus*) and all nests of Arctic Terns (*Sterna paradisaea*) contained eggs and were presumably unaffected by the storm. Two Bonaparte's Gulls (*Larus philadelphia*) that hatched on 6 July had left the nest by 8 July; they were seen daily until 20 July. Another Bonaparte's Gull nest was apparently toppled by the wind, and a third failed to hatch.

Nests of 11 species of shorebirds were found: Golden Plover (*Pluvialis dominica*), Semipalmated Plover (*Charadrius semipalmatus*), Hudsonian Curlew (*Numenius phaeopus*), Wilson's Snipe (*Gallinago gallinago*), Least Sandpiper (*Erolia minutilla*), Dunlin (*Erolia alpina*), Short-billed Dowitcher (*Limnodromus griseus*), Stilt Sandpiper (*Micropalama himantopus*), Semipalmated Sandpiper (*Ereunetes pusillus*), Hudsonian Godwit (*Limosa haemastica*), and Northern Phalarope (*Lobipes lobatus*). Eggs in more than half of these nests hatched after 8 July, but there was a major hatching period for most of these species between 30 June and 2 July. We have no direct evidence of mortality among the early hatching young, but because no flying young were seen by 20 July (in 1964, flying young sandpipers were conspicuous by that date) we suspect that some of the earlier nests may have failed to produce a normal number of young.

Two nests of Dunlin, and one each of Least Sandpiper, Stilt Sandpiper, and Hudsonian Curlew contained newly hatched chicks on the morning of 8 July. The chicks of the Least and Stilt sandpipers left their nests the next morning and the Dunlin nests were empty when they were rechecked. The curlew nest contained two chicks and one pipped egg on the morning of 8 July. On the next day 2 chicks were found dead near the nest; their stomachs were empty, but their yolk sacs were still large. Possibly these chicks wandered from the nest and became chilled while the third egg was hatching. The third chick was not found, but it may have been with the agitated parents. A Golden Plover nest containing 3 young and 1 egg on the evening of 7 July had 4 young still in the nest on the evening of 9 July, when 2 nests with eggs, 1 of Semipalmated Plover and 1 of Hudsonian Curlew, were found deserted.

Discussion

The cold, driving rain on the afternoon and evening of 8 July was probably largely responsible for the observed mortality, but the effects of the inclement weather on 6 and 7 July cannot be discounted. Because we cannot precisely define the conditions that caused nestling mortality, it is impossible to determine how often they might occur. Strong winds are frequent in summer along the Hudson Bay coast. The Fort Churchill Weather Office informs us that one-half inch or more of rain fell on at least one day between 1 and 15 July in 1961, 1962, 1963, and 1965. Probably a combination of cold, wet, and windy conditions, and not any of these conditions alone, is necessary to cause sizeable nestling losses.

Weather conditions far less severe than those reported above can cause extensive losses among young birds. Sutton and Parmelee (1954a, b, c; 1955; 1956), reported two storms on Baffin Island in 1953 that affected the survival of certain birds. They found that nests of Snow Buntings (*Plectrophenax nivalis*) and Greenland Wheatears (*Oenanthe oenanthe*) that contained live young during the storms were unaffected. However, "during inclement weather whole nestfuls of young Water-Pipits (*Anthus spinoletta*) died of starvation not far from bunting nests which suffered no losses at all. Young Horned Larks perished in or near their nests from starvation or exposure or both." (1954b: 175) No mortality was noted in six nests of Snowy Owl (*Nyctaea scandiaca*) that contained young. In no species was there evidence of reduced hatching success following the bad weather. Although Sutton and Parmelee (1954a:82; 1954b:175) suggested that young pipits

died of starvation, they apparently did not confirm this suggestion by post-mortem examination of nestlings.

The Baffin Island data are few, but they indicate differences in survival among passerine birds. The species seemingly unaffected by the weather, Snow Buntings and Greenland Wheatears, nested under rocks or in crevices. Only the open tundra nesters suffered demonstrable losses. At Churchill, a major difference in survival was noted between passerine and non-passerine species. We attribute the higher survival rate of the non-passerines to the precocial condition of their young. The great mobility of precocial chicks enables them to reach sheltered areas during bad weather, and their dense downy plumage aids in preventing soaking.

The differences in survival rate among passerines, and between passerines and non-passerines, may help to explain the major compositional features of the arctic avifauna. This avifauna, in contrast to those of temperate and tropical regions, largely comprises non-passerine species. Snyder (1957) lists only 11 passerines among the 71 breeding bird species in the Canadian Arctic. It seems important that all of the non-passerines that occupy the Arctic have ptilopaedic — and in most cases, precocial — young. This condition seems to have preadapted certain non-passerine groups for life in the Arctic. The young of passerine birds, however, are altricial. The data from Churchill show that the altricial young of passerines may face a critical period if cold, wet, and windy conditions occur while they are in the nest. Thus we suggest that one of the factors accounting for the paucity of passerine bird species in arctic regions is the susceptibility of their altricial young to inclement weather.

Some arctic passerines possess adaptations that may aid them in protecting their young from adverse weather. The tendency to nest in crevices or among rocks seems to be an important adaptation in the Snow Bunting. Water Pipits occasionally nest in similar situations (Snyder 1957). Chats of the genus *Oenanthe* characteristically nest under rocks (Meinertzhagen 1954), and this behavior may have preadapted *Oenanthe oenanthe* for the Arctic. Sutton and Parmelee's data showed a high survival rate for buntings and wheatears, but a very low rate for pipits. None of the pipit nests that they studied were built among rocks. Other passerine birds have occupied the Arctic without evolving troglodytic nesting habits. Lapland Longspurs, Tree Sparrows, Common and Hoary redpolls line their nests with feathers, which presumably add to the insulative value of the nest. This habit is also shared by the Snow Bunting and Greenland Wheatear. White-crowned Sparrows and Horned Larks occasionally add a few feathers to their nests. Males of the Water Pipit (Gross 1932), Common Redpoll (Walkinshaw 1948), and Snow Bunting (Tinbergen 1939) may feed brooding females on or near the nest. This behavior can result in additional protection for the nestlings during bad weather. Newly hatched longspurs appear woolier than many other emberizine chicks; perhaps minor differences in length or amount of natal down have selective value. In the Raven (*Corvus corax*), adaptations permitting nesting at high latitudes include: 1) burial of eggs in the nest lining before the start of incubation; 2) feeding of the incubating female by the male; 3) burial of young in the nest lining at low ambient temperatures; 4) brooding by male when female is absent (Gwinner 1965). Nests may be lined with hare or fox fur (Todd 1963).

More data on the occurrence of adaptations that may aid in protecting passerine young from adverse weather conditions are needed. Before their importance can be evaluated, however, data on the frequency of large scale mortality and on the year-to-year stability of arctic passerine populations must be obtained.

Summary

On 8 July 1965, a severe wind and rain storm caused extensive mortality among passerine bird nestlings in the Churchill, Manitoba region. Nestlings were found dead in 54 of 57 nests that contained young prior to the storm. Nests that contained only eggs were unaffected by the weather. Nestlings died from exposure. There was little evidence that adults were unable to find food for the nestlings during the bad weather.

Non-passerine species appeared to be largely unaffected by the weather, though some mortality of young sandpipers was suspected. We suggest that the poor survival of the altricial passerine young was a result of their inability to withstand, or escape, the cold, wet, and windy conditions. It is further suggested that the altricial condition of their young may be important in accounting for the paucity of arctic passerine species.

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