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FOOD AND FEEDING HABITS OF THE TREE SPARROW*

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The immense quantities of weed seeds consumed by the sparrow tribe early attracted the attention of the United States Biological Survey, and the classic studies of Beal and Judd are known to every serious ornithologist. The winter food of the Tree Sparrow (*Spizella arborea*) has been adequately covered in these papers; the one by F. E. L. Beal ('97) estimated the amount eaten, while the one by S. D. Judd ('01) listed the precise nature of the food. Since that time occasional observations and a considerable amount of material hitherto unpublished have accumulated to amplify this winter list. As far as the writer has been able to determine, however, no information has been published on the summer food of this species. With the purpose in view of gathering some facts on the summer food, a representative series of birds, ranging from one day old to adults, and covering the period from June 5 to August 19, was collected at Churchill, Manitoba, during the summers of 1933 and 1934. It is the purpose of this paper to assemble the known data concerning the food and feeding habits of the Tree Sparrow (*Spizella arborea*), summarizing and amplifying the standard publications by more recent papers and personal investigation.

Assistance is gratefully acknowledged to Miss Phoebe Knappen for a detailed report of the stomach analyses on file at the U. S. Biological Survey; and to Mr. Clarence Cottam and Mr. Leon Kelso for analysis of the material collected at Churchill; and to a host of banding operators who have reported on the nature of bait used at their stations for the Tree Sparrow.

WINTER FOOD

Amount of Food. Beal ('97) found that a single Tree Sparrow eats about one-fourth ounce of seeds per day; allowing the conservative estimate that ten birds per square mile spend an average of 200 days in this country, then in the state of Iowa, this species alone de-

*A portion of a doctoral thesis submitted to Cornell University in 1935.

stroys 875 tons of weed seed annually. This figure, enormous as it sounds, Beal thought could, without exaggeration, be multiplied by four.

In the stomach of an individual bird he recorded 700 seeds of pigeon grass, a figure which the writer found to be similarly conservative; for a specimen collected at Ithaca, New York, contained 982 seeds in the crop alone, with another 200 in a crushed mass in the stomach.

Nature of the Food. During the sojourn of the Tree Sparrow in the United States its food was found by Judd ('01) to consist almost entirely of weed and grass seeds. His examination of 517 stomachs collected from Massachusetts to Kansas and from October to May disclosed 98 per cent of seed food, with about 2 per cent of animal matter, and a minute quantity of fruit. Mineral matter plays a not inconsiderable part in the digestive processes, and Judd found coarse bits of sand and tiny stones making up 10 per cent of the stomach contents. The Tree Sparrow shows the essential difference from associated fringillids in the large consumption of grass seed, which makes up fully 50 per cent of his vegetable diet. Panicums, pigeon grass, and allied grasses seem to be preferred, after which ragweed, lamb's quarters, and the Polygonums compose two-thirds of his food, the remaining 10 per cent being a variety of insignificant seeds.

The animal food was found by Judd to consist chiefly of weevils and other beetles, ground beetles, rose beetles, wasp-like insects, ants, caterpillars, bugs, grasshoppers, and spiders. Knight ('08) found them eating small beetles, smooth caterpillars, flies, grubs, and larvae, especially in the spring and fall, though seeds were predominant even then. Downs (1866) saw them frequently at horse droppings, probably in search of the insects which infest such matter.

Hamilton ('33) found small stoneflies (*Allocaonia recta*) in the stomachs of four out of five Tree Sparrows collected along a small stream near Ithaca, New York, in midwinter. He suggests that any warm day throughout the winter will bring thousands of transformed imagos to the vegetation surrounding such streams, and that since probably few birds would refuse them, this would account for the little flocks of sparrows, kinglets, and other birds which haunt these brushy streams.

Miss Knappen ('34) in summarizing the material in the Biological Survey files states that in the fourteen midwinter stomachs containing animal food, this constituted about one-third of all food taken, the proportions varying from 1 to 90 per cent of the total stomach content.

In form it consisted of insects and spiders as eggs, larvae, pupae, and adults. As spring advanced the animal content increased. The analysis of a May 12 specimen from North Dakota is worth recording:

Three small Coleoptera larvae.....	---
One large Carabid larvae.....	56
One large Carabid larva.....	56
Two caterpillars (one cutworm).....	30
One spider	5
One grasshopper	4
Total.....	100 per cent

The accompanying graph (Graph I), compiled from data sent to the writer by Miss Knappen, shows the progressive change through the winter season in the proportion of individuals eating animal food.

In the following tables (Tables 1 and 2) are shown all the forms upon which the Tree Sparrow has been found to feed in winter, so far as I have discovered in the literature. Unless otherwise specified the plants are listed on the authority of Judd, and the animals on the authority of the Biological Survey files.

TABLE 1. Plant matter used as food by the Tree Sparrow in winter, chiefly from Judd ('01).

GRASS SEEDS (50 per cent of vegetable diet)	MISCELLANEOUS (10 per cent of vegetable diet)
<i>Andropogon virginicus</i> L.—Beard grass.	<i>Acer rubrum</i> —Red maple flower and buds (Gentry, 1876).
<i>Aristida dichotoma</i> Michx.—Poverty grass.	<i>Alnus</i> sp.—Alder catkins (Brewster '06).
<i>Digitarium sanguinale</i> (L.) Scop.—Crab grass.	<i>Andromeda floribunda</i> Pursh.—Panicled andromeda (Thoreau '10).
<i>Eleusine indica</i> Gaertn.—Yard grass.	<i>Aster</i> sp.—Asters (Knight '08).
<i>Panicum</i> sp.—Panic grass.	"Berries" (DeKay 1844).
<i>Phleum pratense</i> L.—Timothy.	"Dried berries" (Dawson '93).
Pig grass.	<i>Betula</i> sp.—Birch (Judd '01).
<i>Poa compressa</i> L.—Wire grass.	<i>Cichorium Intybus</i> L.—Chicory (Brewster '06).
<i>Poa pratensis</i> L.—June grass.	Cultivated grain and millet, 1 per cent (Judd '01).
<i>Setaria glauca</i> (L.) Beauv.—Pigeon grass.	Cyperaceae—Sedges (Judd '01).
<i>Setaria viridis</i> (L.) Beauv.—Bottle grass.	<i>Diervilla</i> —Bush honeysuckle (Horsey '22-'24).
<i>Sporobolus neglectus</i> Nash—Sheathed rush grass.	<i>Euphorbia</i> sp.—Spurge (Judd '01).
WEED SEEDS (40 per cent of vegetable diet)	<i>Helianthus</i> sp.—Sunflower (Judd '01).
<i>Amaranthus retroflexus</i> L.—Pigweed.	<i>Hordeum jubatum</i> L.—Squirrel-tail grass (Stephens '17).
<i>Ambrosia artemisiifolia</i> L.—Ragweed.	<i>Hypericum prolificum</i> L.—Shrubby St. John's-wort (Allen '24).
<i>Chenopodium album</i> L.—Lamb's quarters.	<i>Hypericum</i> sp.—St. John's-wort (Horsey '22-'24).
<i>Polygonum aviculare</i> L.—Knot weed.	<i>Juniperus</i> sp.—Cedar berries (Warren 1890).
<i>Polygonum convolvulus</i> L.—Bind weed.	<i>Juniperus virginiana</i> and <i>communis</i> (Gentry, 1876).
<i>Polygonum lapathifolium</i> L.—Smartweed.	

Ligustrum vulgare L.—Privet berries (Rogers, corres.).	Solidago sp.—Goldenrod (Judd '01).
Lithospermum sp.—Gromwell (Judd '01).	Spiraea tomentosa L.—Hardhack (Thoreau '10).
Lonicera periclymenum (Gentry, 1876).	Stellaria media (L.) Cyrill—Chickweed (Judd '01).
Nicotiana Tabacum L.—Tobacco (Forbush '29).	Symphoricarpos racemosus Michx.—Snowberry (Blakiston, 1863).
Oxalis sp.—Wood sorrel (Judd '01).	Taraxacum officinale Weber—Dandelion (Judd '01).
Philadelphus coronarius L.—Mock orange (Horsey '22-'24).	Trifolium sp.—Clover (Doan, 1888).
Portulaca sp.—Purslane (Judd '01).	Tsuga canadensis (L.) Carr.—Hemlock scales (Thoreau '10).
Prunus pumila L.—Sand cherry (Gates '12).	Vaccinium sp.—Blueberry (Judd '01).
Rhus Toxicodendron L.—Poison ivy berries (Author).	Viburnum lentago (Gentry, 1876).
Rubus sp.—Blackberry (Judd '01).	Viola sp.—Violet (Judd '01).
Rumex Acetosella L.—Sheep sorrel (Judd '01).	Weigela—(Horsey '22-'24).

TABLE 2. Animal matter used as food by forty-five Tree Sparrows in winter. Data taken chiefly from the files of the U. S. Biological Survey.

Insect	No. and Stage	Total in %	Insect	No. and Stage	Total in %
Agrotis sp.	1 adult	5	Formica sanguinea (Gentry, 1876)	remains	
Allocaupnia recta (Hamilton, '33)	Sev. adults	tr.	Harpalus pensylvanicus	remains	
Aphodius inquinatus	1 adult	5	Harpalus compar (Gentry, 1876)	remains	
	4 adults	30	Heteroptera	1 adult	30
Aphodius sp.	6 adults	80	Hymenoptera	1 adult	1
	1 adult	50		1 adult	5
Araneida	1 adult	10	Ichneumonidae	1 adult	5
	1 adult	5	Insecta	1 adult	5
	1 adult	11		1 adult	1
	1 adult	30		1 adult	1
	2 adults	25		1 adult	5
	1 adult	50	Jassidae	1 adult	5
Blissus leucopterus	1 adult	10	Lumbricis terrestris (Gentry, 1876)	remains	
Carabidae	1 adult	5	Musca domestica (Gentry, 1876)	remains	
	1 larva	36	Lepidoptera	2 pupae	5
	2 adult	15		1 pupa	10
	1 adult	10		1 larva	40
Casnonia pennsylvanica (Gentry, 1876)	remains			indeter.	20
Chrysomelidae	1 adult	20	Noctuidae (cutworms)	1 larva	10
Coleoptera	1 adult	10		2 larvae	30
	2 adults	30		1 larva	30
	3 larvae	20	Orthoptera	eggs	20
	1 adult	5		1 adult	4
Cratonychus cinereus	remains		Pentatomidae	4 adults	45
Cratonychus pertinax (Gentry, 1876)	remains		Phytonomus nigrirostris	1 adult	tr.
Diptera	1 pupa	5	Pupa cases	12	60
Formicoidea	adults	10			
	adults	15			

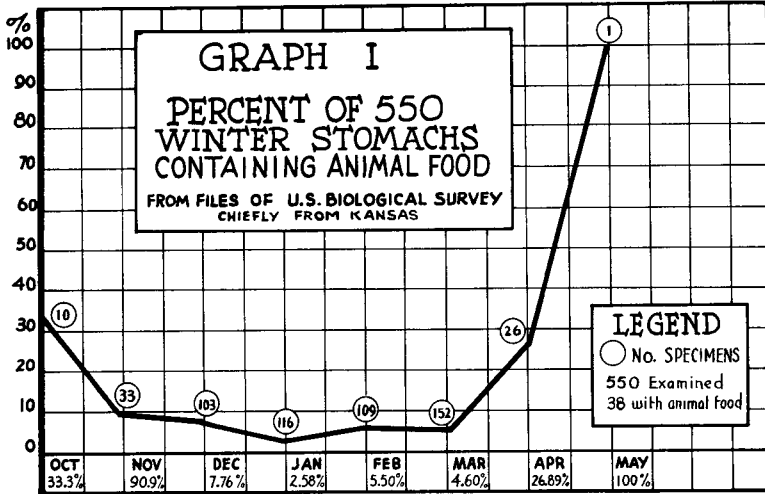


FIG. 8. Graph I, showing the percentage of animal matter in the stomachs of 550 Tree Sparrows taken during the winter season.

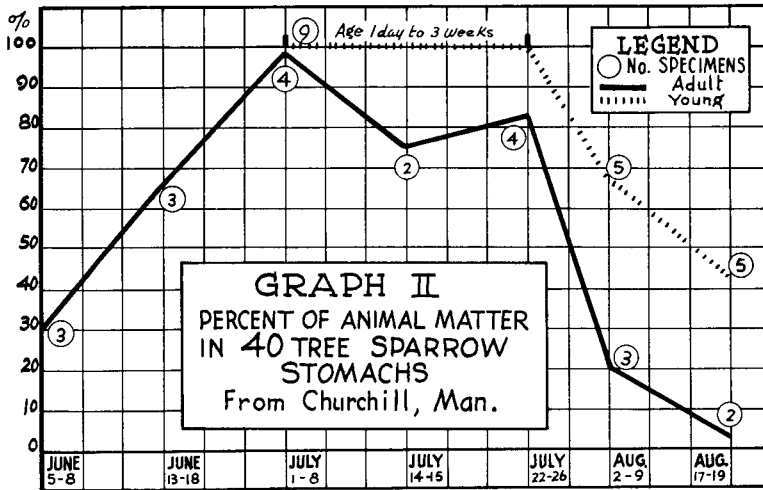


FIG. 9. Graph II, showing the percentage of animal matter in 40 Tree Sparrow stomachs taken at Churchill, Man., during the breeding season.

Insect	No. and Stage	Total in %	Insect	No. and Stage	Total in %
Rhynchophora	1 adult	30	Sitones sp.	2 adults	40
	2 adults	40	Staphylinidae	1 adult	5
	1 adult	25	Tabanis lineola	remains	
	2 adults	5	(Gentry, 1876)		
	1 adult	10	Tanymecus confertus	1 adult	tr.
Scarites subterraneus (Gentry, 1876)	remains		Totrix fumiferana (Tothill, '23)		
Schizoneura lonigera (J. A. Allen, 1868)					

Bait at Feeding Stations. Almost any fine, cracked grain or crumby material will attract the Tree Sparrows when the snow covers their natural feeding grounds. Commercial chick scratch, consisting of cracked corn and wheat and obtainable at any grain store, was used almost exclusively at the writer's automatic feeding stations at Ithaca, New York. See Figure 10. Whole grains of wheat were found to be rather large, while the sunflower seeds and raw peanuts, so popular with the chickadees and nuthatches, were not touched by the Tree Sparrows. Suet was occasionally nibbled when attached to the top of the feeder. From other banders and the literature came a list of possibilities that range from the substantial to the ridiculous:

Cracked corn	Sweepings from mills
Cracked wheat	Hayseed and chaff
Cracked oats	Ground pumpkin seed
Cracked millet	Bird seed
Cracked hemp	Weed seeds
Cracked buckwheat	Bread crumbs
Cracked nuts	Doughnuts
Peanut butter	Raw pie crust

Time of Feeding. No definite cycles of feeding could be observed, either at the banding station or with captive birds. Early morning and just before dusk usually brought larger numbers to the traps, when the birds were obviously most in need of ready food, but at other times their visits were sporadic. Some banders have also found noon a popular hour. Small groups that occasionally spent the day in the immediate vicinity of the banding station were found to drift over every half hour or so, pick about at the food scattered around the traps, and if not captured would wander away again after five or ten minutes of feeding.

Method of Feeding. Since in winter their diet consists principally of weed seeds Tree Sparrows feed largely on the ground, scratching among the dry grasses or hopping up at the bent-over weeds. They are less inclined to dig than Song Sparrows, and, where food is plentiful, will pass lightly over the more obvious patches. Judd ('01) occa-



FIG. 10. The automatic feeding station maintained by the author at Ithaca, N. Y. See page 70.



FIG. 11. The wire cage constructed by the author for the purpose of observing the feeding of the young Tree Sparrows after the nestling period. See page 78.

sionally found them bending the slender weed stalks to the ground, thereafter holding them with their feet as they picked out the seeds. Thoreau ('10) watched them reach or hop up to the fine grass from the ground. Frequently they have been observed swaying from a weed top, simultaneously filling their crops and spreading a banquet table on the snow beneath. It has often been averred that they will deliberately shake the weeds with claws or bills to dislodge the seeds, and Chubb ('29) gives us a vivid picture of the process: "One perched on a curved weed cluster, the tip of which was loosely held in the light snow, and shook it so vigorously that the end of the weed was freed with a slight jerk, scattering a little shower of seeds which were immediately picked up. Another one flew to an evening primrose between three and four feet high. With a number of quick vibrating motions the dry top was made to shiver vigorously several times. Without even attempting to pick any seeds from the pods he dropped to the snow and picked up the proceeds of his labor. It was noticed that whenever this method was used there was no attempt to gather seeds directly from the plants."

That one bird will perform this service for another, as is sometimes intimated, is unlikely. While there is frequently teamwork, it is crediting the bird with too much intelligence to assume that it is conscious. On the contrary, it was observed that they rarely come within six inches of one another, and maintain a small but definite individual feeding territory. Occasionally one encroaches upon another, and after a brief show of annoyance one or the other breaks away.

Such food as berries and alder catkins, upon which they frequently nibble, must usually be secured from the bushes on which they grow, sometimes as high as forty to fifty feet above the ground, as in the case of the poison ivy growing up the trunk of the elms near the feeding station at Ithaca, New York.

In the early summer at Churchill, Manitoba, they were seen, usually in pairs, feeding about the grassy edges of little pools, and not infrequently picking off the fresh buds of the stunted willows and birches. These were obtained either by perching on the branch or by hopping up from the ground, sometimes to a height of several inches. Later, when the young had hatched and the diet had changed to chiefly animal food, the parents were seen gleaning caterpillars and small insects among the branches and fresh leaves of the thickets immediately surrounding the nest. Occasionally one was observed darting into the air for a mosquito or moth, though these flights were short, and if the prey escaped it was not ardently pursued.

Excreta. Closely associated with food are the excreta. Normally, according to Kendeigh ('34), a bird will defecate every half hour. A captive individual retained overnight by the writer deposited during the night a whitish, almost liquid substance, which Kendeigh states is chiefly waste from the kidneys. During the following morning it was fed only chick feed, and the excrement was yellowish. Later, fine gravel and dirt were placed in the cage, and the droppings thereafter assumed the appearance noted in the field, a pearl gray with white tips. The weight of an excrement sac averaged .5 to .6 grams.

SUMMER FOOD

Nature of the Food. The transition from a vegetable to an animal diet begins to be noted in the Tree Sparrow during the spring migration, in late April and May. Upon its arrival at its northern breeding grounds, however, it finds conditions nearer winter than summer, and seeds continue to form the greater part of its diet until past the middle of June, when insects first become active. By August the brief nesting season is over, and the proportion of seeds consumed again approaches the 98 per cent maintained during the winter.

Young birds up to three or four weeks are fed almost 100 per cent animal matter, with a trace of Rosaceae leaves for their greens. When they begin to forage for themselves about the first day of August, seeds and fruit are taken to a limited extent, their proportions gradually increasing. The last stomachs examined, however, on August 19 still showed a considerably larger proportion of animal food than did the adults of the same date. These seasonal fluctuations are depicted on the accompanying graph (Graph II).

A trace of gravel is first found in young birds of three days. At five days and thereafter it may compose from 10 to 15 per cent of the stomach content. In August when they are feeding independently the gravel content is increased to adult proportions, ranging from 15 to 70 per cent, the majority about 35 per cent.

Lists of the plant and animal forms recorded for the Tree Sparrow in summer are given below in Tables 3 and 4. In summarizing the individual contents it was noted that the outstanding vegetable item was the seeds of the genus *Carex*. These were found throughout the summer in all adults and juvenals that contained any vegetable matter, though they were not found in the nestlings. At least six species of *Carex* were distinguishable in a single birds. In late July and August seeds of the crowberry (*Empetrum nigrum* L.), cranberry (*Vaccinium Vitis-Idaea* L.), and bulblets of the alpine knotweed (*Polygonum viviparum* L.) became an important part of the menu. Grass

seeds, which form such a large proportion of the winter food, were strikingly scant in the summer diet, being found in only one individual in late August. Besides seeds, plant matter was found in the form of soft bits of wood or chips, fibers, leaf fragments, galls, and unidentifiable debris.

The insects represent a large number of families and genera, among which the following groups are most conspicuous: Arachnida, Coleoptera (especially *Donacia*), Ichneumonidae, Lepidoptera, Nematinae, and Trichoptera. Though in many cases a form is found only in a single individual, it is probable that the same species were eaten by young and old alike, since this was the case wherever there were several records. The adult stage predominated, but eggs, larvae, and pupae were also taken. In observations at the nest the adult birds came repeatedly with mouths overflowing with small green and brown caterpillars, as well as flies, mosquitoes, etc.

TABLE 3. Showing plant matter eaten by thirty-nine Tree Sparrows in summer at Churchill, Manitoba, the identifications being made by L. H. Kelso, of the U. S. Biological Survey.

Plant Food	Stage	Date	Age of Bird
<i>Alnus</i> sp.	Seeds	Early June	Adult
<i>Carex</i> sp.	Seeds	All season	Adults and juv.
<i>Carex incurva</i>	Seeds	End of June	Adult
<i>Empetrum nigrum</i>	Seeds	July-August	9-day young, juv., and adults
<i>Luzula spicata</i>	Seeds	Early June	Adult
<i>Luzula saltuensis</i>	Seeds	August	Juvenal
<i>Poa</i> sp.	Seeds	Late August	Juvenal
<i>Potentilla</i> sp.	Seeds	Early June	Adult
<i>Polygonum viviparum</i>	Bulblets	Late July and Aug.	Adult
Rosaceae	Leaf fragments	July	3- and 6-day young
<i>Rubus arcticus</i>	Seeds	Late August	Adult
<i>Vaccinium Vitis-Idaea</i>	Seeds	All season	Juvenal and adult
<i>Vaccinium Vitis-Idaea</i>	Fruit	August	Juvenal
<i>Vaccinium</i> sp.	Seeds	All season	Juvenal and adult

TABLE 4. Showing the animal matter eaten by Thirty-nine Tree Sparrows in summer at Churchill, Manitoba, the identifications being made by L. H. Kelso, of the U. S. Biological Survey.

Animal Food	Stage	Age of Bird
Amblytelinae	Ad.	Adult, Juvenal
Amphipoda	Ad.	Adult
<i>Anthoca</i> sp.	Ad.	Juvenal
Anthomyiidae	Ad.	Adult, Juvenal
<i>Apanteles</i> sp.	Coc.	Adult
Arachnida	Ad.	Adult, Juvenal, Young
Bethylidae	Ad.	Adult

Animal Food	Stage	Age of Bird
Calimocne sp.	Ad.	Juvenal
Camponotus h. pennsylvanicus	Ad.	Adult
Cantharidae	Ad.	Adult, Young
Cantharus sp.	Ad.	Young
Carabus sp.	Ad.	Young
Chalcididae	Ad.	Adult, Juvenal
Chelonus sp.	Ad.	Adult
Chironomidae	Ad.	Adult, Young
Chironomus sp.	Ad.	Adult, Juvenal
Chrysotus sp.	Ad.	Young
Cicadellidae	Ad.	Adult
Coleoptera	Ad.	Adult, Juvenal, Young
Corixidae	Ad.	Adult
Cre mastinae	Ad.	Young
Curculionidae	Ad.	Adult, Juvenal
Dolerus sp.	Ad.	Adult, Juvenal
Dolichopodidae	Ad.	Adult
Dolichopus sp.	Ad.	Juvenal
Donacia sp.	Ad.	Adult, Juvenal, Young
Drymidae	Ad.	Juvenal
Dytiscidae	Ad.	Adult
Elateridae	Ad.	Young
Empididae	Ad.	Adult
Ephemeridae	Ad.	Young
Formica sp.	Ad.	Adult
Formicidae	Ad.	Adult
Geometridae	Ad., Lar.	Juvenal, Young
Habropelte sp.	Ad.	Adult
Helina sp.	Ad.	Adult
Hemite lini	Ad.	Adult
Hydroporus sp.	Ad.	Adult
Hylemyia sp.	Ad.	Young
Hymenoptera	Ad.	Adult, Juvenal, Young
Ichneumonidae	Ad.	Adult, Juvenal, Young
Insecta (indet.)	Ad., Lar., Eggs	Adult, Juvenal, Young
Jassidae	Ad.	Adult
Lasius sp.	Ad.	Young
Lepidoptera (indet.)	Ad., Lar., Eggs	Adult, Young
Leptidae	Ad.	Young
Leptothorax sp.	Ad.	Adult, Juvenal
Limnobiidae	Ad.	Young
Metriocnemus sp.	Ad.	Young
Microlepidoptera	Ad.	Young
Mollusk shells	Debris	Adult, Young
Myrica rubra	Ad.	Adult, Juvenal
Myrica sp.	Ad.	Juvenal
Nematinae	Ad., Lar.	Adult, Juvenal, Young
Noctuidae	Ad., Lar.	Adult, Young
Pemphredon sp.	Ad.	Juvenal
Perlidae	Ad.	Young
Phalangida	Ad.	Adult
Potania sp.	Ad.	Young
Psen sp.	Ad.	Adult
Psocidae	Ad.	Adult, Juvenal, Young
Rhamphomyia sp.	Ad.	Adult
Rhyacophila sp.	Ad.	Juvenal

Animal Food	Stage	Age of Bird
Scatophaga sp.	Ad.	Juvenal
Serphidae	Ad.	Adult, Juvenal, Young
Serphoidea	Ad.	Juvenal
Serphus sp.	Ad.	Juvenal
Simulium sp.	Ad.	Adult, Juvenal
Sphaerium sp.	Shell fragm.	Adult
Spilogona sp.	Ad.	Adult
Spitzozona sp.	Ad.	Adult
Tabanus sp.	Ad., Eggs	Adult, Juvenal
Tanypidae	Ad.	Young
Tenthredinidae	Ad.	Adult
Tineidae	Ad.	Juvenal
Trichoptera	Ad.	Adult, Juvenal, Young
Trioxa sp.	Ad.	Adult
Vipionidae	Ad.	Adult, Juvenal

Feeding of the Young. The following observations were made at Churchill, Manitoba, in 1933 and 1934. With the hatching of the young birds begin the duties of the male, for from the start he shares the responsibility of feeding almost equally with his mate; and during the last days in the nest he almost doubles her contribution. For a time this does not seriously affect his singing, as the young do not need to be fed more than three or four times an hour. Even when duties have become more pressing he usually flies from the nest to some conspicuous perch and sings a few hasty bars before seeking another caterpillar. But by the end of the nestling period the territories are on the whole rather quiet.

The feeding itself is not generally accompanied by any voice, though if the female has been brooding when the male comes she usually leaves with a low twittering. Sometimes she does not leave when he comes, but simply raises herself on the rim of the nest. On several occasions he was seen to pass food to her, which she fed to the young. Twice she apparently swallowed it herself, though why he should feed her is not clear, as she left the nest frequently. At times the male stood quietly on the rim after feeding the young, once as long as seven minutes while his mate was absent. Sometimes the pair came together to the nest and stood fondly over their family, peering down at them, uttering low cooing notes, and touching one another's bills in a manner that is not explainable as any mere instinct to propagate the species.

In the smaller territories the caterpillars, mosquitoes, etc., which make up the bird's diet, are gleaned from the immediate neighborhood of the nest, though in the more open territory both adults were observed to travel frequently to a ditch which was 450 feet distant. At first the material is partially masticated, and the pulpy mass is jammed

far down the young bird's throat. Several birds may be fed at a single visit. Later great billfulls of more or less entire insects are brought to the nest. But however great the quantity, it seems scarcely enough to satisfy one or two gaping mouths. The enormity of the old birds' task was realized when a male collected in the field was found to hold in its bill forty-one adult insects, four larvae, and fragments of others, all captured, presumably, within three or four minutes.

While the amount of feeding per hour advances conspicuously after the first few days, it maintains thereafter a more or less constant rate of about sixteen feedings per hour. No particular variation was noted at different hours of the day. These facts, with the relative share of the sexes, are indicated in the following table (Table 5) of representative observation periods at different stages of nestling life.

TABLE 5. Showing seasonal and diurnal variation in feeding periods of nestling Tree Sparrows, observations being made at Churchill, Manitoba.

	First Day	Early Morning of 6 days	Noon of 7 days	Evening of 9 days
Feedings per hour:				
Male	3	8	6	9
Female	4	10	10	5
Intervals between feedings.				
Average	8 min.	3 min.	4 min	4.5 min.
Maximum	25	10	8	10
Minimum	1±	1±	1±	1±

Although during June and July there is almost full daylight from 2:00 A. M. until 10:00 P. M. in the North, Tree Sparrows do not begin feeding until 3:15, and cease shortly before 9:00, making a working day of 17.75 hours. With this in mind, it may then be computed that, at an average of sixteen feedings per hour, some 275 feedings are made daily, to be divided among the four or five young. It is interesting to compare with this the parental care given by that closely related species of more temperate latitudes, the Chipping Sparrow (Weed, 1898). Averaging twelve visits per hour, to be divided among only three birds, each individual young of this species seems to be fed as many times per hour as do individual young of the Tree Sparrow. But here the working day begins at 5:00 A. M., and closes at 7:30 P. M., with only 14.50 hours in which to work. Other factors doubtless enter into the question, but it is strongly suggestive that these three extra hours a day make it possible for young Tree Sparrows (at nine and a half days) to leave the nest two days earlier than Chipping

Sparrows (at eleven and a half days). Thus the longer hours of daylight compensate in a measure for the briefness of the nesting season.

In order to observe feeding habits of young after the nestling period, a wire cage 12x8x12 inches was placed over one nest and the adjacent shrubbery (Fig. 11). Through the quarter-inch meshes of this cage the adult birds soon learned to feed the young in, it is believed, a perfectly normal manner. Fledglings over two weeks old, both at this 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 three had escaped). On this day the young bird was first observed to pick about on the cage floor, and when a bread crust was proffered him from the lunchbox he nibbled at it with interest. While it was not possible to follow this individual further, it is probable that parental care ended shortly thereafter. During August an occasional adult observed in the field could be seen with a bill full of food, though the young at this age were able to fly freely, and presumably could forage for themselves.

ECONOMIC IMPORTANCE

Because of the vast quantities of obnoxious weed seeds which the Tree Sparrows consume during the winter sojourn in the States, much has been made of the economic value of this species. It was estimated by the Department of Agriculture that the sparrow tribe—of which the Tree Sparrow is one of the most abundant species—saved the farmer \$90,000,000 a year. Judd ('01) described the thoroughness with which they clean up a patch before moving on. On an area eighteen inches square in a weedy ditch where they had been feeding, he found 1,130 half seeds and only two whole ones, and only half a dozen seeds left in the whole field, which, he says, was devoid of weeds the next year.

Since Judd's time, however, there has been some doubt of the value of the sparrow tribe. Certainly Judd overestimated the thoroughness of their gleanings, else they could not return year after year to the same areas, nor would they wander so freely over their little territories, only to cover the same ground another day. And certainly there is no scarcity of weeds in the country regardless of the great hordes of these birds. The reproductive capacities of the plants easily outdo the eating capacities of the sparrows, and there will probably always be sufficient weeds left to bother the farmer and propagate the

species. Indeed, if there were no sparrows, the overcrowding of the plants themselves would soon establish a balance.

But if not actually beneficial, these birds are at least harmless. They occasionally sample grain, but to no appreciable extent. The charge has been made that they distribute rather than destroy the seeds, but this accusation has been refuted by Judd's study. He found that in the thousands of stomachs containing ragweed, there never was an unbroken seed; the outer ribbed shell of the akene was cracked and not swallowed, but parts of the true seed coat in the shape of angular fragments three to five millimeters long, dirty gray externally and greenish-white internally, were usually found during stomach examination. Uncrushed cotyledons were seldom found, the gizzard being filled with a pasty mass of endosperm with scarcely a dozen whole seeds, which seems to preclude the possibility of subsequent germination. This is also held for pigeon grass, crab grass, pigweed, lamb's quarters, sunflower, the polygonums, and most other seeds, even including the hard drupes of the blackberry. With the harder, smaller seeds the possibility of germination is better, but, Judd points out, the birds take seeds for food, and it seems probable that such use would prevent the evacuation of any but a most insignificant portion of the food taken.

In the summer the Tree Sparrow is of no economic significance whatever, as it nests beyond the reaches of civilization. But whether or not we can evaluate the species in cold dollars and cents, it will always be welcome as a gentle, cheerful little creature of our winter fields and gardens.

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EAST LANSING, MICH.

A STUDY OF A VIRGINIA RAIL AND SORA RAIL AT THEIR NESTS¹

BY HENRY MOUSLEY

Working over limited areas of ground year after year certainly has its advantages, since one gets to know where certain birds make their homes, and provided nothing happens to them during the winter and at migration times, one can usually count on finding them again not far from the old haunts year after year, thus providing for a renewal of acquaintance with their home life at points where, from some cause or another it may have been broken off.

This has been so in my case with the Sora Rail (*Porzana carolina*) and the Virginia Rail (*Rallus limicola*), pairs of which have nested for some years in two little cattail marshes (one pair in each), but I was never able to find their nests in the making, and obtain their incubation period. This period in the case of the former is said by Mr. Bent² to be fourteen days, while in the case of the latter the exact length has not been recorded, but is known to be not less than fifteen days. In 1935 I discovered the nest of the Virginia Rail after the young had left because of its location in the same marsh with the nest

¹Read by title at the American Ornithologists' Union at Pittsburgh, Pa., October 21, 1936.

²Life History of North American Marsh Birds, Smithsonian Institution, U. S. Nat. Mus. Bull., 135, 1926.