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A STUDY OF DEVELOPMENT OF YOUNG TREE SPARROWS AT CHURCHILL, MANITOBA

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IN A previous issue of *Bird-Banding*[1] there was presented a study of the nesting habits of the American Tree Sparrow (*Spizella arborea*) from the time of their arrival on the breeding grounds at Churchill, Manitoba, until the end of the incubation period. The present paper continues the life history of this species, following the development of the young birds from hatching until they assume the adult plumage.

NESTLING

Hatching. From twelve to fifteen hours before hatching, the eggs usually became chipped about the larger end, at first so slightly that no break in the shell could be detected except by feeling gently for a vague roughness. Hatching was found to take place at any time of the day, with intervals of from one or two to thirty hours between the first and last young's arrival. The best results seemed to obtain, however, when the entire brood came within fifteen hours, for in two cases of long-delayed hatching, the young did not survive. The order of hatching was not dependent upon the order of laying, as proved by Nest I, where the eggs were marked day by day.

At Nest VII the first young was observed in the act of emerging. The egg had been cracked into two unequal parts, the broad end twice the size of the pointed end, from the latter of which the scrawny creature was dangling head downward on the floor of the nest. The parent returned shortly, surveyed her offspring and settled over the nest, alternately brooding and incubating. After

[1] Baumgartner, A. M.—*Bird-Banding*, July 1937, VIII, 3, pp. 99-108.

two minutes she hopped onto the rim, took up the larger piece of shell and swallowed it. After another minute of incubating, she disposed of the smaller end in similar fashion. The down on the nestling was dry within about three hours, except for a suggestion of stickiness on the head.

There follows a tabular description of the young bird at the time of hatching:

TABLE I

DESCRIPTION OF TREE SPARROW AT HATCHING

Skin: Yellowish, with a pinkish undertone.

Eyes: Very dark grey showing through skin.

Bill and feet: Pinkish horn color.

Egg tooth: Whitish prominence at tip of upper mandible, persistent for about two days.

Lining of mouth: Orangish pink.

Down: Fuscous; sparse tufts disposed as follows:
1 on base of each leg.
5–6 on middle of back.
1 on scapulars and upper humerus.
2–3 on femur.
2–3 at base of skull.
Large tuft over each eye.
Scarcely perceptible on ventral surface.

Feather tracts: No suggestion visible.

Measurements (averages of 5 birds):

Length (top of crown to tail-bud)	33.5 mm.
Wing (from bend to tip)	6.0 "
Tail	none
Tarsus (to toe)	5.0 "
Culmen	4.0 "
Weight (down still wet)	1.62 gms.

Comparative Development of Individuals. Though the order of egg laying did not appear to be a significant factor, the sequence of hatching was decidedly so. Young hatched several hours before their brothers usually maintained the lead in development, at least for the first few days, sometimes throughout nest life. Thus at Nest I birds were marked at hatching with red, yellow, blue, and green threads respectively. In the development of feather tracts and in weight Red was always a trifle more advanced, with Green perceptively in the rear, and Green was the last to leave the nest.

Plumage Development. Development of feather tracts can best be presented pictorially (See Plate I). In the following table (Table II) is given the comparative growth of the more important tracts, indicating in each case the length of the sheath and the amount of free feather protruding beyond it.

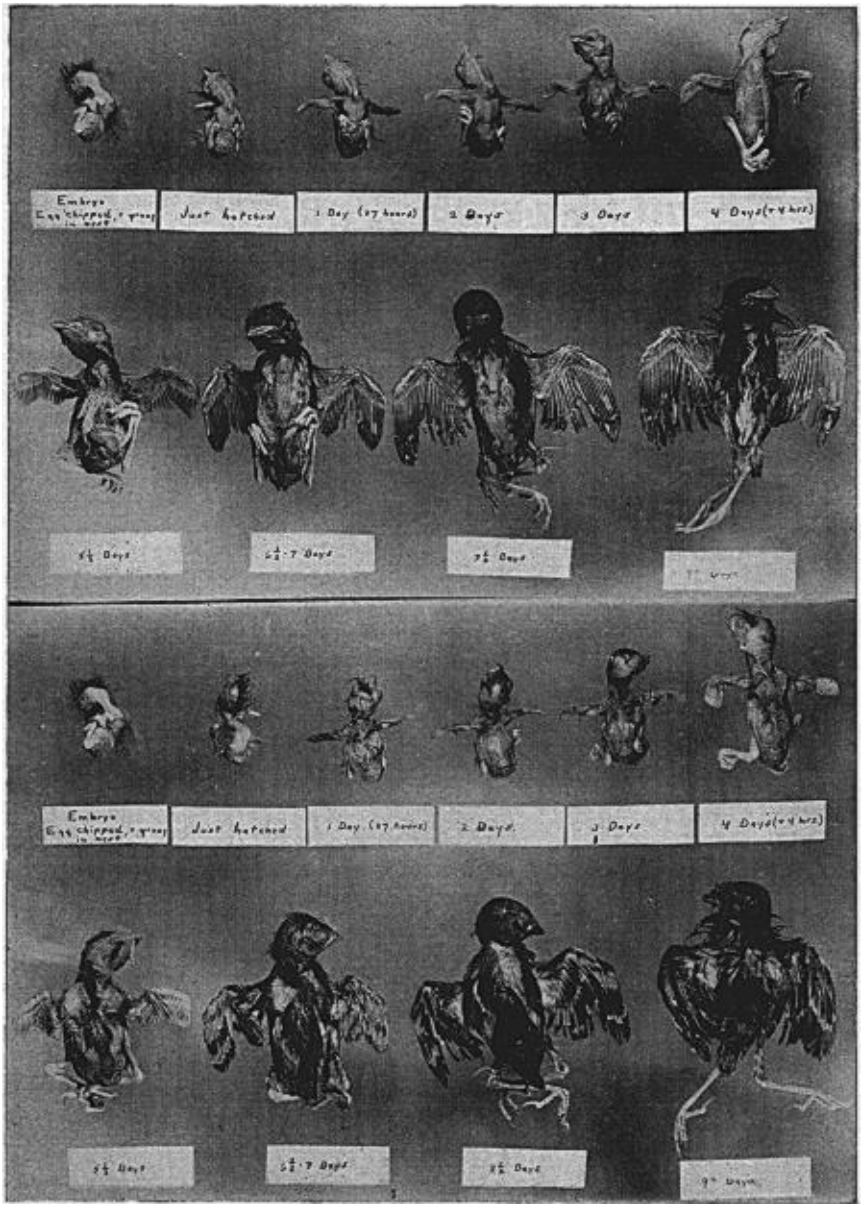


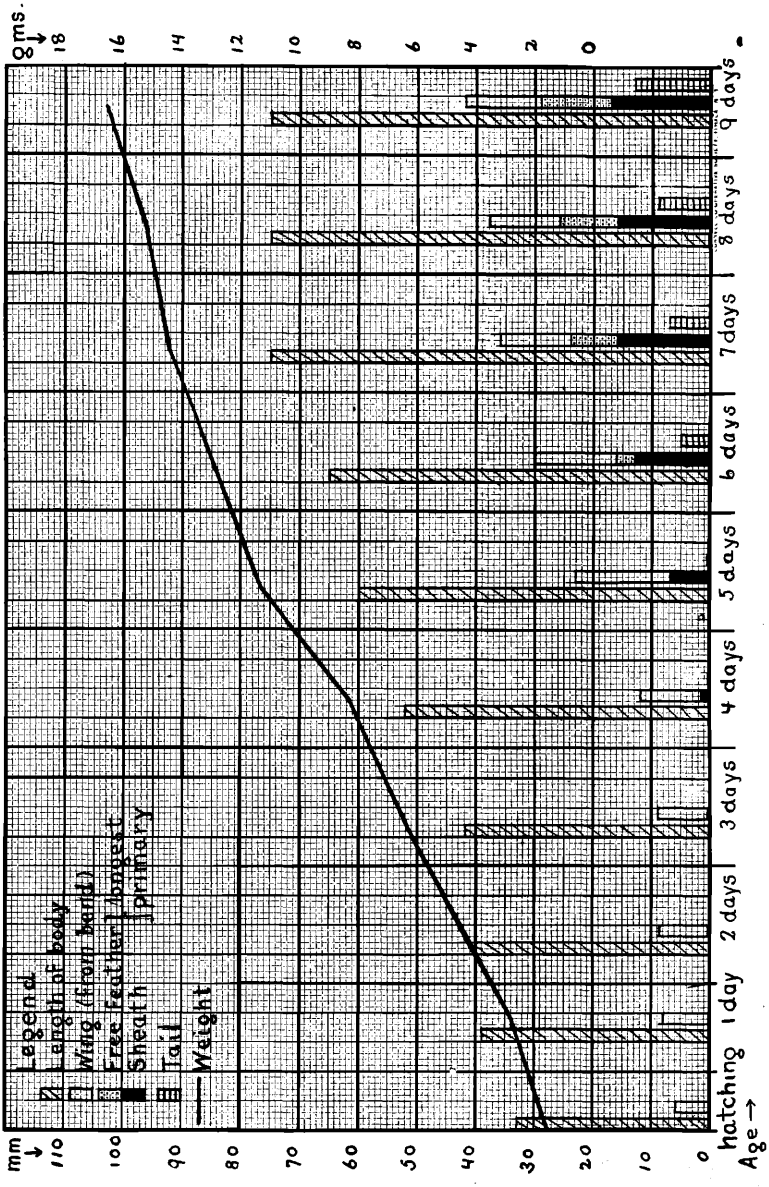
PLATE I.—Development of Feather Tracts.
Upper picture, Ventral View.
Lower picture, Dorsal View.

TABLE II

DEVELOPMENT OF FEATHER TRACTS OF NESTLING TREE SPARROWS

Age	*Dorsal Tract*	*Ventral Tract*	*Alar Tract (Longest Primary)*	*Caudal Tract (Outer Tail-feather)*
Just Hatched	None	None	None	None
1 Day	None	None	None	None
2 Days	Dark dots under skin	Light dots under skin	Faint dots above	
3 Days	Dats faintly raised	Dots slightly raised	Faint dots above	
4 Days	Pin feathers protruding	Pin feathers 1 mm.	Primary sheath 1.5 mm. Covert .8 mm.	
5 Days	Pin feathers 4 mm. Capital tract protruding	Sheath 3 mm. Free feathers 1 mm.	Primary sheath 7 mm. Covert sheath 5 mm.	Sheath .5 mm.
6 Days	Sheath 5 mm. Free feathers 7 mm. Capital tract: Sheath 2 mm. Free feathers 3 mm.	Sheath 3 mm. Free feathers 7 mm.	Primary: Sheath 13 mm. Free feathers 3 mm. Covert: Sheath 5 mm. Free feathers 4.8 mm.	Sheath 3 mm. Free feathers 1 mm.
7 Days	Sheath 5 mm. Free feathers 8 mm. Capital tract: Sheath 2 mm. Free feathers 5 mm.	Sheath 5 mm. Free feathers 11 mm.	Primary: Sheath 16 mm. Free feathers 8 mm. Covert: Sheath 5 mm. Free feathers 8 mm.	Sheath 4 mm. Free feathers 3 mm.
8 Days	Almost covered Sheath 5 mm. Free feathers 9 mm. Capital tract: Sheath 2 mm. Free feathers 5.5 mm.	Lower belly bare Sheath 5 mm. Free feathers 15 mm.	Primary: Sheath 16 mm. Free feathers 10 mm. Covert: Sheath 5 mm. Free feathers 10 mm.	Sheath 5 mm. Free feathers 3 mm.
9 Days	Back covered Sheath 5 mm. Free feathers 12 mm. Capital tract: Sheath 2 mm. Free feathers 6 mm.	Lower belly still slightly bare Sheath 5 mm. Free feathers 17 mm.	Wings ⅔ grown Primary: Sheath 17 mm. Free feathers 12 mm. Covert: Sheath 6 mm. Free feathers 11 mm.	Tail still a stub Sheath 6 mm. Free feathers 4 mm.

Measurements. Advances in the average weight and dimensions of a varying number of nestlings are tabulated below (Table III); the correlation between average weight, length of body (from crown to tail-bud) wing, and tail is depicted in the accompanying histiograph (Plate II). After eight days two factors caused an abrupt and unnatural drop in my average weights: first, the heavier and



Development of Nestling Tree Sparrows

PLATE II

more vigorous broods scattered when I approached, and secondly, one nest was covered with a wire cage in order to retain the birds for further study. For these reasons it was deemed best to omit those figures entirely, giving only a single but perfectly normal weight at nine and a quarter days from Nest I which had been undisturbed for almost a week. By "days," it should be noted, is meant the number of complete days old of a young bird.

TABLE III

AVERAGE GROWTH IN WEIGHT AND DIMENSIONS OF NESTLINGS

(Varying Number)

Age	*Weight*	*Length*	*Ex.*	*Width*	*Tail*	*Tar.*	*Culmen*
New hatched	1.62 gm.	33 mm.	28 mm.	6 mm.	None	5 mm.	4 mm.
1 Day	2.84 "	39 "	36 "	8 "	"	7 "	4 "
2 Days	4.42 "	40 "	40 "	8.5 "	"	8 "	4.5 "
3 "	6.50 "	42 "	41 "	9 "	"	9 "	5 "
4 "	8.29 "	52 "	59 "	12 "	"	11 "	6 "
5 "	11.29 "	60 "	89 "	23 "	.5 mm.	16 "	7 "
6 "	12.96 "	65 "	115 "	30 "	5 "	18 "	7.5 "
7 "	14.74 "	75 "	128 "	36 "	7 "	20 "	8 "
8 "	15.20 "	75 "	138 "	38 "	9 "	20 "	8 "
9 "	16.70 "	75 "	144 "	42 "	13 "	20 "	8.5 "

Summarizing the tabular data, the average gain in weight for the entire nest period of nine and one-half days was found to be 15.08 gms., or 930 per cent of the bird's weight at hatching, and about 80 per cent of its final adult weight. While the actual daily gain increased more or less steadily until the age of five days, after which gains were less striking, the per cent of increase, on the other hand, (*i.e.*, the per cent of gain over the actual weight at the end of the preceding day), decreased uniformly from a 75 per cent increase during the first day to a paltry 9 per cent on the last. Bills and feet by this time had attained almost full size; wings were about two-thirds grown, and tails barely started.

Response. At the age of two days the young were sufficiently developed to sit up in the nest and stretch for food. From this time until fear was acquired they would respond with outstretched necks and gaping mouths to motion—approach to the nest, the stirring of twigs or a touch on the nest. The sense of hearing did not seem to be responsible for such reactions, since noises not associated with movements they could feel were ignored. At four days the eyes were half open, and at the end of five were wide open, after which their responses were somewhat more discriminating.

No sound was emitted until the age of five days, and even at eight days they usually simply raised their heads to accept what the parents brought.

Below are listed the various calls, with the age at which they were first heard:

TABLE IV

CALL NOTES OF YOUNG TREE SPARROWS

Context	*Note*	*Age First Heard*
Food calls	Soft "tsssseeeee"	5 days
	Noisy "tssssss tsssss"	6 "
	Weak "aah aah"	8 "
	Prolonged "aah aah aah aah aah"	9½ "
	Prolonged "wehy wehy wehy"	9½ "
Discomfort	Plaintive high "peeep" (while being weighed, sometimes in nest after prolonged absence of parents).	6 "
Fear	Harsh "squaaank," with rising inflection and increasing vehemence at end (suggested at seven and one-half days	8 "
	Raucous "raaah raaah" (similar to food cry but much harsher)	8 "

Fear was acquired quite suddenly between seven and one-half and eight days, correlating perfectly with the development of physical independence. In my daily rounds I had found them at first unalarmed by human presence and quiet during weighing, except for a certain amount of squirming at the coldness of the metal scales. At the age of seven days they were still somewhat bare beneath, and their legs were not yet strong enough to support their weight, though they were quite agile at kicking themselves off the scales. At eight days, fully covered above and with well developed leg muscles, they crouched low in the nest, and at the first touch scattered to the four winds, screaming with an ardor that brought the parents and a dozen neighbors to the vicinity. At Nest III where three banded young had hatched half a day before the other two, weighings were made just before these birds were eight and seven and one-half days old respectively. By keeping them in a box they were retained long enough to weigh. As soon as they were returned to the nest, the three older birds scrambled off into the bushes, while the other two remained serenely their full term of nine and one-half days in the nest.

Parental Care, Brooding. During their early days the female covered the young most of the time. An observation period at Nest I from ten A.M. to four P.M. on the first day found her on the nest 74 per cent of the time. Periods averaged about eight minutes, occasionally as long as a half hour, with intervals of only three to an extreme of eight minutes away from the nest. After a few days, feeding occupied a greater proportion of her time, and brooding periods were short and infrequent, rarely exceeding three minutes. At six and one-half days she was on 20 per cent of the very early morning, but not at all later in the day, though the female at Nest IX was flushed from her nest on the eighth day. At night most of the birds remained with their young the full term of nine and one-half days, although the nestlings were fully covered (at least dorsally) at the age of eight.

Feeding. The feeding habits of the Tree Sparrow, including feeding of the young, have already been published[2] and only a brief summary will be included here. Both adults were found to share in this work, at first equally, later with the heaviest load falling on the male. During the first few days the young were fed only three or four times an hour. Thereafter an average of sixteen feedings per hour was maintained, at intervals ranging from one to ten minutes between visits.

FLEDGLING

By the above term is meant the juvenal bird from the time it leaves the nest until it has assumed its winter dress, a period of about a month. Leaving normally at the age of nine and one-half days, the young would depart, if handled, at the tender age of eight.

Leaving the nest. During the ninth day in the nest the young became quite active, shifting and stretching frequently. The parent bringing food was greeted by outstretched necks, fluttering wings, and noisy clamors. The undisturbed, normal method of departure was observed at Nest I. Arriving at the nest in the early afternoon of July 8th, I found three of the brood already gone and the youngest, banded with a green thread at the time of hatching, sitting alone in the nest. The female bird came soon thereafter with food, which Green accepted quietly without move to follow. Quite different was his reaction when the male came. Immediately the young bird hopped past the proferred food and out onto the open tundra, peeping vigorously, sprawling and stumbling over the uneven ground one or two feet behind his father, who led him toward the near-by willow-birch thicket. About twenty feet from the nest he was fed, and thereafter he was given a morsel after every few feet, at intervals of fifteen to thirty seconds. Occasionally Green wandered off the course and after considerable peeping by both parties, was finally found and fed. Thus it took them twenty minutes to traverse a hundred feet of hummocky tundra.

At the edge of the thicket the young bird was allowed to rest in the shelter of a hummock. Whether exhaustion or a sense of security in the tangle of shrubbery terminated the journey I do not know, nor can I explain Green's preference for masculine leadership. Yet the performance was repeated almost identically when twice I brought him back to the nest. Green showed no desire to travel alone, nor to follow the female parent, whose instincts seem to have clung to the nest. Throughout my visit she chipped anxiously about it and fed her offspring several times while he was there. The third time that he was forcibly returned he concealed himself in the shrubbery directly behind the nest. The female came and did not see him, calmly swallowed the food herself

[2] Baumgartner, A. M.—Wilson Bulletin, June 1937, XLIX, 2, 65–80.

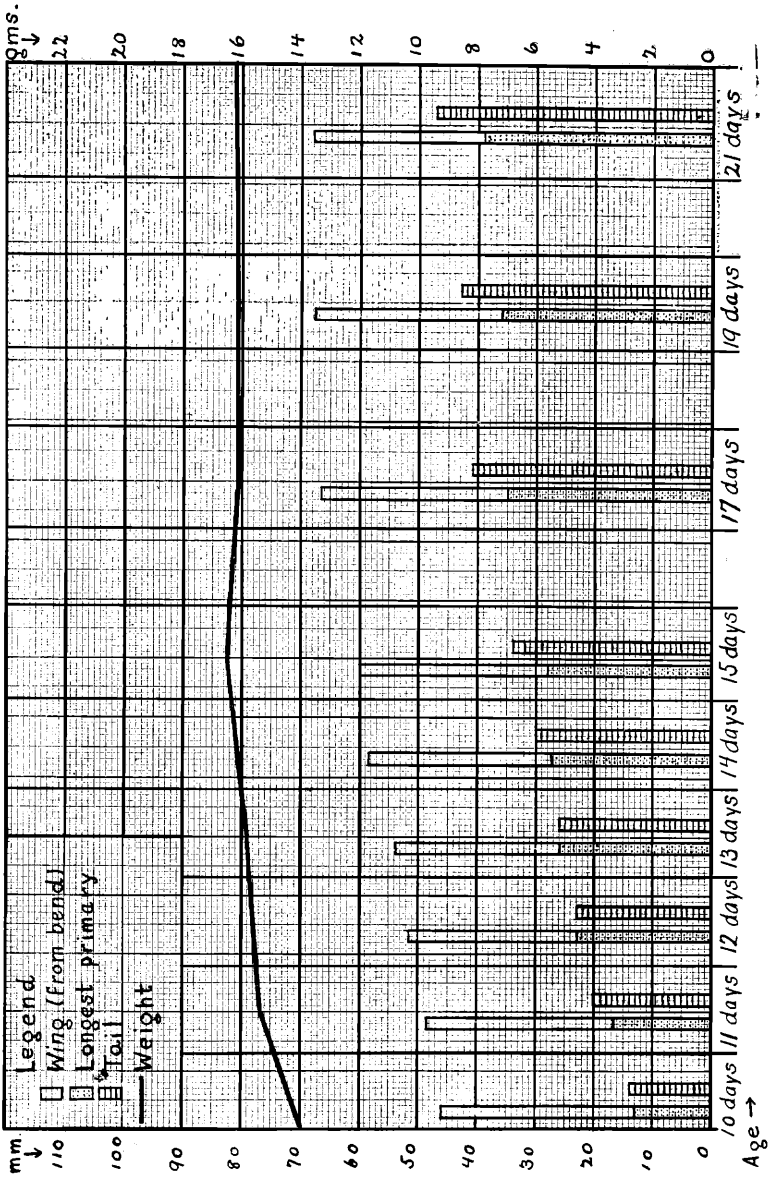

mm.
gms.
Legend
Wing (from bend)
Longest primary
Tail
Weight
Age →
10 days
11 days
12 days
13 days
14 days
15 days
17 days
19 days
21 days
Development of Fledgling Tree Sparrows

PLATE III

and brooded for two minutes on the empty nest. Subsequently the male appeared and Green, now a true fledgling, hopped after him to the shelter of the thicket.

Development. After this time physical development of the young had of necessity to be studied from captive birds. A wire cage 12 by 8 by 12 inches had been placed over Nest IV before the occupants had departed. The young were fed freely through the meshes and growth is believed to have continued fairly normally. Observations upon free birds were used as checks whenever possible and fully substantiated this belief. The loss of weight which I had observed in nine- and ten-day birds, or first believed to be due to caging, was paralleled in the wild state in the case of a banded bird from Nest I which was recovered a day after it had left the nest. Its weight had dropped from 16.7 gms. to 15.2 gms. On July 13th a young bird of unknown age was captured, banded, measured, and placed in the "Ranch." After two days the original young had attained the measurements of this new bird at the time of his capture, and they continued to show weights and measurements two days less advanced than his.

Four measurements were taken daily whose development and relationships are shown on the accompanying histiograph (Plate III). In this period from ten to twenty-one days of age, the total gain was 3 gms. per bird, giving these fledglings of three weeks of age an average weight only half a gram less than that of immature specimens collected in mid August at the height of the fall molt. Wings were still slightly short and tails about two-thirds grown.

Flight. As has been indicated, young birds were quite unable to fly when they left the nest. The day following the departure from Nest I described above, Green was found perched in a small tamarack about fifteen inches from the ground in the same thicket to which I had followed him the previous afternoon. He was easily captured by hand, and upon his release he stumbled away over the uneven hummocks without attempting to fly. Five days later a banded young from this same brood flushed six feet in front of me and flew laboriously some thirty or forty feet. The development of the caged young again corresponded with observations afield. Within the "Ranch" droppings were first found on the branches a few inches above ground level when the young were fifteen days old, and they were thereafter conspicuously more active and quarrelsome. It is interesting to note a slight drop in weight at this time (Plate III). By the end of July young birds everywhere were flying about freely within the little thickets of their territory.

Parental Care. Fledglings over two weeks old, both at the cage and in the field, seem to have been fed as frequently as during their nest life. On July 26, when they were twenty-two days old, the male made three visits to the enclosure in half an hour, although

there was but one bird inside and three at large (the others had escaped). The female did not make her appearance at the cage, but was glimpsed at intervals in the neighborhood. As she had always been more shy than her mate it is probable that she preferred feeding the hungry mouths of the rest of her brood. It was on this day that the young bird still in the "Ranch" gave the first indication of independent feeding. He was observed picking at the ground and was much attracted to a bread crust from my lunchbox.

Data on birds of known age terminated abruptly the next day with the death of my last Ranchman. It was suspected that the waning of parental care might have been the cause, but examination of the stomach disclosed undigested seeds and other matter, so that he apparently had not starved.

Family groups farther afield were observed until the fifteenth of August, but only occasionally was an adult seen gathering food for the young or feeding them. Of a large series collected during this month all were found to be in heavy molt, and many of the young taken August 19th were in almost complete adult plumage Measurements were comparable to adult figures, while in weight they averaged slightly less, as indicated by Table V.

TABLE V
WEIGHT OF AUGUST TREE SPARROWS

No. Weighed	*Sex*	*Weight*	*No. Weighed*	*Sex*	*Weight*
6	M ad.	19.7 gms.	14	M im.	18.1 gms.
4	F ad.	17.7 "	12	F im.	16.8 "
10	Average	18.7 gms.	10	Average	17.9 gms.

On August 21st, the last day in the field, the tundras were deluged with Tree Sparrows. Leaving the thickets where they had been reared they were feeding now on the grass seeds of the open flats. The young were full fledged, adults and immatures now indistinguishable, and the fall flocking had begun.

SUMMARY

This article continues the study of nesting habits of the Tree Sparrow at Churchill, Manitoba (first part published in *Bird Banding*, July 1937), tracing the development of the young from hatching through the fall molt.

Aspects considered are hatching, a description of the young at hatching, comparative rate of development of young in one nest, development of plumage, weight and measurements, response by call notes and actions, and the phases of parental care: brooding, nest sanitation, feeding. The method of leaving the nest and consequent development of flight, the waning of parental care, molt and fall flocking are discussed under the subheading "Fledgling." Developments of weight, measurements, and plumage of fledglings were followed by covering the nest with a floorless cage of hardware cloth. There are two histiographs and two tables depicting development of plumage, weights, and measurements day by day.