THE FOOD OF ORCHARD BIRDS WITH SPECIAL REFERENCE TO THE PEAR PSYLLA

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T. T. ODELL

ABSTRACT

Experiments are described which were conducted during the years 1923 to 1926 with the object of determining the value of orchard birds as destroyers of the pear psylla (Psyllia pyricola) and the possibility of increasing the number of insectiveous birds in the orchard.

Censuses of the birds living in the orchard or visiting it were made at frequent intervals. Some of the birds were collected and examinations made of the stomach contents. Nesting boxes were provided and two feeding stations were kept stocked with suet, sunflower seeds, and grain.

This work showed that the birds which eat psyllas in large numbers are the chickadee, the kinglets, and the red-breasted nuthatch. None of these birds will live in an orchard, such as the one in which these observations were made, during the summer. But the number of psyllas taken was large during the winter. This is the time when one psylla less means many hundreds less during the next summer.

The effort to increase the number of insectiveous birds nesting in the orchard was successful only in the case of the bluebird and the flicker. Neither of these birds is considered particularly useful from the point of view of the orchardist, their chief food being ground beetles and ants, respectively.

INTRODUCTION

Altho the statement has been made from time to time during the last 40 years by entomologists and ornithologists that without the birds agriculture would be impossible, yet not only are birds neglected

1Assistant Professor in Biology, Hobart College, Geneva, N. Y. Acknowledgment is made to P. J. Parrott, Entomologist of this Station, who suggested the problem to the author; to Prof. E. H. Eaton of Hobart College who aided in erecting the bird boxes and in making bird counts; and to the Station authorities for supplying necessary labor, a truck, bird food, and other materials. Much assistance was also rendered by members of the Departments of Ornithology, Entomology, and Botany at Cornell University.
but often it seems that everything is done to prevent them from aiding to keep in check the insect hordes which threaten agriculture.

In 1916, Powers stated that the annual loss to the farming interests due to insects is from $800,000,000 to $1,000,000,000. Every year new pests are coming to the front to make agriculture and horticulture more difficult and less profitable. If it were not for constant vigilance and unceasing effort, these pests would make it impossible to raise enough food for the population of this country. He also stated that an eminent French scientist estimates that, if all the insectivorous birds were killed, the earth would become uninhabitable in nine years; and that in spite of all that man could do.

In clearing the wilderness and turning all available land to agriculture and horticulture man destroyed or is destroying the natural habitat of many species of birds. These birds, which in the natural order kept insects in check, have become reduced in numbers. Also, many insects, new to this country, have been imported with seeds, nursery stock, and farm products. This class of insects usually becomes the most difficult one to control because in most cases they are free from the natural enemies of their native land. The pear psylla is one of this group. (See Plate I). After a time it not infrequently happens that parasites or bird enemies develop to help check the ravages of these imported pests. The psylla is undoubtedly preyed upon by a number of natural agents, but with respect to the character and scope of their activities, especially of birds, there is little definite knowledge.

PROCEDURE

With reference to the proposed study of the influence of birds on the psylla population of pear orchards, it was planned to work out this problem along the following lines. First, to make a census of the birds which frequented the orchard during the winter months. That chickadees and white-breasted nuthatches fed on psyllas was known, but there was no knowledge relative to the feeding habits of other species of birds. Second, to make a survey of the orchard to determine how many nesting places were available for birds which nest in holes or boxes. The next step was to put out food to attract more winter birds, and nesting boxes to increase the number of summer birds which would probably nest in boxes. It was hoped that by these methods the number of chickadees, downy woodpeckers, and white-

breasted nuthatches could be increased in the winter. It was hoped, too, that these three species could be persuaded to nest in the orchard or its environs, as they were the species in which the greatest hope was placed as psylla eaters. Also, it was thought desirable to persuade flickers to nest in the orchard because of the large part which ants play in their diet in view of the possibility that some such relation might exist between ants and psyllas as exists between ants and some aphids.

The last, but perhaps most important step, was to keep as many records as possible of the birds of the orchard, to observe what food they were taking, and to collect those which appeared to be eating psyllas and make examinations of stomach contents. Also, a study of the food of the orchard birds was to be made from the literature of the subject. In this way it was hoped to determine which birds eat psyllas and to increase the number of individuals of these species in the orchard.

Chickadees and white-breasted nuthatches had been observed feeding on the twigs and trunks of pear trees which were known to harbor a large number of psyllas. These observations led to the belief that these birds were eating the psyllas. A chickadee was collected and an examination of its stomach showed that this belief was well grounded. It was suggested to the author that he take up the whole problem of what birds eat pear psyllas and in what quantities and what seasons they are taken. It was also suggested that an effort be made to determine whether or not the number of birds which eat psyllas could be increased in the orchard.

It was decided to carry on the investigation in the pear orchards of the McKay brothers at Geneva, if permission could be had from the owners. They not only gave their consent but offered any assistance which they might be able to render. Accordingly, the work was begun in March 1923.

THE ORCHARD

The investigation was undertaken in one of the pear plantings of the McKay brothers at Geneva. The orchard (Fig. 1) in which this study has been carried on is located on Preemption Road just west of the city. The ground in the orchard rises gently from east to west. On the east it is bounded for its entire length by a hedge of white cedars about 30 feet tall. For most of its length this hedge is so thick that it is with difficulty that one can pass thru it. On the south the orchard is bounded by open fields and a small clump of basket willows. Part of the south and west boundary was formed by a poor peach
orchard until the fall of 1925 when this was removed. The west boundary is a large open pasture which slopes abruptly from the orchard. The north side is flanked by a mixed growth of hardwoods, aspens, maples, and two rows of small evergreens for about two-thirds of its length. There is considerable undergrowth in this small wooded

**FIG. 1.—PLAN OF MCKAY ORCHARD, SHOWING LOCATION OF FEEDING STATIONS AND NESTING BOXES.**
area. The remainder of the north side is bounded by a tilled field on which corn was raised two summers and beans a third. To the north of the wooded area is a continuation of the pasture which touches the orchard on the west. A small stream runs thru this pasture at varying distances from the orchard.

**BIRD CENSUS OF McKay ORCHARD**

Below is given a brief summary of 55 trips made to the orchard in an attempt to take a census of the bird population. This is only a part of the trips made. A few were not recorded and the note-book containing the records for the fall of 1924 has been lost.

**Table 1.—Summary of Bird Census of McKay Orchard, 1923 to 1926.**

<table>
<thead>
<tr>
<th>Name of species</th>
<th>Times Recorded</th>
<th>Number of Individuals Recorded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screech owl</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Hairy woodpecker</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Downy woodpecker</td>
<td>14</td>
<td>21</td>
</tr>
<tr>
<td>Northern flicker</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Phoebe</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Wood pewee</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Baltimore oriole</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Bronzed grackle</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>American goldfinch</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>Chipping Sparrow</td>
<td>9</td>
<td>30</td>
</tr>
<tr>
<td>Junco</td>
<td>13</td>
<td>1,300</td>
</tr>
<tr>
<td>Song Sparrow</td>
<td>12</td>
<td>76</td>
</tr>
<tr>
<td>Red-eyed vireo</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Yellow warbler</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Myrtle warbler</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td>Northern yellowthroat</td>
<td>2</td>
<td>7</td>
</tr>
<tr>
<td>White-breasted nuthatch</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>Red-breasted nuthatch</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Chickadee</td>
<td>22</td>
<td>200 to 250</td>
</tr>
<tr>
<td>Golden-crowned kinglet</td>
<td>4</td>
<td>102</td>
</tr>
<tr>
<td>Ruby-crowned kinglet</td>
<td>5</td>
<td>8 to 11</td>
</tr>
<tr>
<td>Robin</td>
<td>11</td>
<td>75 to 85</td>
</tr>
<tr>
<td>Bluebird</td>
<td>15</td>
<td>45 to 55</td>
</tr>
</tbody>
</table>

There are very few summer records because of the author's absence from Geneva most of the time during the summer. For this reason such birds as the yellowthroat, vireo, oriole, and pewee are not credited with large enough numbers in either column. They were overlooked until the last summer of the author's work. Of course these birds did not live in the orchard. But they lived in close proximity to it. The record for the other birds is fairly accurate and gives one some idea of their relative abundance. In the case of the flicker it
was observed that, altho a pair had a nest with young in it during the summer of 1926, the author never saw the old birds on his trips to the orchard unless he waited especially to see them. Two screech owls probably spent most of the time during two winters in various flicker boxes in the orchard, but they were never seen except when a call was made upon all of the boxes which they frequented.

The records show that the number of chickadees was larger after the food was put out for them than it had been before. It is true that during the winter of 1924 they seemed especially common everywhere. But during the winter of 1925–26 they did not seem especially common in general, yet there were four to six times as many chickadees seen on most trips as were seen on any trip before feeding was begun.

The number of nuthatches remained about the same for the whole time. These and the downy woodpecker were the two birds which it had been hoped would increase in number to the greatest extent, but neither of them seemed to care enough for the food put out to come to the orchard in larger numbers than they had before.

The junco, grackle, and myrtle warbler form another class. These birds were not recorded many times, but when they did occur they were present in fairly large numbers. They apparently came to the orchard for food which was plentiful at the time. None of these birds nested in the orchard.

Tree sparrows were abundant in the orchard at various times during the winter months, but they were always engaged in eating...
weed seeds. So far as the observations of the author went, they never fed in the trees, therefore a specimen was not collected for examination of its stomach contents. They are not a factor in the control of the pear psylla.

From these observations it probably would be found upon examination of stomach contents that the following birds, in the order named, eat the pear psylla in considerable numbers: Chickadees, nuthatches, kinglets, myrtle warblers, song sparrows, and chipping sparrows.

The food study was limited to those birds which were found by observation to live and feed in this pear orchard or in its immediate vicinity. Birds which were seen in the orchard upon only a few occasions during the three and one-half seasons which are covered by the records were not given consideration.

FOOD OF ORCHARD BIRDS
WHAT THE LITERATURE REVEALED

A survey of the literature leads to the conclusion that the birds of the McKay orchard may be classed as those which are beneficial on account of the seeds which they eat; those which are beneficial because of the insects which they take; and those which are either neutral or harmful, depending upon the crops which are of principal importance. Among the insect eaters are several birds which, judged from the fact that they eat closely related forms, would probably eat the pear psylla whenever it was abundant. Of course these groups are not to be considered as definite. There is overlapping in some cases because the typical seed-eating birds take insects during the summer and the typical insect-eating birds often vary their diet by taking a few seeds or some fruit. The birds of each category are listed below.

Among the birds which are most beneficial from the point of view of the number of seeds eaten are the goldfinch, chipping sparrow, junco, and song sparrow. These birds aid in keeping the orchard free of weeds.

The catbird and the robin are of some benefit to the farmer who is interested primarily in raising apples and pears. But they are undoubtedly neutral or harmful where small fruits or sweet cherries are the principal crops.

The bronzed grackle helps to keep some orchard insects in check, but where the orchardist is interested in grain as well as fruit this species might prove more detrimental than beneficial, especially if it were present in large numbers.
The birds which are beneficial as general insect eaters and which never do any serious damage are as follows: Hairy woodpecker, downy woodpecker, northern flicker, Baltimore oriole, goldfinch, chipping sparrow, wood pewee, phoebe, song sparrow, vireos, warblers, house wrens, nuthatches, kinglets, chickadee, and bluebird. The oriole is the only doubtful bird on this list. This species is charged with depredations on fruit, but the charges are not well substantiated.

Where pear psyllas were abundant, the following birds would probably eat them: Hairy woodpecker, downy woodpecker, goldfinch, chipping sparrow, song sparrow, Baltimore oriole, vireos, warblers, house wren, nuthatches, kinglets, and chickadee. The wood pewee and the phoebe might also be classed here, but their habit of taking most of their food on the wing leads to the belief that they would ordinarily eat few psyllas. This last group of birds include those which stomach examinations have shown eat plant lice, scale insects, jumping plant lice, and other small Hemiptera.

The Biological Survey could furnish the author with only two references to birds eating pear psyllas in all the literature dealing with the food of birds. These references are quoted below:

"Birds have been seen picking the adult psyllas out of their winter retreats in Niagara county; so industrious were the birds that but few psyllas were left in some trees."\(^3\)

"A prominent grower of pears in New York reported to us that he has lost many of his pear crops, amounting to thousands of bushels, by this pest, and in the fall, as it was present in great numbers on the trunks of the trees, it appeared that it would pass the winter there and destroy his crops again next year. However, the white-breasted nuthatches came to the orchard in numbers, and he encouraged them to remain by fastening pieces of fat meat in his trees and protecting them from molestation. The nuthatches remained and fed on the pest all winter and cleaned up the trees so effectively that he could scarcely find any of the insects in the spring."\(^4\)

The author's study of the literature on the food of birds and on the pear psylla brought no more references to light. Apparently, when pear psyllas were present in the stomachs of birds which had been examined they were identified only as to family. At least, they have been recorded, if at all, only under the general head of Psyllidae or


PLATE I.—THE PEAR PSYLLA.
1, Nymphs, stages 1 to 3; 2, nymphs, stages 4 and 5; 3, eggs; 4, winter adult.
(All figures much enlarged.)
Plate II.—Types of Wooden Boxes Used in McKay Orchard.

Above, Paper Box Used in McKay Orchard.
jumping plant lice. This does not seem strange when the condition in
which these insects are found in the stomachs is taken into considera-
tion.

WHAT STOMACH EXAMINATIONS REVEALED

All of the collecting was done with the purpose of verifying observa-
tions. There seemed to be no need to make a large collection of birds,
since so many stomachs have been examined by the Biological Survey
workers and state ornithologists and entomologists. It seemed neces-
sary, however, to collect at least one specimen of each bird which was
thought from a study of the literature might eat psyllas. It was also
decided to collect any bird which was observed feeding where it seemed
probable that it was eating psyllas. If too few specimens were col-
lected, it was because the author did not wish to reduce the number of
insectiverous birds unnecessarily. In the case of the downy wood-
pecker so few were observed in the orchards visited that to have col-
lected one would have taken the only specimen which made visits to
the orchard.

Below is given a list of the birds collected with a summary of the
stomach contents of each.

Northern flicker collected April 26, 1925.—The entire stomach con-
tents consisted of ants.

Wood pewee, female, collected July 8, 1926.—The animal food made
up practically 100 per cent of the stomach contents. Most of the food
was so well digested that identification was difficult. The parts
which could be identified consisted of beetles and flies and a few wings
of Hymenoptera.

Slate-colored junco collected October 11, 1924.—Vegetable matter
constituted 100 per cent of the food. About 50 per cent of the con-
tents of the stomach was too well digested to permit of identification.
The remainder consisted of seeds, some whole and some partially
digested. Panicum capillare L. made up 50 per cent. Rumex sp. was
represented by a few seeds. There was one seed of Amaranthus
retriflexus and some seeds of the family Caryophyllaceae.

Song sparrow collected July 9, 1926.—Animal matter constituted 95
per cent of the food. The remainder was composed of a few parts of
seeds. The animal food was made up of parts of beetles and three
wings of an Acalyptrate muscid. What seemed remarkable was that
the stomach contained no mineral matter.
Myrtle warbler, immature, collected September 30, 1925.—Insect food made up 100 per cent of the stomach contents. Seventy-five per cent was unidentifiable. Parts of beetles made up 20 per cent; psyllas 5 per cent. There were 4 whole adult psyllas, 14 nymphs, and 2 extra forewings.

Northern yellowthroat collected June 28, 1925.—The animal matter constituted all of the identifiable material. There were no psyllas or psylla parts. The hard parts were pieces of beetles and a few wings of Hemiptera.

White-breasted nuthatch collected October 12, 1923.—Spiders constituted 2 per cent of the contents; eggs 2 per cent; psyllas 1 per cent; beetles 5 per cent; and unidentifiable material 90 per cent.

White-breasted nuthatch collected January 7, 1925.—The whole stomach contents consisted of what might have been the segments of some Myriapods. The identification is uncertain.

Red-breasted nuthatch collected January 4, 1924.—In this stomach was a small amount of grit. The rest of the contents was made up of unidentifiable material 50 per cent; pear psyllas 22 per cent; bud scales 21 per cent; Tingitid wings 3 per cent; and beetle parts 1 per cent.

Chickadee collected November 30, 1923.—Two were collected and the stomach contents put into one vial. It was composed entirely of animal matter. Unidentifiable matter made up 50 per cent of the whole. The remainder consisted of 25 per cent pear psylla wings (about 400 forewings); Hemiptera egg cases 10 per cent; spiders 8 per cent; beetles 5 per cent; and grubs 2 per cent.

Chickadee collected December 31, 1925.—Animal matter composed 100 per cent of the contents. The food was grouped as follows: Unidentifiable 45 per cent; pear psyllas 45 per cent (250 forewings and 3 whole adults); Hemiptera eggs 8 per cent; and flies 2 per cent.

Golden-crowned kinglet collected April 30, 1926.—One hundred per cent of the stomach contents was animal matter. Practically all of it was composed of the forewings and other hard parts of the pear psylla. There were 300 forewings of this insect.

Golden-crowned kinglet collected April 8, 1925.—Animal food made up 90 per cent or more of the stomach contents. The rest was some starchy vegetable matter. Practically all of the animal matter consisted of pear psyllas. There were 193 forewings and 7 whole psyllas.

Golden-crowned kinglet collected April 15, 1924.—The whole stomach contents appeared to be made up of animal matter. The part which could be identified consisted of 175 psylla forewings and two wings of an Acalyptrate muscid.
Tree sparrow collected November 7, 1925.—There was very little in this stomach. What was present consisted of some grit and a small amount of unidentifiable matter.

An effort was made to determine the status of the screech owls which wintered and nested in the orchard. Each time that the nesting boxes were cleaned all litter and pellets left by the owls were saved and examined.

From the nesting box where the young owls were raised in the summer of 1926 were obtained one wilson warbler and the feathers of one yellow warbler, one northern yellowthroat, one goldfinch, one robin, and two song sparrows.

An examination of the feathers and pellets collected during the fall, winter, and spring yielded the following: Five whole skulls of the short-tailed shrew (Bia r i n a  b r e v i c a u d a ); 12 right mandibles, 9 left mandibles, and a few pieces of skull of the deer mouse ( P e r o m y s c u s  l e u c o p u s ); 21 skulls, 27 right mandibles, and 21 left mandibles of the meadow mouse ( M i c r o t u s  p e n n s y l v a n i c u s ); a few bones of a bird about the size of a robin; some pieces of crayfish exoskeleton; a few bones of a frog; and feathers of a snow bunting and of a prairie-horned lark.

SUMMARY OF FOOD STUDIES

A study of the stomach contents of the chickadees collected proved that the author's observations to the effect that this bird eats pear psyllas in large numbers during the winter were correct. The average number of psyllas present in the stomachs of the three birds collected was 108 per bird.

As was expected, after observing them feeding in the orchard, all of the stomachs of the golden-crowned kinglets contained pear psyllas. The highest number in one stomach was 150 psyllas and the average was about 80 per stomach.

The red-breasted nuthatch had eaten psyllas to the extent of almost one-fourth of its stomach contents. If this bird were not so uncommon in the vicinity of Geneva it might be of great benefit to the horticulturist in keeping down the number of psyllas.

The white-breasted nuthatches, which it was thought would pick up many psyllas in their search for food in the crevices of the bark of the tree trunks, made a poor showing upon examination of their stomachs. The average number of psyllas for the two specimens collected was only 0.5 per cent per stomach. From this it appears that little help can be expected from this bird.
The other bird which had eaten psyllas was the myrtle warbler. In the stomach of the one collected they made up 5 per cent of the stomach contents.

From this study it seems probable that if any help is to be had from the birds in keeping the pear psylla in check the chief reliance must be placed upon the chickadee. These birds not only take the largest number of psyllas, but they are present in the orchard for the longest period of time during each year. The kinglets, on the other hand, are more numerous during the short time when they frequent the orchard. The red-breasted nuthatch, as has been stated before, is an uncommon species. In any winter when they happen to wander into an orchard infested with the pear psylla they will do valuable work in decreasing the number of the pest. Too little work has been done on the warblers to make any statement as to their value in connection with the pear psylla. The work of others in examining the stomachs of warblers leads one to suppose that they would eat the pear psylla. They may play a more important part in the control of this pest than has been intimated. At present there is no means known to attract them to a particular orchard. During migration they did not seem to recognize the McKay orchard as a good feeding place at any time when observations were being made in the orchard. It is evident, however, that the myrtle warbler at least would eat psyllas if they were found.

Taking into consideration only the psyllas found in the stomachs examined, it does not seem like a very large number. McAtee,\textsuperscript{5} however, figures that the stomach contents can be multiplied by 5 or 6 to get the daily consumption of food when a bird has been living on an average mixed diet. He states, too, that when soft-bodied insects, such as aphids, have been taken almost entirely the multiplier may be safely raised to 10. It seems as tho the pear psylla could be classed with the aphids as a quickly digested food. On this basis the average number of psyllas accounted for per day by one chickadee, when the psyllas are active, would be 1,080. A dozen chickadees seems a conservative estimate of the number which lived and fed in the orchard after operations were commenced for attracting them. Therefore, the number of psyllas accounted for by these chickadees on any day when they were active would be 12,960. The consumption of the golden-crowned kinglets figured in the same way would be 20,000 per day. During the stay of this species the psyllas are active.

It has been demonstrated that the number of chickadees can be increased in the orchard. At present there is no way known of attracting migrating birds to the orchard. The kinglets and the warblers are in this class. Therefore, the main hope is in the chickadee. It seems probable that by taking more care in keeping the food hoppers filled and in protecting the birds the number of chickadees could be increased to an even greater extent than they have been. This would mean that whenever the weather was favorable for the activity of the psylla flies in winter there would be present an army mobilized and ready to destroy thousands of them. Winter control measures have not proved very satisfactory and the over-wintering adults are free to despoil the trees unless checked by some natural enemy such as the birds. It must be taken into consideration, too, that every psylla eaten during the winter curtails the number the next summer when the most damage is done by this insect. Fall spraying is recommended to reduce the number of adults which winter over. The chickadee and the golden-crowned kinglet do the same type of work. They are certainly worthy of protection and encouragement.

ATTEMPTS TO INCREASE BENEFICIAL BIRDS

The methods employed to increase the winter bird residents of the orchards were to provide food and shelter. At first suet was placed on trees at various points thruout the orchard. These pieces of suet were covered with one-fourth inch mesh hardware cloth to prevent the large birds and animals from removing it. Later, two posts supporting automatic food hoppers were set up at two points on the north side of the orchard. In the hoppers was placed sunflower seed and on the side of each in a container of hardware cloth were placed pieces of suet. The matter of shelter was taken care of by placing nesting boxes at various points thruout the orchard. It was thought that the birds might live in them during inclement weather during the winter.

At the beginning of this study it was thought probable that chickadees, downy woodpeckers, white-breasted nuthatches, and possibly flickers would nest in these boxes. At the same time it was believed that the boxes would be made use of by bluebirds and possibly house wrens. A survey of the orchard in the spring of 1923 revealed no suitable places for birds which like to live in holes or boxes to nest.

During April, 1923, 24 nesting boxes were put up in trees in the orchard and its environs. They were placed on the trunks or branches
of the trees from 7 to 15 feet from the ground. These boxes were of
three sizes to accommodate chickadees, bluebirds, and flickers. It
was thought that these three sizes would accommodate any other
birds which might like to nest in a box. The largest boxes were
8 x 8 x 16 inches with an entry 2½ inches in diameter. The next
size was 5 x 5 x 10 inches with the entry 1¾ inches in diameter. The
smallest size was 4 x 4 x 8 inches with an entrance 1¾ inches in diam-
eter. All of the boxes were of seven-eighth inch hard pine. The front
of the box was hinged so that the box could be opened for examination
and cleaning. The largest boxes were provided with strips inside
the doors to keep out any light except that which might enter thru the
main opening. Each box was fastened to the tree by two straps of
thin sheet iron. The openings were placed toward the east in order
to give its occupants as much protection as possible from the prevail-
ing storms. Besides the boxes placed in the McKay orchard, 10 were
put up in the Sanford orchard less than a quarter of a mile away. In
December, 1923, 12 more boxes were placed in the McKay orchard.

On June 28, 1926, 10 paper boxes, built on the pattern described by
Allen,⁶ were placed on iron posts in the McKay orchard. These boxes
were of proper size for bluebirds. They were placed 8 feet from the
ground so as to be out of the way of human depredation. (See Plate II.)

During the period from December 1923 to June 28, 1926, there were
13 flicker boxes, 12 bluebird boxes, and 11 chickadee boxes in the
McKay orchard. The 10 paper boxes erected on July 28, 1926, raised
the number of bluebird boxes to 22 and the total number of boxes to
46. This is undoubtedly more nesting boxes than would be used by
the birds at any one time. A more careful record than has been kept
might reveal some preference on the part of the birds for location of
the boxes.

SUMMARY OF NESTING RECORDS

During the summer of 1923 five pair of bluebirds nested in the
boxes in the McKay orchard. It is uncertain whether or not the
young were raised. So far as is known no other birds attempted to
nest in the houses during that summer.

In the summer of 1924 four pair of bluebirds and four pair of flickers
nested according to the records. Three of the bluebirds may have
been successful in raising their young.

In 1925 four bluebird’s nests were built. Only one of them was un-
molested. The others were rifled before the young had left. One

⁶Bird Lore, Jan. 1920.
pair of flickers succeeded in raising young. It appeared that wrens had attempted nesting in two of the chickadee boxes.

During 1926 two pair of bluebirds reared young in the bird houses. One pair of screech owls probably was successful. The pair of flickers would have brought two young to maturity if it had not been for boys.

At each survey of the nesting boxes all nests of squirrels and deer mice and old nests of birds were cleaned out. Whenever it was possible the deer mice and the squirrels were killed.

The records for four summers show that the bluebirds, flickers, and screech owls attempted to use the nesting boxes. But each summer revealed a gradual decline in the number of bluebirds from the year before and there was no increase in the number of flickers. This leads to the conclusion that these birds at least would make use of nesting boxes if conditions were right. The birds are probably too much exposed to their enemies when nesting in boxes put up in the trees. Whether or not the presence of a pair of screech owls nesting in or near the orchard had anything to do with this reduction in the number of nesting birds is unknown. It is doubtful whether or not the screech owl can be tolerated as a nesting species in an orchard where an attempt is being made to increase the number of nesting birds.

It is quite evident that the only winter bird which showed any increase in numbers was the chickadee. To increase the number of individuals of this species was an easy task. It depended upon furnishing food in the form of suet and sunflower seeds. This fare is inexpensive, too. It is the author's belief that the cedar hedge furnished more attractive shelter to the chickadees and certainly to the kinglets than did the nesting boxes.

The downy woodpecker and the white-breasted nuthatch did not seem to be affected by the feeding operations. Their number remained stationary during the entire experiment. The reason for the different response of these birds is to be found, no doubt, in the difference of their dispositions. The chickadee loves the company of its own species. The downy and the nuthatch are more fond of the company of other species, especially that of the chickadee.

At present no means of attracting migrant kinglets and warblers to an orchard is known. The most likely method seems to be the planting of the proper kind of trees and shrubs to form suitable thickets for the sheltering of these birds when they stop to rest on their north-
ward and southward journeys. The cedar hedge at the edge of the McKay orchard seemed especially attractive to the kinglets.

In spite of the discouraging results obtained in the attempt to increase nesting birds, it seems to the author that if the proper methods are used over a period of years a great deal can be done in this direction. The bluebirds can be increased. There seems no reason that the wrens should not find the bird houses and nest in them. The flickers will use a few boxes if they are properly protected. With further effort the chickadees can be persuaded to nest in the vicinity of the orchard. Houses with smaller entries and places on iron poles nearer the ground in the wooded area should prove attractive. The feeding operations should be continued thru the summer to keep the chickadees near. This part of the work has only just begun. The boxes will have to be protected from enemies and a closer watch kept of the birds during the nesting season. A careful study should be made of the relation to the nesting birds of the grackle, screech owl, and crow.

CONCLUSIONS

The general conclusions of these observations may be briefly summarized as follows:

   a. Summer residents of the orchard.
      Screech owl, northern flicker, goldfinch, chipping sparrow, song sparrow, robin, bluebird.
   b. Summer residents of the environs.
      Phoebe, wood pewee, Baltimore oriole, red-eyed vireo, yellow warbler, northern yellowthroat.
   c. Summer visitants of the orchard.
      Crow, bronzed grackle.
   d. Migrant visitants of the orchard.
      Junco, myrtle warbler, ruby-crowned kinglet, golden-crowned kinglet.
   e. Winter residents of the orchard.
      Screech owl, downy woodpecker, white-breasted nut-hatch, chickadee.
   f. Winter visitants of the orchard.
      Hairy woodpecker, goldfinch, junco, red-breasted nut-hatch, robin, tree sparrow, crow, cooper hawk, brown creeper.
2. Birds which eat the pear psylla.
   a. In small numbers.
      White-breasted nuthatch, myrtle warbler.
   b. In large numbers.
      Chickadee, golden-crowned kinglet, red-breasted nuthatch.

It has been proved that the number of chickadees can be increased in the orchard in winter. So far no success has been attained in increasing the numbers of downy woodpecker and the white-breasted nuthatch. There is no method known for increasing the number of migrant kinglets and warblers. The method which seems most likely to meet with success is to provide suitable shelter in the form of hedges and thickets made up of the proper kinds of trees and shrubs. The efforts to induce birds which eat psyllas to become summer residents of the orchard have failed. This phase of the subject needs further study and work. Some means can be found, no doubt, to persuade the chickadees, at least, to nest in the vicinity of the orchard under consideration.

It has been shown that chickadees and the golden-crowned kinglets account for a large number of psyllas during the fall, winter, and spring. This is of great help to the orchardist because it is supplementary to the fall spraying operations which are aimed at decreasing the number of egg-laying adults of the following spring and in this way the number of pests to be fought during the following summer.

When compared with the large amounts of money expended for dusts and sprays and the machines to apply them, the expense necessary to provide food for an army of chickadees in an orchard is almost nothing. A few pounds of suet and a bushel of sunflower seed will keep the birds in the orchard where they will more than pay for the food in the psyllas taken.

There is a growing belief that birds, if properly treated, will do much to help the agriculturist in his battle with insect pests. The results of this study add a small amount to the evidence which is being gradually amassed in favor of this belief.