144
781
THS

# FOOD ANALYSIS OF THE STARLING

[Sturnus vulgaris vulgaris]

## WITH NOTES ON HABITS AND CONTROL

Thesis for the Degree of M. S.

Lee William Fisher

1935

THESIS


Starlinger

Wagenvoord & Co.
LIBRARY BOOK BINDERS
LANSING, MICH.

1977 256

JAN 07 2008
1108

OCT 25 1990
D290

# FOOD ANALYSIS OF THE STARLING (Sturnus vulgaris vulgaris) WITH NOTES ON HABITS AND CONTROL.

Thesis

Submitted to the Faculty of the Michigan State College in Partial Fulfillment of the Requirements for the Degree of Master of Science.

by

Lee William Fisher

1935

THESIS

TABLE OF CONTENTS



98890

TABLE OF CONTENTS (continued)

## ACKNOWLEDGMENTS

The author is greatly indebted to Professor J. W. Stack, of the Department of Zoology, for the many helpful suggestions and under whose careful guidance this work was done. Gratitude is extended to Doctor H. T. Darlington and Doctor E. A. Bessey of the Department of Botany, to Professor E. I. McDaniel and Mr. W. F. Morofsky of the Department of Entomology for their kind assistance in the identification of plant and insect material; and to Doctor H. R. Hunt of the Department of Zoology for the constructive criticisms of this manuscript.

# I

## INTRODUCTION

The rapid spread of the Starling (Sturnus vulgaris vulgaris) since the introduction of the species into the United States is the cause of a great deal of controversy for the agriculturist, the horticulturist, the fruit grower, and the bird lover. The diversity of opinion that is expressed concerning the economic value of the starling is well justified, when we consider the beneficial and detrimental results to man that have resulted by introducing a new species into an area. One needs to mention but two familiar examples, (1) the Gipsy moth and (2) the English sparrow, in order to realize what may happen when nature is temporarily upset by the introduction of a new species into a strange country.

When one evaluates the enormous amount of data that has been collected in the field and in the laboratory on bird life, there remains no doubt as to the economic importance of birds in relation to mankind. The role of birds in checking various injurious insects and other animal pests of our crops is well known. The potential ability for doing harm, such as attacking cultivated fruits, the spreading of noxious weeds, or the effect that an over-abundance of a species may have on other bird life, is also recognized. But to know whether a particular species is harmful or injurious, so far as man is concerned, it is necessary to make a careful and systematic study as to the nature of the food consumed by the

birds. This is done by the examination of bird stomachs and observations in the field.

One of the most intensive studies of this type was carried on in the United States, during the year 1916, by E. R. Kalmbach and I.N. Gabrielson of the Bureau of Biological Survey (1921). They examined over two thousand five hundred stomachs of the starling, the largest number of this species that has ever been examined by any investigators in the United States or elsewhere. With the exception of a report by Forbush (1915) on one hundred and two starling stomachs collected in 1910, it is the only attempt in the United States, before 1916 or since, to determine the food habits of this species in significant numbers.

Numerous data have been collected in Europe on the food habits of this species. Gilmour (1912) examined and reported on the contents of one hundred seventy-five stomachs; Hammond (1912) on two hundred thirty-nine; and Collinge (1913) on three hundred twenty-eight. Lewis (1927) made a comprehensive study of the distribution and economic status of the species in Ontario, Canada.

The conclusions arrived at by the investigators do not agree as to the usefulness of the species. Although some list the starling among the useful forms, there are others that class the bird as injurious rather than beneficial. The opinions that are expressed by the farmer and others who are interested in the starling are no less divided. Such general disagreement may in part be due to the fact that the conclusions arrived at are greatly influenced by the season, the place of collection, and the number of birds collected.

In the present investigation there has been collected and carefully examined the contents of more than three hundred stomachs of the adult starling. This work has also been supplemented with numerous observations in the field. In addition, experiments were carried on to devise some methods of control.

Numerous complaints about starling depredations from fruit growers, especially cherry orchardists, from farmers and other sources; the lack of any similar work being done by others; the desirability of finding out, if possible, the causes of the rapid increase in numbers and whether or not any changes have occurred in the food habits of the species, suggested an unusual opportunity to work on a problem of some possible economic importance.

As previously intimated, it is well to bear in mind that the season, the place of collection, and the number of birds collected are variable factors; therefore changing of any one of these would naturally tend to alter, more or less, the conclusions.

## II

## DESCRIPTION OF THE STARLING

The starling is now a common member of our avifauna, therefore little time need be spent in the field, by any careful observer, in order to see great numbers of individuals. But in spite of the abundance of the species few recognize it when seen. This may be due to the fact that the starling has a few characteristics that are similar to those of birds long known, as well as to the great difference that exists between the plumage of the young and adult, or the marked changes that occur in the appearance of the old birds in the spring and fall. However, the starling is easily recognized when one has learned a few of its outstanding characteristics.

The adult starling is about eight and one-half inches in length, of about the same weight as the robin, and of about the same size as the eastern red-wing (Agelaius phoeniceus phoeniceus). The tail is short, which gives it when at rest a hump-backed appearance. During the breeding season, which occurs in early spring, the bill is yellow and this is a conspicuous mark of identification. After the breeding season the bill darkens until it is almost black. It is at this time that the molt takes place and the new feathers are tipped with white, except on the back where they are tipped with a light brown, thus giving a mottled appearance which is very noticeable when the birds are near at hand. But during the winter most of the white tips wear off leaving the bird dark below.

In this plumage the starling is frequently mistaken for other gregarious black colored birds as the red-wing and cowbird. If seen at close range the starling will be found to have a very beautiful plumage which reflects purple, green, and blue. The young when leaving the nest are of a uniform dark olive-brown.

The starling has a characteristic flight. It is distinguishable from the flight of other species by the perfect coördination of movement between members of a flock, the rapid wing beat, the great speed and the ability to change its course suddenly. Like the purple martin it is able to sail on fixed wings for a considerable distance.

The principal notes of the starling generally heard are a clear hissing-like whistle or two, and when danger is near this is followed by a coarse rasping alarm call. By a close study of the calls and songs of the starling, they will be found to be varied and many. Bready (1929), in a study of the varied songs of the starling, writes: "Those who have not studied bird-music may wonder how the starling's song compares with that of native species. He has not the brilliancy nor the volume of the thrushes. He has not the variety possessed by the catbird, the brown thrasher, the mocking bird or the robin which sing what may be called 'continuous music' in which chord form and short patterns are mingled indiscriminately. It is in his clear quality of voice, his accuracy of pitch and his grasp of the diatonic scale that he excels. Considering bird-music from the point of view of progress through the pentatonic formula to the diatonic scale we shall find the starling well in advance of many others."

The starling is a versatile mimic and will give good call imitations of the English sparrow, bronzed grackle, white-breasted nuthatch, bob-white, flicker, blue jay, and others.

# III

## HISTORY OF THE STARLING

One of the earliest reports on the description and natural history of the starling was published in Great Britain by Lewin in 1795. From his description of the water ouzel, the following paragraph is of interest as to the lineage of the starling.

"Linnaeus places the water ouzel in the genus stare; and indeed it bears considerable resemblance to the starling, in the flatness of its bill, and the shortness of its tail. But I have thought it advisable to class the ouzels by themselves, as an intermediate link between the stare and the thrush genus; since they seem to form a gradual passage from one to the other, in the order in which they are here placed, which will appear evident from a view of the figures." He also mentions that the bird was then plentiful and could be seen in large flocks during the winter months.

In its original habitat the starling breeds from northern Norway and from about 64° north latitude in Russia and western Siberia to the Mediterranean, except in Spain and Portugal. It migrates in winter as far as northern Africa and India (Cooke, 1928). From this region it has been introduced into other countries, where its rapid spread and increase in numbers have instigated studies in reference to its economic importance.

The starling was introduced into Victoria, Australia, by the Zoological and Acclimatization Society in 1862 (Kinghorn, 1933). At present they are distributed over almost the whole of the cultivated lands of South-eastern Australia and the whole of Tasmania.

Five years later the starlings were introduced into New Zealand (Thomson, 1922). "The Otago Society imported and liberated three in 1867, 81 in 1868, and 85 in 1869. The Canterbury Society introduced 20 in 1867, and 40 in 1871. The Auckland Society introduced 15 in 1867, and 82 in 1868; while the Wellington Society's record was 60 in 1877; 90 in 1878; 14 in 1881; 100 in 1882; and 34 in 1883. Besides all these, great numbers were introduced by private enterprise. The increase of this species was phenominal. M. C. Hutchins writes (November, 1913): "When I arrived in Napier from England in 1875, there were only four starlings in town. They increased rapidly and took possession of the limestone bluff that looks out over the bay, boring into the softer veins of limestone. After eleven years they were there in hundreds of thousands. The bird has few, if any, natural enemies."

It was not until 1890 and 1891 that the starling became permanently established in the United States, when one hundred sixty birds were released in Central Park, New York City, by Eugene Schiefflin (Bready, 1929). Although attempts were made to introduce the species as early as 1850, it is thought that the thousands that are now scattered over the greater part of the United States and parts of Canada have been derived from the birds that were liberated in New York City.

For a period of six years the starling did not breed beyond the limits of New York City. By 1916 it had extended its breeding range to New Hampshire and Vermont, on the north; Virginia, on the south; and westward into Pennsylvania and across the Alleghany Mountains. By 1927 the breeding range extended from southern Ontario and southern Michigan to Tennessee, northeastern Georgia and South Carolina. Again in 1933 there was a noticeable increase in the extension of the range, when records of the starling were reported from Wisconsin, Iowa, Nebraska, Kansas, Arkansas, and Texas. However, in much of this territory the birds are not abundant enough to be of any economic importance.

The first appearance of the starling in Michigan, according to records collected by J. W. Stack of the Department of Zoology at Michigan State College, was recorded at Ypsilanti, in 1922. By 1927 they were breeding regularly across the southern part of Michigan, and at the present time are reported from most of the counties in the State in such large numbers that they are causing considerable worry as to the possible effect that an over-abundance of the species may have on the agricultural interests of the State and upon other birds and forms of wild life.

## IV

## REVIEW OF LITERATURE

Gilmour (1912) was one of the earliest investigators to determine the food of the starling in Great Britain, when in 1885 he examined the contents of one hundred seventy-five stomachs. He concluded: "Starlings are most monotonous in regard to diet. All food stuffs found in the crops and gizzards examined are conveniently grouped thus, (1) Grubs; (2) Insects, etc.; (3) Cereal grains; (4) Miscellaneous. First two compose 70%; third 22%; grain not very valuable because most taken after harvest time, so that comparative usefulness of the bird is made to depend upon the character of the insect food. The starling we can say with truth is our natural friend, by habit and by instinct."

It was not until 1908 that the next paper on the stomach contents of the starling was published by Newstead. He reported the results from the examination of sixteen specimens along with valuable field observations. From the study, he favored the starling and placed it with the class of beneficial birds.

In 1912 Hammond examined and reported on the contents of two hundred thirty-nine birds. Later, in 1913 Collinge contributed an important paper on the examination of three hundred twenty-eight starling stomachs. Both of these authors reported favorably of the species, although they admit the starling too numerous in some localities. Collinge states: "Considerably reduced in numbers, I

believe the starling would regain the good name it has borne in the past, and prove a most useful bird to the farmer; at present it is far too numerous and a source of considerable loss."

Most of the authorities on the economic status of the starling in Germany, France, Belgium, Hungary, and Switzerland agree that the species is beneficial. However, this is not the case where the starling has been introduced into other countries.

The result of the introduction of the species into Australia and Tasmania has been very unfavorable. On the relation of the starling to other birds in the above territory, Kinghorn (1933) writes as follows: "The Starling adopts a most antagonistic attitude to the native birds, and not only are its tactics irritating, but it persistently drives away many of our more valuable insectivorous species, and takes possession of all available nesting sites. This is more noticeable in timbered country, where it claims most of the hollow limbs and holes in trees that otherwise would be occupied by other birds. It appears to be a natural aggressor, for even when there are plenty of nesting sites for all, it most invariably prefers those places occupied by other species. Furthermore, it has been observed to alight in a tree where smaller insectivorous birds are feeding and drive them away."

The introduction of the starling into New Zealand seems to have resulted as unfavorably as in Australia. Thomson (1922) writes, concerning the effects of the starling

on other animal life in New Zealand, as follows: "The effects produced on the insect life of the country by starlings, and through that on the vegetable and other animal life, is incalculable. They have nearly destroyed the grasshoppers which used formerly to be so abundant and many other groups of insects must have suffered equally. They also remove great quantities of ticks from sheep, and cattle, and help to keep insect pests from them.

"Indirectly they are credited by many observers with having exterminated pheasants, partridges, introduced quail, wild turkeys, wild fowls, etc., from many districts, by having so eaten out the insect food, that these larger birds are now unable to rear their young broods.

"In many places they are accused of being fruit-stealers, attacking not only small fruits, but also pears, plums, and peaches, and some of my correspondents have thought this was a new trait developed in their new surroundings. But it is familiar enough in the northern countries from which the starlings came."

In 1910, exactly twenty years after the starling had been introduced into the United States, Forbush (1915), in coöperation with the Bureau of Biological Survey, made a personal investigation and collected data through correspondence on the economic aspects of the starling. According to the following statement by Forbush, the species had already shown a capacity for harmfulness: "The starling drives away Flickers, Bluebirds, and House wrens by occupying their nest-

ing place, and competes actively with our birds for food supply. Especially in winter the starlings scour the country so thoroughly that they must devour most of the food supply upon which our winter birds are accustomed to subsist." He further states: "The accounts of the great damage inflicted upon berry patches and vineyards in Europe give us some idea what we may expect in the future."

As previously mentioned, Kalmbach and Gabrielson (1921) contributed one of the most important papers on the economic status of the starling in the United States or elsewhere. They examined and reported on the contents of two thousand four hundred sixty-six well filled stomachs. They concluded that most of the food habits of the starling were either beneficial or of a neutral character, and that the time the bird spends in destroying crops or in molesting other birds is extremely short compared with the endless hours is spends searching for insects or feeding on wild fruits.

In Ontario, Canada, valuable work has been done on the economic value of the starling by Lewis (1927). His conclusions concerning the economic status of the starling in Canada were essentially the same as those of Kalmbach and Gabrielson in the United States.

# V

## HABITS OF THE STARLING

On account of the gregarious habit of the starling, they are most always seen in numbers, when feeding, roosting, or in flight. (See Plate III.) The exception to this occurs during the breeding season, which begins in April and extends through July, when the birds pair off and start out in search of nesting sites.

Starlings have much in common with English sparrows. Like the English sparrows their nests are rather bulky, damp, and foul with the odor of accumulated filth, and may be found in corners, crevices, and beneath eaves about barns and silos, in fact in almost any cavity they are able to enter. They seem to prefer natural cavities in trees, but will take possession of the nest sites of hole-nesting species such as the bluebirds, flickers, and woodpeckers.

Of interest, concerning the depredation by the starling in Michigan, Stack (1933) writes: "Although it has been proven that the starling destroys noxious insects and therefore is considered by some observers to be either beneficial or of neutral benefit to man's welfare, the complaints received from Michigan farmers point out that great loss and damage has and will occur as a result of the enormous numbers now present in certain parts of the State and of the fact that they feed upon both vegetable and animal food.

"The greatest damage thus far reported in the State has occurred where flocks of starlings have visited cherry orchards previous to the harvesting of the crop. W. P. Hartman, of the W. R. Roach Canning Company, reported that during the summer of 1932 the starling was much more in evidence on the east side of the State than ever before, that it appeared in countless flocks numbering into the hundreds, perhaps thousands. At their Croswell orchard, consisting of 200 acres, it was estimated conservatively that in three days the starlings consumed not less than 20 tons of cherries. Similar reports of cherry damage have been recorded from orchardists in Ohio and Connecticut. In addition to such depredations, the starling has been reported as doing considerable damage to other small fruit, garden truck, corn, apples, peaches, and pears."

Starlings are very prolific birds, in that they raise from two to three broods a year, with three to six young to each brood. They are not intolerant of their own kind as nesting neighbors, as some of our own species like the robin, and therefore are able to multiply rapidly in a small area. The young are able to fly as soon as they leave the nest and soon gather in large flocks which number into thousands. They often select their summer roosting place in trees that are located in the residential section of cities, and occasionally in wooded areas near the outskirts of the city. The noise and filth from

the roosting of thousands of these birds within our city limits has caused numerous complaints.

In these summer roosts other species are often found. From a roost located on North Ottawa Street in Lansing, Michigan, during the latter two weeks of August, 1934, forty birds were shot. Of these, four were cowbirds, two were purple martins, one a robin, and the remainder starlings. From another roost located in a pine grove on the Michigan State College grounds, during September, one hundred twenty-seven birds were shot. Among these were fourteen bronzed grackles, nine cowbirds, four English sparrows, and one hundred starlings. (See Plate IV.)

As winter and cold weather come on, they abandon these summer roosts and seek shelter in barns, silos, or other buildings. Four winter roosts were located on the Michigan State College grounds. Three were found in double-type silos as pictured in Plate V, and one in a barn, pictured in Plate VI. These are typical winter roosting places of starlings that remain over winter in this vicinity.

The starling is able to stand a great variation in temperature. But to secure added comfort during some of the extreme low temperatures that oftimes occur in the north, other means of protection from the cold are often sought. This is especially true during the day when they do not receive the heat that is derived from the crowding of bodies during the night roost. One means of accomplishing this is by seeking the heat from chimneys and heat-ventilators of buildings.

The ventilating chimney on top of the building pictured in Plate VII is a typical day-warming station of the starling, during the cold winter months. This is the Bacteriology building of the Michigan State College. Any one passing this building and other similar buildings on the campus, on a winter day, can hear the clear notes of the starling, and may wonder from where they come. It is by taking advantage of such means of protection offered by man that the starling is able to overcome certain conditions which are unfavorable to our own native species.

The fact that the starling is an omnivorous feeder, gives it another advantage over many of our native birds. The starling will resort to almost any kind of food when pressed by hunger. Four hundred ninety-four specifically different food items were found in the food of the bird, by Kalmbach and Gabrielson (1921). In the present food analysis of the species, winter food was found to consist mostly of garbage, which was available in large quantities around garbage grounds, and about the only competitor for this type of food is the English sparrow. (See Plate VIII.)

The starling is a very nervous and cautious individual. It is very difficult to approach without frightening it away. Plus its natural pugnaciousness and expert flying ability it is well equipped to protect itself.

## VI

## CONTROL MEASURES

A number of successful bird traps have been constructed for the purpose of capturing many of our native birds. Many of these traps have been modified in one way or another in order to trap the starling. Some have had a slight degree of success; for example, bird banders have been successful in trapping starlings with the sieve trap and occasionally with the funnel trap. (See Figures I and II.) But none of these traps have taken the starling in numbers that are significant; that is, to act as a check upon their numbers for the purpose of controlling their increase.

In the present work several methods were tried as measures of control for the starling. The first method was a modification of a trap known as the "Australian Crow Trap". (See Figure III.) The trap was made of wood and wire mesh. Its dimensions were 9'x6'x6'. Parts were made in separate sections for the sake of convenience in transporting it from one place to another. Ordinary screen-door hooks were attached to each section in order to facilitate the setting up or taking down of the trap. One inch wire mesh was used to cover both sides and the four triangular spaces on each end. Small staples fasten the wire to the frame work. Wire was stretched on top of the frame down to the ladder which rests in the V shape frame at each end of the trap. The first three rungs on each end of

the ladder were set three inches apart, these prevent the birds from escaping by climbing out at each end of the trap, the remaining rungs four inches, the purpose being to allow the birds to enter the trap very easily, but when trying to get out their wing spread prevented them from doing so.

The trap was placed near a regular winter feeding ground of the starling. (See Plate VIII.) Over a period of seven weeks during January, February, and part of March, of 1934, the trap was left in this location. Food such as apples, suet, lettuce, and several cereal grains, which were thought to be attractive to the starling, were placed around and within the trap. During this period no birds entered the trap, although they continued to eat all food placed around and near it. Several reasons may account for the failure in trapping any of the birds. First, there is the natural wariness and cautiousness of the starling in approaching anything that may place them in danger. Second, there was easy access to other food which was abundant in the nearby garbage grounds. Had there been a heavy snowfall causing a scarcity of food and the starling been hard pressed by hunger, it is fairly reasonable to believe that the birds would have entered the trap. This type of trap is one of the most successful crow traps made, and few birds are more wary of traps and danger than the crow.

The second method resorted to, was the use of calcium cyanide in dust form. Calcium cyanide dust on coming in contact with the moisture of the air produces

hydro-cyanic-acid gas. The high toxicity of this particular gas makes it a dangerous weapon to use where starlings roost in barns and silos. The concentration of the gas necessary to kill the birds is about one-third of that needed to kill man (Liston, 1923). Therefore the danger to animals, such as farm stock, is very great unless strict precautions are taken to remove all stock from buildings where gas is used.

With a small hand-operated dust gun having fifty feet of hose and brass tubing, several trials were made on starlings roosting under the eaves of an empty barn. But due to unfavorable weather conditions, the attempts to collect starlings in this manner were unsuccessful. However, hydrocyanic-acid gas has been used successfully in destroying English sparrows, where they roost in vines and on ledges along the sides of buildings. Recently the gas was used effectively in dispersing and eliminating large winter roosts within the city of Washington, D. C.

Another method tried was the "Linnen Trammel Bird Net". These nets are made of strong silk cord, in various lengths and widths. They are often used by bird banders and if properly attended do not injure the birds.

Two of these nets, twenty-four feet in length and five in width, were placed above each other across the top of the inside of a barn, where several hundred birds roosted each night. The nets were left up over a period of five nights. Although the position of the nets were changed several times, only nine starlings were taken.

The most successful and simple method of collecting a large number of starlings within an inclosed roost, proved to be with the aid of an electric flashlight. The birds, confused by the light, fly toward it or to the spot where the light is pointed. Then, it is only a matter of reaching out and grasping them. On March 14, 1934, shortly after dark, ninety-one birds were taken with the aid of an electric flashlight, within less than an hour's time, from a roost located in a barn on the Michigan State College grounds. On several occasions a number of them were banded in the same manner. The use of this method upon a large number of winter roosts over a wide area, should act as a check on the number of starlings.

# VII

## METHOD OF PROCEDURE

STOMACH ANALYSIS: When ever it was possible the stomach contents were examined within forty-eight hours after the birds were shot. Otherwise they were preserved in alcohol and examined as soon as it was convenient.

After opening the body with a pair of scissors and determining the sex of the bird, the entire digestive tract, from the oesophagus to the rectum, was removed and placed in a dish. It was then cut open with a scalpel, and its contents scraped and washed into a filter, where much of the insect material remained on top. The vegetable and animal matter was separated on filter papers and placed under a binocular microscope to be studied.

In a number of the stomachs examined an actual count of the different food items could be made; but during the winter months, when the starling fed mostly on vegetable refuse, such was not the case. Therefore, in order to determine the approximate monthly food percentages of vegetable and animal matter, it was necessary to estimate the different items by volume rather than by number (McAtee, 1912.)

Monthly percentages of animal and vegetable food were based upon the number of stomachs collected in each month, and from these percentages the annual percentage was taken (Table I).

OBSERVATIONS IN THE FIELD: With the aid of a blanket, which served as a blind, and a pair of field glasses, a number of interesting observations were made in the field on the feeding habits of the starling. Thereby many of the food items that were identified in stomach analysis were previously anticipated. These observations not only aided in the identification of the food later found in the stomachs, but were also of inestimable value in deciding whether the habits of the bird were injurious or beneficial.

# VIII

## PRESENTATION OF THE DATA

Three hundred four stomachs of the adult starling were examined. Of these, one hundred eighty-three were males and one hundred twenty-one females. The majority of the birds were collected at sun down or shortly after from starling roosts. They were all taken in the vicinity of East Lansing, Michigan. (See Map I.)

One hundred birds were collected during September of 1933, and a varying number in each of the subsequent months as follows: October, eight birds; November, seven; December, four; January, five; February, six; March, ninety-one; April, thirty-three; May, nine; June, five; July, two; and August, thirty-four. Thirty of the three hundred four stomachs were found to be empty.

The monthly and yearly percentages of the animal and vegetable foods of the adult starling are shown in Table I. In Tables II, IIa, III, IIIa, IV, V, VI, VII, VIII, IX, X, XI, XII, XIII, and XIIIa are recorded the number, per cent, frequency, and kinds of vegetable and animal food found in the starling stomachs that were collected in each month of the year. Table II gives a summation of the different types of food found in the birds collected in September. Table XIV, the insect food of the starling and the number of stomachs in which each occurred.

# IX

## DISCUSSION OF THE DATA

FOOD HABITS: Of the total annual food of the adult starlings examined, 45.72 per cent was composed of ~~vegetable~~ animal matter and 54.28 per cent ~~animal~~ vegetable. In Table I, the monthly and yearly percentages of the animal and vegetable foods are recorded. Note that from April to November, inclusive, the animal matter forms more than half of the food consumed by the birds. The greatest amount is taken in May and June, when insects are plentiful. While during the winter months, in December, January, and February, when insects are scarce, the vegetable matter taken in much greater. In January and February (Tables VI and VII) over 87 per cent and 90 per cent, respectively, of the stomachs contained vegetable refuse, such as coffee grounds, egg shells, lemon seeds and so forth. The animal food for January formed 12.28 per cent,and for February 9.10 per cent. This is a fairly high percentage of animal matter, when one takes in consideration the amount of snow and the cold winters that we have here in Michigan. Due to the seasonal movements of the birds and to the limited time for the purpose of collecting them, it was impossible to collect a fixed quota each month; therefore forty-four per cent or one hundred thirty-four of the total number of the birds examined were collected in August and September, and forty per cent or one hundred twenty-four in March and April. The remaining sixteen per

cent or forty-six birds examined were collected over a period of eight months.

VEGETABLE FOOD: Of the one hundred bird's stomachs collected in September, nine were found to be empty. (See Table II.) The wild fruits were found in sixty-six out of the ninety-one remaining stomachs. This would indicate that they form an important food item for the species at this time of the year and in this particular locality. Although a small number of weed seeds were found like Green foxtail (Chaetochloa viridis), Lambs quarters (Chenopodium album), Pigweed (Amaranthus retroflexus), and Ragweed (Ambrosia elatior), such probably could be disregarded as an important source of food for the species, as they were found in only one stomach of those collected.

Of these fruits, only three are of any economic importance, as far as man is concerned. These are poison ivy (Rhus toxicodendron), poison sumac (Rhus vernix), and wheat (Tritigcum sp.). They were found in eleven, two, and five stomachs respectively. When feeding upon poison ivy and poison sumac, the bird acts as a disseminator of the weeds. In case of the wheat, the harvesting season being over, no doubt it was left-over wheat picked up in the field.

The feeding on the wild fruits such as Boston ivy (Parthenocissus quinquefolia), wild grape (Vitis sp.), wild cherry (Prunus sp.), and elderberry (Sambucus canadensis) which were found in thirteen, five, twenty-two,

two, and eighteen, respectively, of the birds examined, might naturally tend to diminish the available food supply for our native species, especially in localities where the starlings are numerous. Whether it results in a general food shortage for our own native birds is not known.

The total vegetable food consumed by the starling formed 46.25 per cent of its entire diet for September. This was composed wholly of wild fruits with the exception of a small quantity of wheat. The number of vegetable food items found totaled three hundred sixty-three. Of these, the cultivated fruits numbered thirty-five, the wild fruits three hundred twenty-eight, and the harmful fruits seventy-two. They occurred in five, sixty-six, and twenty-one, respectively, of the birds examined. (See Table IIb.)

The vegetable food for the following month (recorded in Table III) is also composed entirely of wild fruits with the exception of oats, which occurred in only one stomach, and as in case of the wheat is of no economic importance. Although only eight stomachs were collected, the vegetable matter formed 47.95 per cent of the October diet.

Note, that in the following four months of November, December, January, and February, (Tables IV, V, VI and VII) no wild fruits appear in the food of the starling. It is not until August (Table XIII) that wild fruits again appear in any noticeable variety or amount. The number of birds collected in May, June, and July (Tables X, XI, and

XII) are too few to indicate the relative amount or kinds of wild fruits that may be taken by the species during these months. During the four months from November to March the vegetable matter is composed entirely of vegetable refuse, such as may be found in any garbage pile, (See Plate I.)

It cannot be said that the annual consumption of vegetable matter by the starling in this locality is of any great economic importance. Approximately 68.77 per cent of the vegetable matter consists of vegetable refuse such as egg shells, coffee grounds, beef bone, and so forth, eaten mostly during the winter months. This refuse has no economic value, as the English sparrow is about the only competitor for this type of food. When feeding on poison ivy, poison sumac, and similar wild fruits, the bird does act as a disseminator and therefore has some economic significance. Kalmbach (1921) writes concerning the starling as an agent of dissemination as follows:

"The seeds are eaten, as are all other berries of a similar nature, simply for the thin outer covering of pulp and skin, and the hard parts pass through the digestive tract or are regurgitated, their germinating qualities uninjured. The starling thus becomes an agent in their dissemination, but as the birds so often roost over city streets or in buildings, part of these seeds are deposited in places where they can not grow. In the actual spread of this noxious weed, the starling is probably less responsible than many of our native birds, which scatter most of their regurgitated seeds where they have at least a fair chance to grow."

ANIMAL FOOD: The number, per cent, frequency, and kinds of animal food obtained from the birds collected during each month of the year are recorded in Tables IIa, IIIa, and IV to XIII, inclusive. Of the animal food the Coleoptera form the largest proportion of the insect life taken by the starling. Of the total number of stomachs examined, two hundred fifty-five or over ninety-three per cent contained remains of Coleoptera. The three genera of ground beetles, Poecilus, Calosoma, and Harpulus were found in thirty-nine, fifteen, and eight, respectively, of the birds examined. They are predacious bettles in that they destroy other insects, and therefore are considered beneficial. It was a species of the genus Calosoma which the Federal Government introduced into the United States from Europe to combat the Gypsy Moth. Its larvae feed on foliage of most forest and fruit trees; and the Government has spent millions of dollars in an unsuccessful effort to exterminate them. (Forbush and Fernald, 1896).

The click beetles (Drasterius dorsalis), sometimes known as the snapping beetles, were taken by fourteen birds, and are known as one of our worst insect pests. The larvae are commonly known as wire worms; the name being suggested by the form and hardness of the body. There is hardly a cultivated plant they do not attack; and, as their destructive work is done underground, they are very difficult to destroy. An extensive series of experiments, extending over a period of

years, were carried on by Comstock and Slingerland (1925) in an effort to discover a method of preventing the ravages of wire worms infesting field crops, but without any satisfactory results.

The Clover-root weevil (Sitona hispidula) is by far the most frequent of the identified insects. They were found in the stomachs of eighty-seven birds in eight months of the year. (See Table XIV.) The larvae of this weevil feed on the roots of various species of clover, and do a considerable amount of damage to our clover crop each year. Professor E. I. McDaniel of the Entomology Department of the Michigan State College states that these weevils are numerous in the vicinity of East Lansing, especially on the Michigan State farm grounds.

Another weevil that occurred in a considerable number of stomachs is the Strawberry crown-girdler (Brachyrhinus ovatus), which had been taken by sixty-seven birds and found in birds collected in eight months of the year. This is a dark brown, almost black, snout-beetle, about 5mm. in length, which often invades dwellings, searching for shelter during the winter months in the Northern States and Canada. The larvae feed on the roots of the strawberry, cutting them off near the crown. The adults consume the foliage.

It is interesting to note that weevils were found in stomachs collected in every month of the year except July and December. The absence of weevils in birds examined

during these two months may be due to the small number collected. Only two birds were taken in July and four in December.

The May-beetles or June-bugs were found in four of the birds taken in May. (See Table X.) The adults frequently do much injury by eating the foliage of trees. The larvae are commonly known as white grubs and are often great pests in gardens and cultivated fields. They destroy the roots of plants and grasses. No satisfactory method of fighting this nuisance has been discovered as yet.

The Dung beetles belong to the same family as the May-beetles. They were taken by twenty birds in seven months of the year.

The Carrion beetles belong to the family Silphidae and were taken by one bird in July and one in September. These beetles usually feed upon decaying animal matter. It is said that a few species of this family have been known to be predacious when pressed by hunger, destroying living snails and insects, and even members of their own species.

The Tiger beetles belong to the family Cincindelidae, and were taken by three birds, one in May and two in August. (See Tables X and XIIIa.) Their name is suggested by the predacious habits of both adult and larvae. Comstock (1925) gives an interesting description of the habits of the larvae, as follows: "The larvae live in vertical burrows in ploughed fields and sandy places that have

become dry and hard. The larva takes a position of watchfulness at the mouth of its burrow. Its dirt-colored head is bent at right angles to its lighter-colored body and makes a neat plug to the opening hole. Its rapacious jaws extend upward, wide open, ready to seize the first unwary insect that walks over this living trap, or near it; for a larva will throw its body forward some distance in order to seize its prey."

Of the order Orthoptera, the grasshoppers and crickets were identified in fifty-one and in five, respectively, of the total number of birds examined. While the crickets were found only in the stomachs of birds collected only in September, the grasshoppers were eaten by birds in seven months of the year. It is estimated that grasshoppers cause an annual loss in this country of over $50,000,000. (Marlatt, 1917.) Therefore the feeding on these insects by the starling would tend to lessen their numbers.

Ants, of the order Hymenoptera, were identified in birds taken in six months of the year, and found in fifty-four stomachs. As far as man is concerned ants are commonly considered to be neutral economically.

True bugs belong to the order Hemiptera, and were eaten by ten birds. Three assassin bugs belonging to the family Reduviidae were identified in a bird collected in September. They are predacious, living on the blood of insects, and have been known in some cases to attack higher animals and occasionally man suffers from them.

Spiders were taken by six birds, and are generally classed as beneficial, as they capture insects in their webs.

Unidentified larvae were found in the stomachs of ten birds.

In Table I, it will be noted that over a period of eight months, from April to November, animal matter forms the greatest item of the annual food of the starling. During the four months of December, January, February, and March, the percentage of animal matter is quite low, due to the lack of insect life at this time of the year. Garbage is practically the only source of food left for the starling during these months. (See Table I.) For this reason the yearly average of animal matter, 45.72%, is lower than that for vegetable matter, 54.28%, even though in eight months of the year the animal matter is much higher than the vegetable matter.

It is quite evident from the large number and variety of insects eaten by the starling, in every month of the year except December, (See Table V), that it prefers an insect diet when such may be had.

To illustrate the amount and variety of food that may be found in the stomach of one bird, see Plate II. This bird was collected in September, and its gastric contents comprised approximately fifty per cent insect matter and fifty per cent of wild fruits.

# X

## CONCLUSIONS

From the study of the stomach contents of the starling it is obvious that the insectivorous habits of the bird are beneficial to man. The feeding on injurious insects such as weevils, click beetles, May beetles, grasshoppers and so forth acts as a check on some of our worst insect pests.

When feeding on wild fruits such as wild grapes, wild cherries, Virginia creeper and so forth, the starling can not be placed in the class of beneficial or detrimental species, until further investigation is carried on to determine whether this type of food is actually depleted or made scarce for our native birds.

The winter food of the starling such as vegetable and animal refuse taken from garbage heaps has no economic value. It does not detract from the food of our native birds, as the English sparrow is about the only competitor for this type of food.

Although the food habits as determined from the stomach analysis of the starling are in its favor, the same can not be said of other habits that have been observed in the field. First, the natural pugnaciousness of the bird which is expressed by their taking possession of the nesting sites of native species such as the bluebirds, flickers, and woodpeckers. Second, there is the objectionable habit

of roosting in flocks of thousands within our city limits, which is accompanied with their noise and filth. Third, the general increase in abundance, which is more noticeable each year. There is no doubt that harmful results occur when a species becomes over-abundant. Therefore, the starling bears careful watching and studying, in order that we may have at hand some means of combating the possible evils resulting from an over-abundance of the species.

The present study is confined to a relatively small area. It produces no evidence as to the true status of the starling throughout Michigan, except as to indicate the potential ability of the species for doing harm. Rather, it suggests that further studies should be carried on to determine its status.

What effect does the feeding on wild fruits and insects by thousands of starlings have upon our native birds? Does it make this source of food so scarce, as to starve out some of our own species? Is there plenty of food for all? As yet, the answer is still unknown.

X

Table I

Monthly Percentages
of the
Animal and Vegetable Food of the Adult Starling.

| Months | % Animal | % Vegetable |
|---|---|---|
| January | 12.28 | 87.72 |
| February | 9.10 | 90.90 |
| March | 31.25 | 68.75 |
| April | 57.40 | 42.60 |
| May | 60.97 | 39.03 |
| June | 73.33 | 26.67 |
| July | 53.33 | 46.67 |
| August | 64.15 | 35.85 |
| September | 53.75 | 46.25 |
| October | 52.05 | 47.95 |
| November | 57.15 | 42.85 |
| December | 23.91 | 76.09 |
| Average for year | 45.72 | 54.28 |

Table II

Number of stomachs examined ... 100

Number of stomachs empty ..... 9

(Collected September 28, 1933.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Vegetable matter ..... | 46.25 | 363 | |
| Boston ivy, Parthenocissus tricuspidata.. | | 34 | 13 |
| Virginia creeper, Parthen. quinquefolia.. | | 45 | 5 |
| Poison ivy, Rhus toxicodendron..... | | 23 | 11 |
| Poison sumac, Rhus vernix..... | | 2 | 2 |
| Wild grape, Vitis sp. ..... | | 57 | 22 |
| Wild cherry, Prunus sp. ..... | | 2 | 2 |
| Wild mustard, Sinapis arvensis..... | | 4 | 2 |
| Elderberry, Sambucus canadensis..... | | 116 | 18 |
| Green foxtail, Chaetochloa viridis..... | | 10 | 1 |
| Lambs quarters, Chenopodium album..... | | 2 | 1 |
| Amaranthus sp. ..... | | 24 | 8 |
| Pigweed, Amaranthus retroflexus..... | | 4 | 1 |
| Ragweed, Ambrosia elatior..... | | 3 | 1 |
| Wheat, Tritiscum sp. ..... | | 35 | 5 |
| Viburnum sp. ..... | | 2 | 2 |

Table IIa

Number of stomachs examined ... 100

Number of stomachs empty ..... 9

(Collected September 28, 1933.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Animal matter | 53.75 | 753 | |
| Coleoptera | | 90 | |
| Ground beetle, Poecilus lucublandus | | 77 | 16 |
| Ground beetle, Calosoma sp. | | 22 | 11 |
| Ground beetle, Harpulus sp. | | 15 | 5 |
| Other ground beetles | | 129 | 40 |
| Carrion beetle, Silphidae | | 2 | 1 |
| Dung beetle, Aphodius sp. | | 5 | 2 |
| Click beetle, Drasterius dorsalis | | 11 | 5 |
| Water beetle, Hydrous triangularis | | 3 | 1 |
| Clover-root weevil, Sitona hispidula | | 70 | 23 |
| Strawberry weevil, Brachyrhinus ovatus | | 166 | 38 |
| Other weevils | | 17 | 6 |
| Other beetles | | 117 | 35 |
| Hymenoptera | | | |
| Ants | | 69 | 19 |
| Orthoptera | | | |
| Grasshoppers | | 23 | 15 |
| Crickets | | 18 | 5 |
| Hemiptera | | | |
| Assassin bug, Reduviidae | | 3 | 1 |
| Arachnida | | | |
| Spiders | | 6 | 2 |

Table IIb

Number of stomachs examined ... 100

Number of stomachs empty ..... 9

(Collected September 28, 1933.)

Total food items

| | % | No. | Frequency |
|---|---|---|---|
| Total vegetable food..... | 46.25 | 363 | |
| Cultivated fruits..... | | 35 | 5 |
| Wild fruits..... | | 328 | 66 |
| Harmful fruits..... | | 72 | 21 |
| Total animal food..... | 53.75 | 753 | |
| Coleoptera..... | | 634 | 90 |
| Hymenoptera..... | | 69 | 19 |
| Orthoptera..... | | 41 | 18 |
| Arachnida..... | | 6 | 2 |
| Hemiptera..... | | 3 | 1 |
| Beneficial insects..... | | 117 | 29 |
| Injurious insects..... | | 305 | 63 |
| Other insects..... | | 331 | |

Table III

Number of stomachs examined ..... 8

Number of stomachs empty ..... 0

(Collected October 26, 1934.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Vegetable matter ..... | 47.95 | | |
| Wild cherry, Prunus sp. ..... | | 9 | 2 |
| Wild grape, Vitis sp. ..... | | 12 | 3 |
| Poison ivy, Rhus toxicodendron..... | | 2 | 1 |
| Virginia creeper, Parthen. quinquefolia | | 3 | 1 |
| Ragweed, Ambrosia elatior ..... | | 2 | 1 |
| Lambs quarters, Chenopodium sp. ..... | | 1 | 1 |
| Elderberry, Sambucus canadensis ..... | | 34 | 4 |
| Oats, Avena sp. ..... | | 3 | 1 |
| Boston ivy, Parthen. tricuspidata ..... | | 2 | 1 |
| Wild fruit, unidentified ..... | | 2 | 1 |

Table IIIa

Number of stomachs examined ..... 8

Number of stomachs empty ..... 0

(Collected October 26, 1934.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Animal matter ..... | 52.05 | | |
| Coleoptera..... | | 88 | 8 |
| Ground beetle, Poecilus lucublandus.... | | 2 | 2 |
| Ground beetle, Calosoma sp. ..... | | 2 | 2 |
| Click beetle, Drasterius dorsalis..... | | 2 | 2 |
| Dung beetle, Aphodius sp. ..... | | 10 | 3 |
| Clover-root weevil, Sitona hispidula... | | 17 | 3 |
| Other weevils..... | | 24 | 5 |
| Other beetles..... | | 31 | 3 |
| Orthoptera | | | |
| Grasshoppers..... | | 8 | 6 |
| Hymenoptera | | | |
| Ants..... | | 1 | 1 |
| Hemiptera | | | |
| True bugs..... | | 3 | 1 |
| Larvae..... | | 3 | 1 |

Table IV

Number of stomachs examined .... 7

Number of stomachs empty ..... 4

(Collected November 21, 1934.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Vegetable matter ..... | 42.85 | | |
| Misc. vegetable refuse | | | |
| Coffee grounds..... | | | 2 |
| Egg shells..... | | | 2 |
| Apple skins..... | | | 1 |
| Animal matter ..... | 57.15 | | |
| Coleoptera..... | | 36 | 3 |
| Click beetle, Drasterius dorsalia..... | | 2 | 1 |
| Clover-root weevil, Sitona hispidula... | | 17 | 2 |
| Other weevils..... | | 8 | 1 |
| Other beetles..... | | 9 | 2 |
| Orthoptera | | | |
| Grasshoppers..... | | 2 | 1 |
| Larvae..... | | 10 | 2 |
| Arachnida | | | |
| Spiders..... | | 1 | 1 |

Table V

Number of stomachs examined ..... 4

Number of stomachs empty ..... 0

(Collected December 14, 1933.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Vegetable matter..... | 76.09 | | |
| Misc. vegetable refuse | | | |
| Coffee grounds..... | | | 4 |
| Egg shells..... | | | 3 |
| Animal matter..... | 23.91 | | |
| Misc. animal refuse | | | |
| Pieces of bone..... | | | 2 |
| No insect matter | | | |

Table VI

Number of stomachs examined ..... 5

Number of stomachs empty ..... 0

(Collected January 17, 1934.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Vegetable matter..... | 87.72 | | |
| Misc. vegetable refuse | | | |
| Coffee grounds..... | | | 4 |
| Egg shells..... | | | 3 |
| Lemon seeds..... | | | 1 |
| Animal matter..... | 12.28 | | |
| Misc. animal refuse | | | |
| Pieces of bone..... | | | 2 |
| Coleoptera..... | | 7 | 3 |
| Strawberry weevil, Brachyrhinus ovatus. | | 2 | 1 |
| Other weevils..... | | 4 | 1 |
| Other beetles..... | | 1 | 1 |

Table VII

Number of stomachs examined ..... 6

Number of stomachs empty ..... 0

(Collected February 15, 1934.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Vegetable matter ..... | 90.90 | | |
| Misc. vegetable refuse | | | |
| Coffee grounds..... | | | 4 |
| Egg shells..... | | | 2 |
| Orange seeds..... | | 3 | 1 |
| Lemon seeds..... | | 1 | 1 |
| | | | |
| Animal matter..... | 9.10 | | |
| Misc. animal refuse | | | |
| Coleoptera..... | | 20 | 4 |
| Strawberry weevil, Brachyrhinus ovatus.. | | 3 | 2 |
| Clover-root weevil, Sitona hispidula.... | | 3 | 2 |
| Other weevils..... | | 10 | 4 |
| Ground beetle, Fam. Carabidae..... | | 1 | 1 |
| Dung beetle, Aphodius sp. ..... | | 1 | 1 |
| Other beetles..... | | 2 | 2 |

Table VIII

Number of stomachs examined ..... 91

Number of stomachs empty ..... 6

(Collected March 14, 1934.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Vegetable matter | 68.75 | | |
| Misc. vegetable refuse | | | |
| Coffee grounds | | | 48 |
| Egg shells | | | 40 |
| Orange seeds | | 21 | 3 |
| Amaranthus sp. | | 4 | 4 |
| Oats, Avena sp. | | 8 | 3 |
| | | | |
| Animal matter | 31.25 | | |
| Misc. animal refuse | | | |
| Pieces of bone | | | 4 |
| Coleoptera | | 563 | 76 |
| Strawberry weevil, Brachyrhinus ovatus | | 44 | 14 |
| Clover-root weevil, Sitona hispidula | | 125 | 30 |
| Other weevils | | 214 | 43 |
| Ground beetle, Fam. Carabidae | | 15 | 11 |
| Other beetles | | 165 | 54 |
| Hemiptera | | 5 | 3 |

Table IX

Number of stomachs examined ..... 33

Number of stomachs empty ..... 2

(Collected April 19, 1934.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Vegetable matter..... | 42.60 | | |
| Misc. vegetable refuse | | | |
| Oats, Avena sp. ..... | | 40 | 3 |
| Animal matter..... | 57.40 | | |
| Coleoptera..... | | 590 | 31 |
| Ground beetle, Poecilus lucublandus.... | | 15 | 9 |
| Ground beetle, Calosoma sp. ..... | | 2 | 1 |
| Ground beetle, Harpulus sp. ..... | | 2 | 1 |
| Other ground beetles..... | | 51 | 9 |
| Dung beetle, Aphodius..... | | 63 | 11 |
| Click beetle, Drasterius dorsalis..... | | 10 | 4 |
| Clover-root weevils, Citona hispidula.. | | 123 | 12 |
| Strawberry weevil, Brachyrhinus ovatus. | | 45 | 4 |
| Other weevils..... | | 185 | 21 |
| Other beetles..... | | 94 | 23 |
| Hymenoptera Ants..... | | 61 | 12 |
| Orthoptera Grasshoppers..... | | 14 | 10 |
| Hemiptera..... | | 12 | 4 |
| Larvae..... | | 7 | 4 |

Table X

Number of stomachs examined ..... 9

Number of stomachs empty ..... 1

(Collected May 8, 1934.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Vegetable matter | 39.03 | | |
| Misc. vegetable refuse | | | |
| Coffee grounds | | | 1 |
| Animal matter | 60.97 | | |
| Coleoptera | | 82 | 8 |
| Ground beetle, Fam. Carabidae | | 10 | 3 |
| Tiger beetle, Fam. Cincindelidae | | 4 | 1 |
| May beetle, Phyllophaga sp. | | 5 | 4 |
| Strawberry weevil, Brachyrhinus ovatus | | 14 | 2 |
| Clover-root weevil, Sitona hispidula | | 12 | 1 |
| Other weevils | | 16 | 2 |
| Other beetles | | 21 | 4 |
| Larvae | | 9 | 1 |

Table XI

Number of stomachs examined ..... 5

Number of stomachs empty..... 2

(Collected June 14, 1934.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Vegetable matter ..... | 26.67 | | |
| Unidentified plant material | | | |
| Animal matter ..... | 73.33 | | |
| Coleoptera..... | | 36 | 3 |
| Ground beetle, Poecilus lucublandus..... | | 2 | 1 |
| Dung beetle, Aphodius sp. ..... | | 1 | 1 |
| Strawberry weevil, Brachyrhinus ovatus.. | | 2 | 1 |
| Clover-root weevil, Sitona hispidula.... | | 4 | 1 |
| Other weevils..... | | 5 | 2 |
| Other beetles..... | | 22 | 2 |
| Orthoptera Grasshoppers..... | | 4 | 2 |
| Hymenoptera Ants..... | | 9 | 2 |
| Arachnida Spiders..... | | 4 | 2 |
| Larvae..... | | 2 | 2 |

Table XII

Number of stomachs examined ..... 2

Number of stomachs empty..... 0

(Collected July 16, 1934.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Vegetable matter..... | 46.67 | | |
| Elderberry, Sambucus canadensis..... | | 9 | 2 |
| Animal matter..... | 53.33 | | |
| Coleoptera..... | | 11 | 2 |
| Dung beetle, Aphodius sp. ..... | | 8 | 1 |
| Carrion beetle, Fam. Silphidae..... | | 3 | 1 |
| Orthoptera | | | |
| Grasshoppers..... | | 3 | 1 |
| Hymenoptera | | | |
| Ants..... | | 2 | 1 |

Table XIII

Number of stomachs examined ..... 34

Number of stomachs empty ..... 6

(Collected August 16, 1934.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Vegetable matter ..... | 35.85 | | |
| Misc. vegetable refuse | | | |
| Coffee grounds..... | | | 1 |
| Egg shells..... | | | 1 |
| Orange seed..... | | 2 | 1 |
| Elderberry, Sambucus canadensis..... | | 119 | 16 |
| Wild grape, Vitis sp. ..... | | 7 | 4 |
| Poison ivy, Rhus toxicodendron..... | | 1 | 1 |
| Pigweed, Amaranthus sp. ..... | | 19 | 3 |
| Ragweed, Ambrosia elatior ..... | | 3 | 1 |
| Wild fruit, unidentified ..... | | 27 | 2 |

Table XIIIa

Number of stomachs examined ..... 34

Number of stomachs empty ..... 6

(Collected August 16, 1934.)

| Kinds of food | % | No. | Frequency |
|---|---|---|---|
| Animal matter..... | 64.15 | | |
| Coleoptera..... | | 261 | 27 |
| Ground beetle, Harpulis sp. ..... | | 3 | 2 |
| Ground beetle, Poecilus lucublandus..... | | 36 | 11 |
| Ground beetle, Calosoma sp. ..... | | 2 | 1 |
| Click beetle, Drasterius dorsalis..... | | 4 | 2 |
| Dung beetle, Aphodius sp. ..... | | 1 | 1 |
| Tiger beetle, Fam. Cincindelidae..... | | 3 | 2 |
| Strawberry weevil, Brachyrhinus ovatus.. | | 19 | 5 |
| Clover-root weevil, Sitona hispidula.... | | 100 | 13 |
| Other weevils..... | | 44 | 14 |
| Other beetles..... | | 49 | 20 |
| Orthoptera Grasshoppers..... | | 20 | 16 |
| Hemiptera True bugs..... | | 3 | 1 |
| Hymenoptera Ants..... | | 125 | 19 |
| Arachnida Spiders..... | | 2 | 1 |

Table XIV

Insect food of the starling
and
number of stomachs in which each occurred.

| | |
|---|---|
| Coleoptera | 255 |
| Clover-root weevil, Sitona hispidula | 87 |
| Strawberry weevil, Brachyrhinus ovatus | 67 |
| Ground beetle, Poecilus lucublandus | 39 |
| Ground beetle, Calosoma sp. | 15 |
| Ground beetle, Harpulus sp. | 8 |
| Dung beetle, Aphodius sp. | 20 |
| Click beetle, Drasterius dorsalis | 14 |
| Tiger beetle, Cincindelidae | 3 |
| Carrion beetle, Silphidae | 2 |
| May beetle, Phyllophaga sp. | 4 |
| Water beetle, Hydrous triangularis | 1 |
| Hymenoptera | |
| Ants | 54 |
| Orthoptera | |
| Grasshoppers | 51 |
| Crickets | 5 |
| Hemiptera | |
| True bugs | 10 |
| Arachnida | |
| Spiders | 6 |
| Unidentified larvae | 10 |

# XII

# BIBLIOGRAPHY

Bready, M. B.
1929. "The European Starling on His Westward Way." Knickerbocker Press. New York

Collinge, W. E.
1913. "The Food of some British Wild Birds." London, Dulau and Company.

Comstock, J. H.
1925. "An Introduction to Entomology"

Cooke, M. T.
1928. "The Spread of the European Starling in North America." U. S. Dept. Agri. Circ. 40.

Dearborn, N.
1917. "The English Sparrow as a Pest." U. S. Dept. Agr. Farmers' Bul. 493.

Forbush, E. H.
1915. "The Starling". Mass. State Bd. Agr. Circ. 45.

Forbush, E. H., and Fernald, C. H.
1896. "The Gypsy Moth." Boston, Wright and Potter Printing Company.

Gilmour, J.
1912. "Food of the Starling". Auk. Vol. 14, p. 9.

Hammond, J.
1912. "An Investigation Concerning the Food of Certain Birds." Journ. Agric. Sci., Vol. 4, pp. 380-409.

Kalmbach, E. R.
1928. "The European Starling in the United States". U. S. Dept. Agr. Farmers' Bul. 1571.

Kalmbach, E. R., and Gabrielson, E. N.
1921. "Economic Value of the Starling in the United States." U. S. Dept. Agr. Bul. 868.

Kinghorn, J. P.
1933. "A Report of the Distribution, Migratory Movements, and Control of the Starling in Australia," South Australian Dept. Agr. Jour. Vol. 36, No. 10, pp. 1154-1158.

Lewin, W.
1795. "The Birds of Great Britain". London, printed for J. Johnson.

BIBLIOGRAPHY (continued)

**Lewis, H. F.**
1927. "A Distributional and Economic Study of the European Starling in Ontario." Univ. Toronto Studies, Biol. Ser. 30.

**Liston, G. W., and Gore, S. N.**
1923. "The Fumigation of Ships with Liston's Cyanide Fumigator." Journal of Hygiene, Vol. 21, No. 3, May, 1923.

**Marlatt, C. L.**
1917. "The Food Bill of Destructive Insects of the United States." Reclamation Record, Vol. VIII, No. 9, p. 427.

**McAtee, W. L.**
1912. "Methods of Estimating the Contents of Bird's Stomach." Auk, 1912, Vol. 29, pp. 449-464.

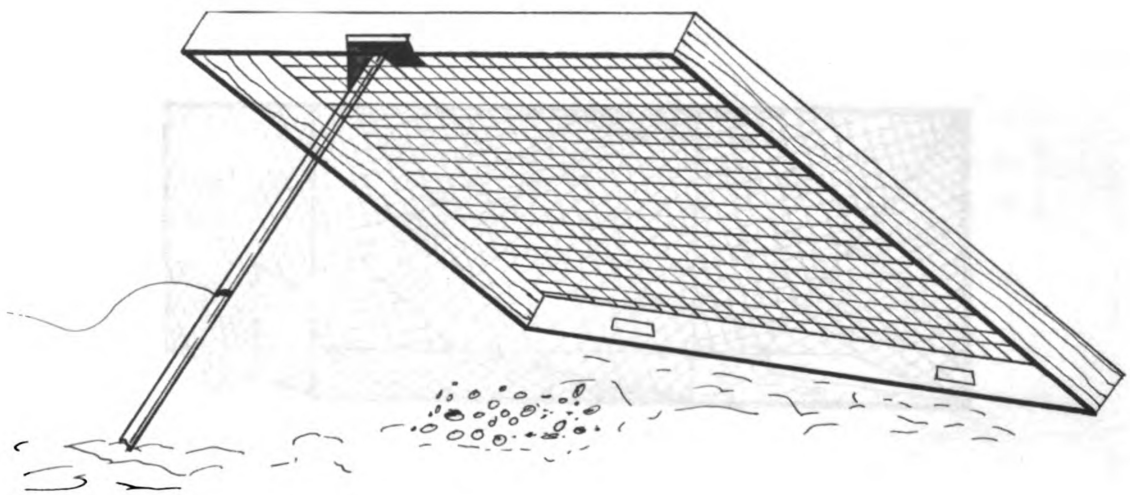
**Newstead, R.**
1908. "The Food of some British Birds." Suppl. Journ. Bd. Agric., 1908, Vol. 15, pp. 8-87.

**Stack, J. W.**
1933. "The European Starling in Michigan". Michigan Agricultural Experiment Station Quarterly Bulletin, Vol. 15, No. 4. May, 1933.

**Thomson, G. M.**
1922. "The Naturalization of Animals and Plants in New Zealand." Cambridge at the University Press.

XIII

FIGURE I

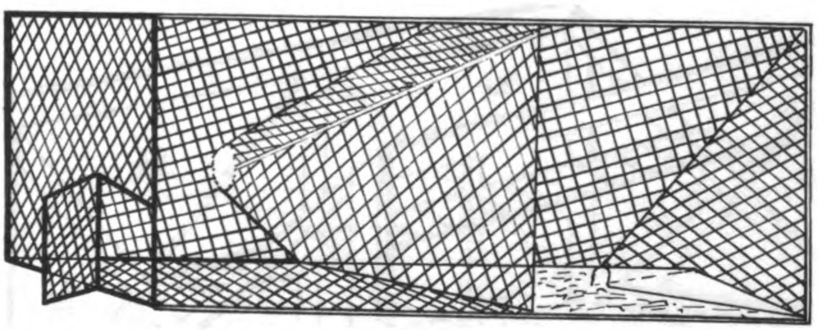


Sieve Trap

The sieve trap is adapted for service where food is abundant.

XIV

FIGURE II

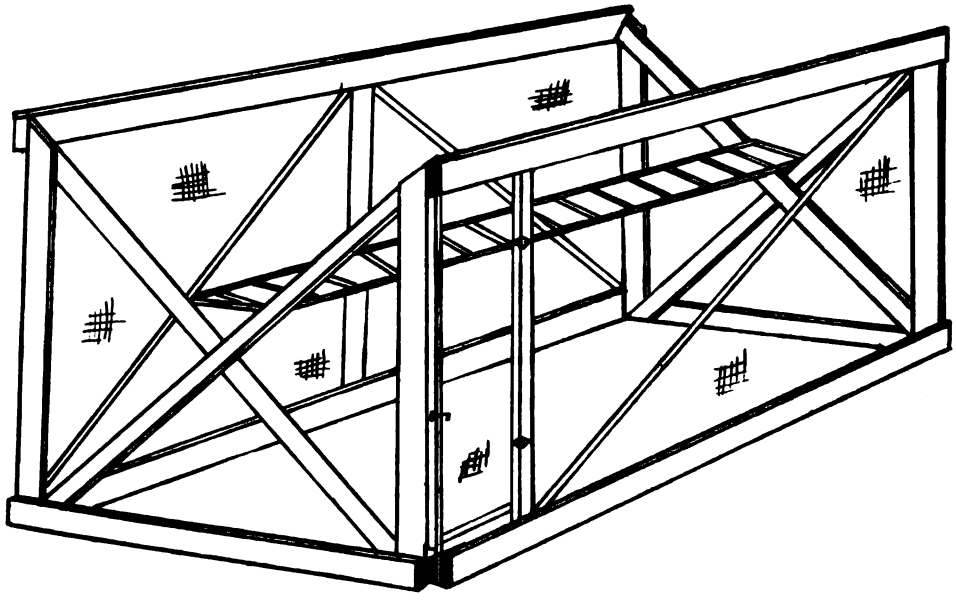


Funnel Trap

Especially important are simple and prompt action, portability, and cheapness, all of which are found in the funnel trap. (Side removed to show interior.)

XV

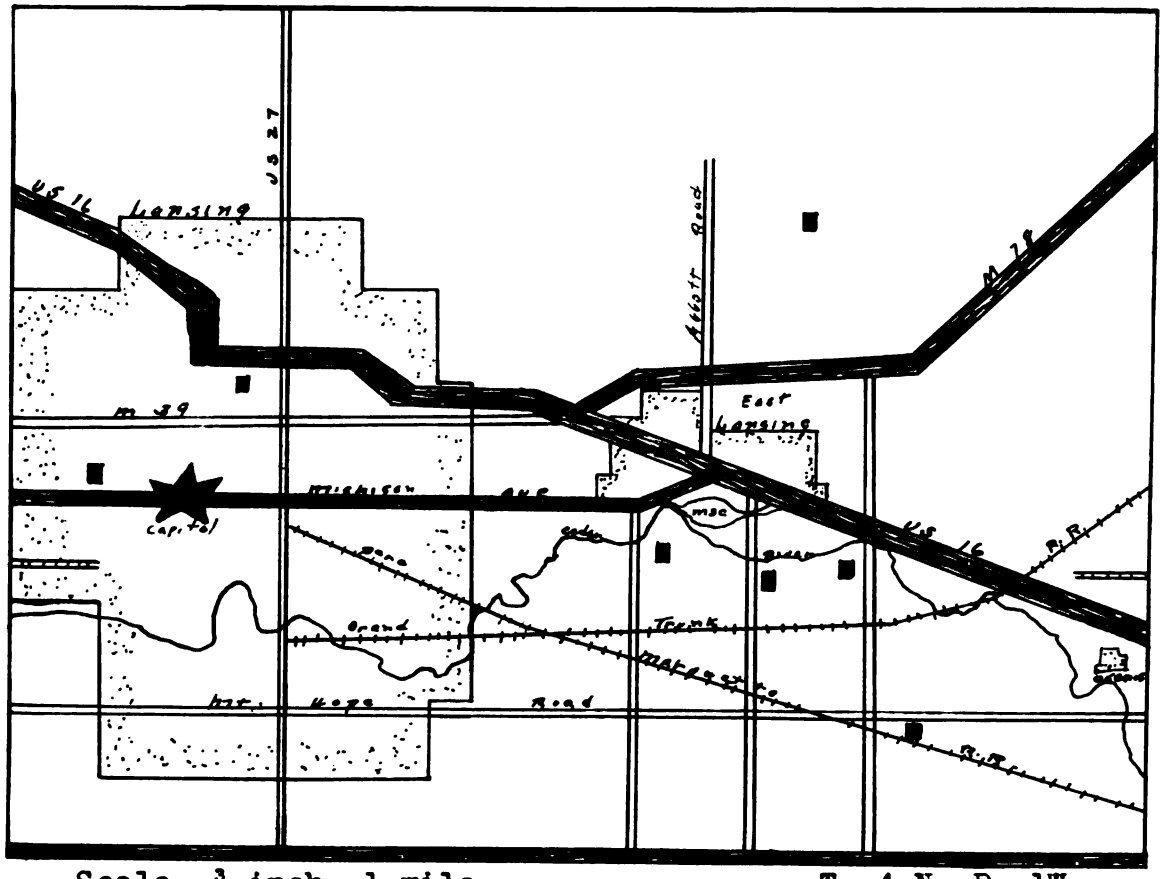
FIGURE III



The Australian Crow Trap slightly modified for the purpose of trapping the starling.

XVI

Map I



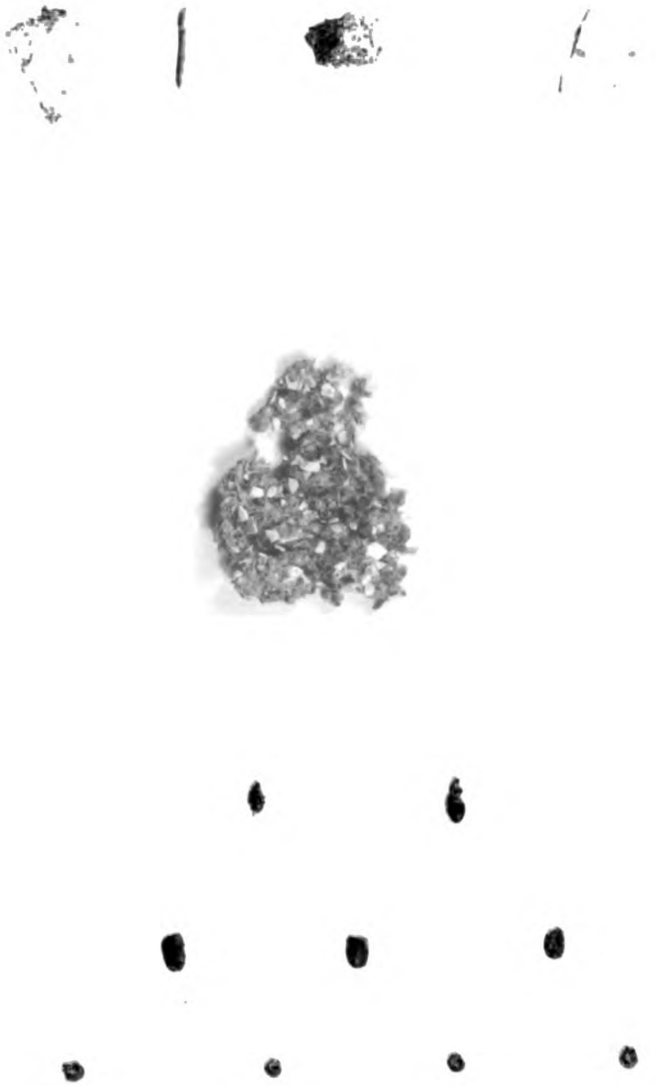

Scale- ¾ inch- 1 mile T. 4 N. R. 1W.

Ingham County

Map of the area showing where the starlings were collected and the locations of their roosts.

XVII

PLATE I



Stomach contents of an adult starling collected in January. Except for the two weevils, the elytra of three, and the thorax of four other weevils shown at bottom of plate, this bird's food consisted entirely of animal and vegetable refuse. Note the animal bone and egg shells in top row. The mass in the center is composed of small bits of egg shells, bone, coffee grounds, and other refuse. This is the winter food of the starling in this locality.

XVIII

PLATE II

Stomach contents of an adult starling collected in September. Note the variety and amount of food that may be taken by one bird. This bird's food consisted of the remains of insects and wild fruit. There were remains of at least eight grasshoppers, thirteen beetles, eighteen weevils, five spiders, and twenty-four seeds of the Virginia creeper that were identified. The large mass in the lower left-hand corner is compose of parts of the same insects, and in the right-hand corner are the skins of the Virginia creeper.

XIX

PLATE III

Picture taken at mid-day of starlings while a number of the birds were resting and singing between intervals of feeding, near a garbage ground.

XX

PLATE IV

Picture of a pine grove that is located on Michigan State College grounds, and, which is a favorite fall and spring roosting place of the starling. As this picture was taken at about sundown, note in lower right-hand corner the starlings coming in to roost.

XXI

PLATE V

The top of a silo as here pictured or a barn (See PLATE VI) is a common winter roosting place of the starling.

XXII

PLATE VI

A typical winter roosting place of the starlings that remain over winter in this vicinity.

XXIII

PLATE VII

The chimney on top of the building here pictured is a typical day-warming station of the starling during the cold winter months.

XXIV

PLATE VIII

A regular winter feeding ground of the starling. In the center of the field note the birds feeding on the garbage and refuse and paying no attention to the swine, that are near them.

ROOM USE ONLY

Jan 2 '37
Jan 18 '37
Feb 1 '37
Mar 10 '
Apr 10 39
Apr 24 39
May 22 39
May 28 '40
Apr 23 47
Jul 12 47
Oct 4 '49
De 4 '52
MY 4 '54
NOV 16 1961
NOV 30 1961
11/29

ROOM USE ONLY

MICHIGAN STATE UNIV. LIBRARIES
31293000938153