Breeding Bird Populations in Northern Manitoba

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Breeding bird censuses were conducted, using the spot-mapping method, in forest and forest-edge (including one riparian strip) plots at Churchill, Herriot Creek, and Gillam in northern Manitoba, and comparisons are made with avifaunas at four other localities in the subarctic and six localities in the boreal forest. Dominant tree species included *Picea glauca, P. mariana, Larix laricina,* and *Pinus banksiana.* Total bird species in the forest plots varied from 19 to 29 and total pairs from 69 to 96 per 40 ha. In the forest-edge plots, number of species varied from 12 to 24 and pairs per 40 ha from 71 to 242. The average number of pairs per species per 40 ha was highest in 2 forest-edge plots, 7.9 and 12.7, and varied from only 3.0 to 3.6 in the other plots. The distribution of pairs per species around the mean was slightly skewed, g_1 = 1.4 to 1.7. Coefficients of species and population similarities were very high between the Churchill and Herriot Creek plots and moderately high between these plots and other areas in the subarctic. Coefficients were significantly lower between the Churchill-Herriot Creek populations and those in the boreal forest to the south, reconfirming the distinctiveness of the subarctic avifauna. The occurrence of highly skewed distribution ($g_1 \geqslant 2.0$) of species populations around the mean at several locations in both the subarctic and boreal forest may indicate ecological immaturity of the biotic community.

Key Words: Bird populations, northern Manitoba, forest-tundra, subarctic, community structure.

The present study is concerned principally with describing and analyzing breeding bird populations in northern Manitoba in the vicinity of Churchill (58° 46′ N, 94° 10′ W), near the mouth of Herriot Creek 26 km southwest of Churchill (58° 33′ N, 94° 19′ W) and at Mile 333 on the Hudson Bay railroad near Gillam (56° 21′ N, 94° 43′ W) about 265 km south of Churchill (Figure 1). Statistical comparisons, using relatively new procedures, are also made with bird populations at other localities in the subarctic and within the boreal forest (Figure 1). The field work was carried out during June, July, and August in 1956, 1957, and 1958.

All three localities lie in the Hudson Bay Lowland, a boggy plain underlain by flat-lying sedimentary rock (Caley and Liberty 1957). Radiocarbon dating of peat samples taken southeast and north of Churchill indicate that the last ice recession occurred near the end of the Thermal Maximum or Xerothermic Period between 5000 and 4000 years ago (Karlstrom 1956, Prest 1957). Marine submergence occurred over the Lowland until about 3000 years ago (Antevs 1931). Some authorities, however, believe that a somewhat longer time has been available for the invasion and establishment of the present biotic communities (Scoggan 1957; Lee 1960). Plant communities of the region have been described by Moir (1954), Ritchie (1956, 1957, 1959), Hustich (1958), and Sjörs (1959).

Recent accounts of birds in the Churchill area are those of Jehl and Smith (1970) and Cooke et al. (1975). Erskine (1977) included the Churchill area in his comprehensive summary of bird counts over all of boreal Canada. An unpublished study by Twomey (1937) included mapping of some nesting territories on a plot that we covered more thoroughly twenty years later. Godfrey (1953) listed birds along the Hudson Bay railroad, including the Gillam region.

Census Plots

Tree composition in the census plots was determined in part by counts on 2500 m² quadrats scattered at random over 5 percent of the area and in part by the point-centered quarter method of Cottam and Curtis (1956). Diameters of a few representative trees were measured at breast height with a steel diameter tape and converted into basal area. The height of these trees was determined with an Abney level and their age with an increment borer (Table 1).

One forest plot and two forest-edge plots were established near the village of Churchill. Under and between the trees in the forest plot (Figure 2), there was a discontinuous shrub stratum of Dwarf Birch (*Betula glandulosa*) and willow (*Salix* spp.), an irregular stratum of low woody plants consisting of species of *Ledum, Empetrum,* and *Vaccinium,* and a thick ground cover of mosses over about 75 percent of the surface. A number of herbaceous species was scattered over the ground; sedges (*Carex* spp.) were present in depressions and lichens (*Cladonia* spp.) on higher mounds.

The forest-edge plots at Churchill bordered tundra, contained mostly stunted and densely branched White

FIGURE 1. Location of census areas. Limits of biotic areas are from Halliday (1937) and J.W. Aldrich (in Kendeigh 1974).

TABLE 1. Dominant tree species in forest study areas of Manitoba

Area	Density trees ha^{-1}	Number of trees measured	Basal area m^2ha^{-1}	Average height m	Average age years
Churchill (13 ha)					
White Spruce, *Picea glauca*	672	13	2.38	7.4	131
Tamarack, *Larix laricina*	642	8	1.17	7.2	114
Herriot Creek (10.25 ha)					
White Spruce, *Picea glauca*	571	6	2.14	14.8	111
Black Spruce, *Picea mariana*	722	10	1.07	7.9	73
Tamarack, *Larix laricina*	432	5	1.08	12.0	118
Gillam (10.75 ha)					
Black Spruce, *Picea mariana*	399	6	2.60	14.8	61
Jack Pine, *Pinus banksiana*	319	5	1.51	10.2	35
Tamarack, *Larix laricina*	72	3	0.21	8.9	21

FIGURE 2. A relatively dry part of the *Picea glauca-Larix laricina* forest at Churchill showing white spruce and lichen dominated surface vegetation.

and Black spruces (*Picea glauca* and *P. mariana*), and were situated on the sheltered side of a rocky ridge. The size of the two areas could only be approximated because of irregular boundaries and spacing of trees but was estimated at about 10 ha. There were about 1236 trees per hectare, 6.4 cm in diameter, and 3 m high (n = 17). Aside from a few scattered clumps of willows, the shrub layer contained species of *Ledum, Rhododendron, Vaccinium,* and *Andromeda.* The ground was covered with moss.

Black Spruce invaded the forest plot at Herriot Creek about 40 years after the other two species had become well established (Table 1). There was an irregular, widely spaced stratum of willows, Dwarf Birch, and Alder (*Alnus crispa*), commonly 1–1.5 m high, and a lower woody stratum of one or more species of *Ledum, Rhododendron, Shepherdia,* and *Vaccinium.* The forest floor consisted of small peat hummocks and depressions covered with a moss carpet of many species, including *Sphagnum.* Mats of *Dryas integrifolia* were common in the better drained areas. Treeless areas, interspersed over about one-third of the area, consisted of small bogs containing water and bog meadows of grasses and sedges with Dwarf Birch and willows around the margins. Some of the bog meadows contained tree stumps, indicating that the openings were of recent development.

The forest-edge plot at Herriot Creek, at its junction with Churchill River, was a riparian strip that extended about 1.9 km, averaged 52.6 m wide, and covered about 10 ha. It differed importantly from the forest-edge plots at Churchill in having a very dense stand of shrubs (*Alnus, Betula,* and *Salix*), with the tallest willows attaining 2.3 m in height. On the river side, the tall shrubs were bordered by grasses, sedges, and a low shrub (*Myrica gale*); on the forest side occurred a mixed stand of spruce and Tamarack (*Larix laricina*).

The Jack Pine (*Pinus banksiana*) in the relatively young Gillam forest plot (Table 1) was confined to a sand and gravel ridge covered with a thin layer of humus. Black Spruce was intermingled among the Jack Pine but formed denser stands in lower and wetter areas. A few small bogs were present. Isolated groups of Balsam Poplar (*Populus balsamifera*), Quaking Aspen (*P. tremuloides*), and Paper Birch (*Betula papyrifera*) occurred on the ridge in areas disturbed by a small Indian settlement some 30 years previously. Alder and willow shrubs occurred irregularly and often widely spaced, and a lower layer containing species of *Ledum* and *Vaccinium* was conspicuous throughout the forest. *Sphagnum* and other mosses and *Cladonia* and other lichens made a ground covering.

A few observations were made in a 12 ha Black Spruce scrub area (forest edge) at Gillam (Figure 3). Spruce and a few Tamarack formed an open stand with most of the trees 1.8 to 2.7 m high. The discontinuous shrub layer consisted of *Salix, Alnus, Ledum, Empetrum,* and *Vaccinium. Rubus chamaemorus* was common throughout. The ground was irregular with peat mounds covered by mosses and lichens and depressions often containing water and supporting a thick growth of grasses and sedges. The area was

FIGURE 3. Low area with grasses, sedges, and standing water (lower right corner) in the *Picea mariana* forest edge at Gillam.

subject to recurrent fires. For further details and lists of plant species collected on the various plots, see Gillespie (1960).

Methods

Our censuses were taken with the spot-mapping method (Kendeigh 1944). The plots were gridded at 50-m intervals, and the locations of singing males were mapped while we traversed back and forth along parallel lines. At least five counts were taken on each area during morning hours. Some nests were located. The population of each species was based on number of whole territories and sum of partial territories on the plot. Species with less than one-half a territory are marked in the table with a "+"; species seen only once were considered visitors only and not recorded. Weather conditions were near normal.

Species composition and bird populations in the various plots were compared in different ways. Coefficients of species similarity (*Ss*) were determined using the Sørensen equation:

$$Ss = 2C/(A+B)$$

where C is the number of species occurring in both plots, and A and B the total number of species in each. Coefficients of population similarity (*Sp*) were obtained by the equation (Odum 1950):

$$Sp = 1.0 - \frac{\Sigma\,(pa - pb)}{Pa + Pb}$$

where p is the population size of an individual species in plot a or b and P is the combined population of all species in each plot. Plus marks in the table are included in calculating *Ss* and as zero population for calculating *Sp*. Both coefficients are expressed as percentages.

Skewness or asymmetry (g_1) in distribution of pairs per species around the mean was calculated with the equation:

$$g_1 = \frac{\Sigma\,(X_1 - \bar{X})^3}{(n-1)\,(n-2)\,s^3/n}$$

where s is the standard deviation of X_1 from $\bar{X}$ and n is the number of species. Plus marks in the table are considered as species present but with zero (< 0.5) pairs. Critical values for significance are given in Table D.25 of Zar (1974). These statistics have been found useful in analyzing populations in other localities (Kendeigh and Fawver 1981, Kendeigh 1982).

Results

Several species of shorebirds nested in the forest areas (Table 2) but did at least part of their feeding elsewhere. A grebe and two species of ducks also frequented the bogs at Herriot Creek. Several other non-passerine species were recorded but population data were obtained only on passerines. Nine species of Fringillidae, seven species of Parulidae, and four spe-

TABLE 2. Breeding bird populations in Manitoba (pairs/40 ha)

Species	Forest plots			Forest-edge plots		Riparian Strip
	Churchill 1956	Herriot Creek 1957–58	Gillam 1958	Churchill 1956	Gillam 1958	Herriot Creek 1957–58
Horned Grebe, *Podiceps auritus*		+[1]				
Northern Pintail, *Anas acuta*		+				
American Wigeon, *Anas americana*		+				
Rough-legged Hawk, *Buteo lagopus*						+
Merlin, *Falco columbarius*	+			+		
Spruce Grouse, *Canachites canadensis*		+				
Common Snipe, *Capella gallinago*	+	+			+	
Spotted Sandpiper, *Actitis macularia*						+
Solitary Sandpiper, *Tringa solitaria*	+	+	+			
Greater Yellowlegs, *Tringa melanoleuca*					+	
Lesser Yellowlegs, *Tringa flavipes*	+	+			+	
Short-billed Dowitcher, *Limnodromus griseus*		+				
Northern Phalarope, *Lobipes lobatus*		+				
Hawk Owl, *Surnia ulula*		+				
Common Nighthawk, *Chordeiles minor*			+		+	
Common Flicker, *Colaptes auratus*		+	+		+	
Northern Three-toed Woodpecker, *Picoides tridactylus*		+				
Yellow-bellied Flycatcher, *Empidonax flaviventris*			8		+	
Alder Flycatcher, *Empidonax alnorum*					10	8
Olive-sided Flycatcher, *Nuttallornis borealis*			3			
Tree Swallow, *Iridoprocne bicolor*					+	
Bank Swallow, *Riparia riparia*		+				+
Gray Jay, *Perisoreus canadensis*	3	3	3		3	
Common Crow, *Corvus brachyrhynchos*				+		
Boreal Chickadee, *Parus hudsonicus*	3	4	3			
American Robin, *Turdus migratorius*	7	4		15	3	
Hermit Thrush, *Catharus guttatus*			7		3	
Swainson's Thrush, *Catharus ustulatus*			10			
Gray-cheeked Thrush, *Catharus minimus*	4	7	+		+	
Ruby-crowned Kinglet, *Regulus calendula*	3	+	7		+	
Solitary Vireo, *Vireo solitarius*			3			
Tennessee Warbler, *Vermivora peregrina*			7			
Orange-crowned Warbler, *Vermivora celata*			3		6	3
Yellow Warbler, *Dendroica petechia*				+		61
Magnolia Warbler, *Dendroica magnolia*			+			
Yellow-rumped Warbler, *Dendroica coronata*	6	10	7	8		+
Blackpoll Warbler, *Dendroica striata*	7	13	7	16	6	+
Palm Warbler, *Dendroica palmarum*			+		7	
Northern Waterthrush, *Seiurus noveboracensis*	11	12			+	46
Wilson's Warbler, *Wilsonia pusilla*					13	+
Rusty Blackbird, *Euphagus carolinensis*	+	8		+	+	+
Pine Grosbeak, *Pinicola enucleator*	3	4	+			
Redpoll, *Carduelis flammea* or *C. hornemanni*	+	+		+		+
Savannah Sparrow, *Passerculus sandwichensis*		3		10	+	44
Dark-eyed Junco, *Junco hyemalis*	6	8	7		3	
Tree Sparrow, *Spizella arborea*	+	16		18		53
Chipping Sparrow, *Spizella passerina*			+			
Harris' Sparrow, *Zonotrichia querula*				5		+
White-crowned Sparrow, *Zonotrichia leucophrys*	7	4		23	7	23
White-throated Sparrow, *Zonotrichia albicollis*			2		7	+

TABLE 2. Breeding bird populations in Manitoba (pairs/40 ha) (concluded)

Species	Forest plots			Forest-edge plots		Riparian Strip
	Churchill 1956	Herriot Creek 1957–58	Gillam 1958	Churchill 1956	Gillam 1958	Herriot Creek 1957–58
Fox Sparrow, *Passerella iliaca*	9	+	3		3	+
Song Sparrow, *Melospiza melodia*						4
Total Species	19	29	23	12	24	19
Total Pairs	69+	96+	80+	95+	71+	242+
Pairs/Species/40 ha	3.6(4.3)[2]	3.3(4.6)	3.3(3.6)	7.9(7.9)	3.0(3.4)	12.7(13.4)
Skewness (g_1)	1.5	1.6	1.4	1.5	1.7	1.7

[1] + = Species represented by less than 0.5 territory. Species recorded only once on a plot are not listed.
[2] Numbers in parentheses exclude waterbirds

cies of Turdidae were predominant. These same groups were most numerous in the forest-edge and riparian plots.

There was a greater similarity between species composition and populations between Churchill and Herriot Creek than between either area and Gillam (Table 3). The same was true for forest-edge and riparian bird communities. Faunas and populations were less similar between areas of forest edge than of forest except for the Herriot Creek and Gillam faunas. Churchill and Herriot Creek are along the northernmost edge of the ecotone between boreal forest and tundra (tree line) while Gillam is well within the ecotone (Figure 1).

The Churchill area had the fewest species in both forest and forest-edge areas, and the Herriot Creek area had the largest total populations (Table 2). Excluding water birds, one species was found exclusively at Churchill, six at Herriot Creek, and 11 at Gillam. Since forest species may occur on the forest edge and forest-edge species penetrate to varying extents into the forest interior, especially in open forests, there was considerable similarity between total faunas and average populations found in each (Table 3). Eight of 34 species were exclusive to the forest, 11 of 31 species were exclusive to the forest edge.

TABLE 3. Coefficients of species similarity (*Ss*) and population similarity (*Sp*)

Localities (Manitoba)	*Ss* (%)	*Sp* (%)
Forest		
Churchill and Herriot Creek	75(81)[1]	62
Churchill and Gillam	48(47)	42
Herriot Creek and Gillam	42(47)	31
Forest-edge and riparian strip		
Churchill and Herriot Creek	58(60)	30
Churchill and Gillam	28(30)	19
Herriot Creek and Gillam	47(51)	12
Forest and forest-edge (including riparian strip)	65(71)	36

[1]Percentages within parentheses exclude waterbirds.

Only a brief study was made of the relation of forest to tundra avifaunas. An area of forest and forest edge (10 ha) was marked at 50-m intervals and adjacent tundra (20 ha) at 100-m intervals at a location 40 km above the mouth of Herriot Creek. Circumstances permitted only a one-day count of the bird populations. The contrast in species distribution was well defined (Figure 4), with seven species restricted to the tundra, 11 to the forest edge, and only three occurring in both (*Ss* = 25%). Foster (1954) recorded six additional species of water birds in another tundra area near Churchill. The species composition of our plot was similar (*Ss* = 63%) to that on three tundra plots at tree line censused near Parsons Lake in the Mackenzie Delta (Owens, R. A. 1974, unpublished report by F. F. Slaney and Co. Ltd., for Canadian Arctic Gas Study Ltd.). Excluding shorebirds, all species in the Mackenzie Delta were recorded in this plot except the Yellow Warbler, and this species was abundant in the riparian strip at the mouth of Herriot Creek.

Discussion

The distinctiveness of biota in the subarctic has long been recognized although referred to in different terms: "Hudsonian fauna" (Allen 1892), "Hudsonian life zone" (Merriam et al. 1910), "northern transition" (Halliday 1937), "forest-tundra ecotone" (Marr 1948), "taiga" (Hustich 1949), "open boreal woodland" (Hare 1950), "zone subarctique" (Rousseau 1952), and "forest-tundra faciation" of the boreal forest (Kendeigh 1974). Do our data support recognition of this biota? To facilitate statistical comparisons, counts of species in forest areas at Churchill and Herriot Creek were averaged ("Churchill"). This is justi-

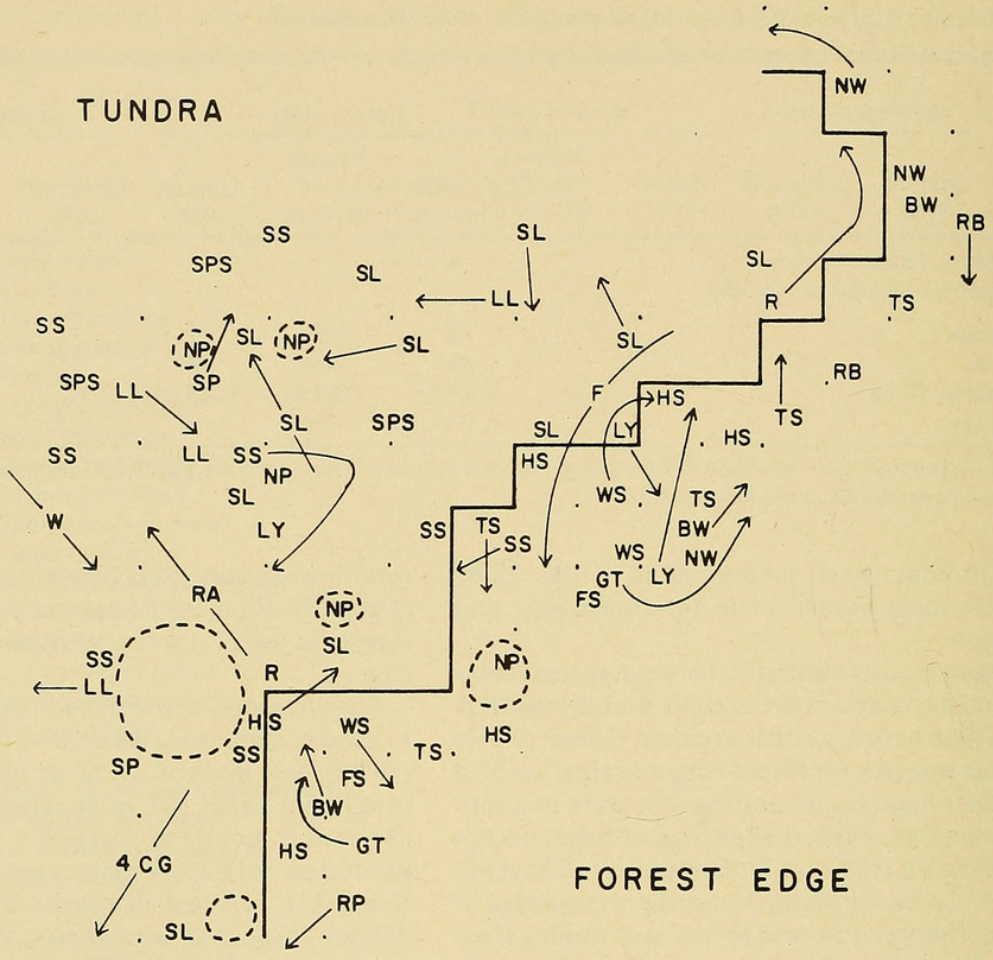

FIGURE 4. Distribution of birds on forest edge and tundra along Herriot Creek on 26 June 1957. Broken lines represent boundaries of ponds and arrows show directions of bird flights.

BW — Blackpoll Warbler
CG — Canada Goose, *Branta canadensis*
F — Common Flicker
FS — Fox Sparrow
GT — Gray-cheeked Thrush
HS — Harris' Sparrow
LL — Lapland Longspur, *Calcarius lapponicus*
LY — Lesser Yellowlegs
NP — Northern Phalarope
NW — Northern Waterthrush
R — American Robin
RA — Common Raven
RB — Rusty Blackbird
RP — Redpoll
SL — Smith's Longspur, *Calcarius pictus*
SP — Semipalmated Plover, *Charadrius semipalmatus*
SPS — Semipalmated Sandpiper, *Calidris pusilla*
SS — Savannah Sparrow
TS — Tree Sparrow
W — Whimbrel, *Numenius phaeopus*
WS — White-crowned Sparrow

fied since high *Ss* and *Sp* (Table 3) indicated that these bird faunas were more similar than they were different. Waterbirds and visitors were excluded at all localities.

Forest-tundra faciation (Subarctic)

Census data were compared for five other areas in the forest-tundra faciation. Areas to the northwest included a mature lichen woodland of Black Spruce, White Spruce, Jack Pine, and Paper Birch east of Great Slave Lake (Harris et al. 1974); three plots in Black Spruce, White Birch, and Tamarack west of Great Slave Lake (Carbyn 1971); and a variety of communities containing Black Spruce, Tamarack, White Birch, and several species of scrub trees and shrubs west of Great Bear Lake (Ebel et al. 1975). The Gillam area, censused by us, lies to the south and three Black Spruce plots at Big Trout Lake, Ontario (Lee and Speirs 1977), are to the southeast.

There was a decline in richness of fauna to the northwest and an increase to the southeast (Table 4). Population levels (pairs per 40 ha) were lowest in the extreme northwest and highest in the extreme southeast. Similarity values (*Ss, Sp*) were higher between

the "Churchill" and Harris et al.'s areas than between the "Churchill" and other areas. Because occurrences of less common species on relatively small census plots and population levels fluctuate from year to year, we suspect similarity values would be higher, with *Ss* exceeding 50 percent, were comparisons based on averages for several years rather than one or two years. Only four of the species in Harris et al.'s area and three in Ebel et al.'s area were not recorded at "Churchill". However 9 of 17 species in Carbyn's areas were different. Lee and Speirs recorded 13 of the 22 species found at "Churchill" and 21 additional species. Only three species were recorded in all five areas: Yellow-rumped Warbler, Blackpoll Warbler, and Dark-eyed Junco; four species were missing from only one area: Gray Jay, Boreal Chickadee, Ruby-crowned Kinglet, and Gray-cheeked Thrush.

Boreal forest

Six areas in the boreal forest were selected for comparison with the avifauna at "Churchill" (Table 4). Black Spruce was the predominant tree species in all areas except in one of the two areas censused by Erskine (1974) where White Spruce was predominant and in Sanders' areas where Balsam Fir (*Abies balsamea*), Paper Birch, and Quaking Aspen were most important. Spruce budworm infestation was at low level or absent in all areas. All avifaunas in the boreal forest had significantly low values of *Ss* and *Sp* compared with "Churchill". Our statistical treatment therefore confirms the distinctiveness of the subarctic forest-tundra faciation.

Community Structure

Aside from the number of species present, the structure of bird communities reflects the manner in which breeding pairs are distributed among the species. The mean number of pairs per species per 40 ha (p/s) gives the general level of species abundance, perhaps more useful than median or mode. However, distribution of p/s around the mean is seldom symmetrical, so that a measure of skewness (g_1) is helpful.

Pairs per species were high in the forest-edge plots at Churchill, in the riparian strip at Herriot Creek, and in Koonz's forest area; low in Ebel et al.'s areas, but varied only between three and six p/s in all other areas (Tables 2, 4).

There was a significant skewness in the distribution of pairs per species around the mean at all localities. As noted elsewhere (Kendeigh and Fawver 1981), g_1 values over 2.0 commonly contain one or more species conspicuously more numerous than others. Thus in Carbyn's areas, the Dark-eyed Junco and in Harris et al.'s area, the Yellow-rumped Warbler each had populations 5 times the average. In the "Churchill" areas with g_1 of 1.5, the most abundant species, Northern Waterthrush, was only 3 times the average. Nearly symmetrical distribution of populations around the mean have been found in some old mature and stable stands of deciduous forest (Kendeigh 1982). An ecologically mature community would be expected to have evolved a high diversity of niches and species occupancy. This would stimulate interspecies competition and a better balance between species populations. Whether or not the extent of skewness varies

TABLE 4. Comparison of forest bird faunas and populations with "Churchill" area

Locality and author	Number of species	*Ss* %	Pairs per 40 ha	*Sp* %	Pair per species per 40 ha	Skewness g_1
		Forest-tundra faciation				
Ebel et al. 1975, Northwest Territories	9	45	22	37	2.4	1.4
Carbyn 1971 (3 areas), NW Territories	17	41	100	31	5.9	2.4
Harris et al. 1974, NW Territories	21	70	84	49	4.0	2.3
"Churchill" (2 areas), Manitoba	22	—	86	—	3.9	1.5
Gillam, Manitoba	22	45	80	39	3.6	1.4
Lee & Speirs 1977 (3 areas), Ontario	34	46	134	35	3.9	2.2
		Boreal forest				
Erskine 1974 (2 areas), British Columbia	14	28	47	22	3.4	1.5
Erskine 1973, Saskatchewan	19	24	86	24	4.5	2.2
Koonz 1974[1], Manitoba	10	25	92	20	9.2	2.6
Erskine 1972, Manitoba	16	32	70	15	4.4	1.9
Sanders 1970 (2 areas), Ontario	45	24	122	7	2.7	2.0
Erskine 1971, Ontario	15	27	91	18	6.1	2.0

[1]An 8.1 ha plot at Sisipuk Lake in western Manitoba; an unpublished report of W.H. Koonz of the Manitoba Department of Renewable Resources and Transportation Services.

inversely with maturity must await determination from analysis of many more studies in a variety of biotopes.

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