THE FOOD OF BIRDS.

By S. A. FORBES.

Excluding the inhabitants of the great seas, birds are the most abundant of the Vertebrata, occupying in this great subkingdom the some prominent position that insects do among invertebrate animals. These two classes thus constitute exceptions to the general rule that the higher and more active animals of each group are the less abundant—a fact doubtless largely due to the immense advantage given them by their power of flight. It is this which, by making migration possible, enables birds to choose their climates and their seasons—thus avoiding, in a great measure, one of the most destructive checks upon the multiplication of animals. Their disproportionate number, their universal distribution, the remarkable locomotive power which enables them readily to escape unfavorable conditions, and their immense activity and higher rate of life, requiring for their maintenance an amount of food relatively enormous, give to birds in their relation to the pursuits and interests of man a significance which only here and there one seems ever fully to have realized. A few figures will illustrate and enforce this proposition.

The careful estimates of three ornithologists and experienced collectors give, as an average of the whole bird-life of Illinois, three birds per acre during the six summer months. That is to say, if all the birds of the year, except the swimmers, were concentrated in these six months, equally distributed throughout them and equally scattered over the State, we should have three birds on every acre of land. It is my opinion that about two-thirds of the food of birds consists of insects, and that this insect food will average, at the lowest reasonable estimate, twenty insects or insects' eggs per day for each individual of these two-thirds, giving a total for the year of seven thousand two hundred per acre, or two hundred and fifty billions for the State—a number which, placed one to each square inch of surface, would cover an area of forty thousand acres.

Estimates of the average number of insects per square yard in this State gives us, at farthest, ten thousand per acre for our whole area. On this basis, if the operations of the birds were to be suspended, the rate of increase of these insect hosts would be accelerated about seventy per cent., and their numbers, instead of remaining year by year at the present average figure, would be increased over two-thirds each year. Anyone familiar with geometrical ratios will understand the inevitable result. In the second year we should find insects nearly three times as numerous as now, and, in about twelve years, if this increase were not otherwise checked, we should have the entire State carpeted with insects, one to the square inch over our whole territory. I have so arranged this computation as to exclude the insoluble question of the relative value of birds and predaceous or parasitic insects, unless we suppose that birds eat an undue *proportion* of beneficial species.

This is intended only as an illustration of the great power of birds for good or evil, and not as a prediction of the consequences of their total destruction. These consequences would not be by any means so simple, but would apparently be fully as grave.

Let us take another view of this matter. According to the computation of our first State Entomologist, Mr. Walsh, the average damage done by insects in Illinois amounts to twenty million dollars a year. These are large figures, certainly; but when we find that this means only about fifty-six cents an acre, we begin to see their probability. At any rate, few intelligent farmers or gardeners would refuse an offer to insure complete protection, year after year, against insects of all sorts for *twenty-five* cents an acre per annum; and we will, therefore place the damage at one-half of the above amount—ten million dollars per annum.

Supposing that, as a consequence of this investigation, we are able to take measures which shall result in the increase, by so much as one per cent., of the efficiency of birds as an insect police, the effect would be a diminution of the above injury to the amount of sixty-six thousand

dollars per annum, equivalent to the addition of over one and one-half million dollars to the permanent value of our property; or, if, as is in fact a most moderate estimate, we should succeed in increasing the efficiency of birds five per cent., we should thereby add eight and one-fourth million dollars to the permanent wealth of the State, provided, as before, that birds do not eat unduly of beneficial species.

These figures will be at once rejected by most naturalists as absurdly low. The young robin of Prof. Treadwell (a bird whose fame has extended over both hemispheres) required not less than sixty earthworms a day to keep it alive. A pair of European jays have been found, Dr. Brewster informs us, to feed their brood half a million caterpillars in a season, and to eat a million of the eggs in a winter. I have myself taken one hundred-and seventy-five larvæ of Bibio from the stomach of a single robin, and the intestine probably contained as many more.

Compared with these numbers, my two thousand four hundred insects a year for each bird seem certainly many times too few; and similar criticisms might very probably be made on other items of the estimate. I prefer, however, to put these matters with a moderation which will command general assent, especially as we see that the importance of the subject does not require exaggeration. Of course the individual farmer or gardener could, by intelligent and careful management, if he knew just what to do, increase the value of his own birds far beyond his individual share of the above-mentioned aggregate.

The subject has, also, a considerable scientific interest. Since the struggle for existence is chiefly a struggle for subsistence, a careful comparative account of the food of various competing species and genera, at different places and seasons and at all ages of the individual, such as has not heretofore been made for any class of animals, cannot fail to throw much light upon the details, causes and effects of this struggle. The flexibility of the food-habits of the widely ranging species, the direct effects of normal departures from the usual average of food elements upon the origin of variations and the general reactions of birds

upon their organic environment, are examples of subjects upon which light should be thrown by this investigation.

That an element of such transcendent importance to all agricultural pursuits, and, through these, to the general welfare, ranking evidently among the larger forces of nature which affect powerfully and continuously the most essential interests of the country, should never have been made the subject of continuous, systematic and accurate study, seems, at first, a surprising phenomenon. It is a subject, however, presenting few attractions to the scientific student, requiring a great amount of time, a good knowledge of ornithology, a minute acquaintance with considerable parts of entomology and botany, and a good degree of skill with the microscope, while it profits the student but slightly relatively to the work done, by way of an increase of his knowledge. What little he learns is gained at every disadvantage. His material is in the worst possible condition for study; and the personal result of his labor is a continual discouragement to him. That whatever individual impulse should have been turned in this direction should have been exhausted long before definite or conclusive results were reached, was, therefore, inevitable. The student soon turned his attention to matters more attractive and more fruitful in knowledge and reputation. In short, this is emphatically one of those questions which, if studied exhaustively at all, must be studied chiefly in the public interest.

The primary purpose of this investigation is the determination of the exact relation of the different species of birds, and of the class in general, to agriculture and horticulture; it would be disgraceful to those in charge of this investigation if the opportunity were to be thrown away which it offers for an increase of that knowledge of the habits and relations of birds whose interest is strictly scientific rather than practical, and this has therefore been held in mind throughout as a legitimate secondary purpose. We need a full knowledge of the direct and indirect benefits and injuries attributable to each species—the ratio of benefit to injury, where both are apparent, the numbers, distribution and migrations of all, and, in fact, a full acquaintance with their entire natural history.

The direct injuries due to birds commonly take the form of depredations upon the fruits of the garden and orchard, and upon the grain in the fields. It is, of course, necessary to know the species chargeable with these, and the ratio which such injuries bear to the benefit likewise attributable to them. The good done by birds is almost wholly indirect, consisting chiefly in the destruction of insects which would become directly or indirectly injurious if allowed to live. Much of the apparent evil for which they are held responsible is also indirect; viz., the destruction of parasitic and predaceous insects which, if not destroyed, would help to diminish the numbers of injurious species. I wish, however, to call especial attention to the fact that *the regular and continuous destruction of parasitic and predaceous insects by birds is not necessarily an evil.* Paradoxical as this statement may seem, it is fully borne out by the following facts:

The most serious losses of the farmer and gardener due to insects are not consequent upon the ordinary and uniform depredations of those species whose numbers remain nearly constant, year after year, but upon excessive and extraordinary depredations of those whose numbers are subject to wide fluctuations. Vegetation has become so far adjusted to our crickets and ordinary grasshoppers, etc., that the foliage they eat can be spared without injury to the plant, and the damage done by them is commonly imperceptible.* It is far otherwise, however, with the vast hordes of the Rocky Mountain locust, of the Colorado potato-beetle, of the chinch-bug and of the army-worm, and many other species which occasionally swarm prodigiously and then almost disappear from view. The injurious species are chiefly the oscillating ones, and the dangerous species are those which show a tendency to oscillate. Anything which tends to limit the fluctuations of an oscillating species, or to prevent the oscillation of a stable species is, therefore, highly useful, while anything which tends to intensify an oscillation, or to convert a stable species into an oscillating one, is as highly pernicious.

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* See Kirby and Spence's Introduction to Entomology, 4th ed., 1822, Vol. I, pp. 247-258.

Now a species is stable because the rate of its reproduction is uniform, because the checks upon its increase are substantially unvarying, and because these two forces balance each other. To set up any vibration in any one of these checks, will necessarily cause a corresponding vibration in the number of the species limited by it. More explicitly, to set up an oscillation in a predaceous or parasitic species must produce a reverse oscillation in the species parasitized or preyed upon. As the former increases, the latter must diminish, and *vice versa*. But either a marked decrease or a marked increase of a species will cause it to oscillate, unless made with extreme slowness—a slowness so extreme as to allow progressive adjustments of all kinds to keep pace with it.

Taking a predaceous beetle as an example, we see that a rapid decrease of its numbers, partly relieving the species which it preys upon from one of the usual checks upon its multiplication, will affect an increase in those species—will thus render the food of the predatory insect more abundant. This will, in turn, faciliate individual maintenance of the predatory insect and thus stimulate reproduction, initiating a forward movement, which, proceeding at a geometrical ratio, must continue until the predaceous species becomes too numerous for its food, or reaches other limitations; when destruction of the excess produced will send it back below the average line again. An oscillation will thus necessarily arise which must be reproduced in the food species connected with it.

On the other hand, if the predaceous species be suddenly increased in number by a diminished power or stringency in one of its accustomed checks, the process will simply be reversed, but the resulting oscillation will be the same. The predaceous species will increase geometrically until its food supply becomes insufficient for it, then by starvation and diminished reproduction it will be again reduced, and so on indefinitely. *Any* marked disturbance of a *fixed adjustment* between the rate of reproduction and the death rate, whether it result in increase or decrease, whether it affects a beneficial or an injurious species, is, therefore, in itself, an *immediate* evil; only to

be incurred where the ultimate good is a certain and liberal compensation.

Again, it is becoming evident that carnivorous insects and insectivorous birds all have their food-preferences. Probably no one species—certainly no one family—of birds or insects would quite take the place of another. Supposing, then, that some birds eat predaceous insects, in part, as well as phytophagous ones—eat the former, perhaps, in undue ratio—still, as the chances are practically infinite that the predaceous insects it eats would not, if allowed to live, eat precisely the same amount and kind of injurious insects as the bird itself, by destroying the bird we should merely liberate a second cause of numerous oscillations Those species neglected by the carnivorous insects would increase beyond their bounds, and those eaten by them would be unduly diminished. It follows from the foregoing reasoning that, as a general rule, *a bird should not be discredited for the regular and established habit of destroying predaceous or parasitic insects,* unless it can be shown that those insects would, if left to themselves, check the fluctuations of some injurious species, or afford a better safeguard against the possible fluctuations of others. It must also be shown that this prospective good will not be overbalanced by some greater evil. In short, the whole burden of proof is on the side of those who would disturb the fixed order of Nature.*

The most important question respecting the relations of birds to insects is, therefore, the determination of those species of birds which serve the most useful purpose as a *constant* check upon those insects which are either injurious or capable of becoming so if they appear in largely increased numbers. Fortunately, whatever oscillations or irregularities may arise, and whatever may be their cause, the general tendency of things is towards their correction. In course of time, if new disturbances do not continually unsettle even the newest arrangements, they will usually right themselves more or

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* For a discussion of the general subject, see Herbert Spencer's Principles of Biology, Vol. 2, Pt. VI, Chap. II, p. 397; and the preceding paper, "On Some Interactions of Organisms."

less completely. The methods of this spontaneous restoration of the unsettled balance of natural forces, are, of course, worthy of the most careful study. It is only by working in harmony with them that we ourselves can help to readjust the disturbed order. A fuller treatment of this matter may best be postponed until the general discussion of results obtained by the investigation. Enough has been said to show that the subject, although complicated and difficult, will richly repay the study necessary to its mastery. A full and accurate knowledge of the mutual relations of the various forms of organic life of a region, both normal and abnormal, is certainly quite as essential to the general welfare as a knowledge of the chemistry and geology of its soils, the peculiarities of its meteorology, or any other part of the inorganic environment.

Concerning the special subject of this paper the knowledge we need is such that we shall be able to afford for every species a tolerably correct answer to the questions, What would be the main consequences if this species were exterminated? if it were reduced to half its present numbers? What if it were doubled in number? if it were quadrupled? When this is known, we shall evidently be able to act wisely and with the best results. That these questions are not unanswerable, I shall undertake to prove by answering them in substance, for several species, in this paper, and by demonstrating the sufficient accuracy of the answers.

Methods.

Three methods are possible in determining the food of birds. The birds may be fed in confinement, and the kinds of food apparently preferred and the amount eaten may be noted. This evidently shows only what the bird *will* eat when restrained of its liberty, of such food as may be placed before it, and furnishes few data which we can use with safety in making up an account of its food in freedom, when foraging for itself. The state of confinement is so abnormal for a bird that on this account, also, we can rarely reason from its habits in that state to its ordinary habits. This method is, therefore, available only

for the solution of a few separate questions. A far more useful method, and, in fact, the usual one, is that of watching birds while taking their natural food in the free state. Now and then a fact may be learned in this way which would escape detection in any other—such as the perforation of cocoons of Cecropia by the downy woodpecker reported by F. M. Webster*—but usually this method is of wholly secondary usefulness. The difficulty is very great of telling with certainty, in the great majority of cases, just what a bird is eating, even if one watches it with a glass. The notion of the food resulting must be distorted, as the species will be seen much more frequently and clearly in some of its haunts than in others. It is impossible by the use of this method, even to *guess* intelligently at the *ratios* of the different elements of the food—a matter of the first importance to an understanding of the subject. It yields very few facts for the time expended, and these, in nearly every instance, could have been learned in much less time, with far greater certainty, and in far greater detail by the following method. Finally, it affords no means of reviewing observations, but the impressions received from the hasty and imperfect glance of a moment must either be rejected wholly or must stand as verified observations.

By the third method, however, that of examining the contents of the stomachs after death, each bird usually affords a large number of objects which can be studied critically, and in detail, and can be indefinitely preserved for reference. These objects give a nearly or quite complete and impartial record of the food for some hours past—those elements taken in a thicket or a tree-top being as evident as those taken on open ground. They are usually identifiable by the skilled student. Even very minute fragments will tell as much as the out-of-door observer can learn under the most favorable circumstances. In the great majority of cases it is possible so far to fix the kinds of food as to bring every element clearly into one of the three classes, beneficial, injurious or neutral.

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* In an unpublished paper read at the meeting of the Illinois State Nat. Hist. Soc., at Bloomington, Feb. 1880.

And here opportunity is afforded for careful and trustworthy estimates of the ratios each element bears to the other, so that the average significance of the food can be discovered. Practically, this is indispensable. Whatever method fails of this, while its results may be interesting, and may have a certain general value, can never afford a basis for anything better than indefinite opinion. It can never settle the case for or against the birds.

This method, while by far the best of the three, has its slight disadvantages. Some things eaten by birds leave no appreciable trace in the stomach. For example, it is difficult, by this method, to determine with certainty those birds which greatly injure grapes by breaking the skin of the fruit and sipping the juice. This difficulty applies only to liquid food. Other errors may arise from the shorter or longer periods for which different kinds of food will last in the stomach; but of this we have no proof. I have depended almost wholly on this third method of investigation, because it is evidently the most profitable and reliable, and because the method of cursory observation having been resorted to heretofore, most of the recorded facts are due to it. So far as one method could correct the deficiencies of the other, it was desirable that this more tedious and laborious but more fruitful one should be given greater prominence.

The stomachs of birds shot at all times of the year, and in all parts of the State, have been preserved in alcohol, each labeled with name, date and localilty. The contents of these stomachs were afterwards transferred, for permanent preservation, to separate vials, bearing copies of the original labels. They were then examined, bit by bit, with the microscope, with whatever powers were necessary to the fullest possible understanding of each fragment. It has been no uncommon thing to spend half a day over a single bird. Full notes of the materials found in each stomach were made on separate slips, and after this careful examination an estimate was made and recorded of the ratios of the different elements to the whole mass of the food of each individual. Objects which I was not able to identify have usually been sent to some more

experienced specialist, except where determination was evidently impossible.*

These memoranda were afterwards classified and the data arranged in tabular form, so as to give a complete recapitulation and summary of the food of each species for each month. The tables thus constructed have furnished the basis for the discussion of the food of the species; and a similar tabular summary of the food of the family has been used in a similar way. Thus every fact observed appears in the final conclusion, and receives, there, its due weight.

Family TURDIDÆ. The Thrushes.†

This family consists, in Illinois, of nine species of birds; the robin, the catbird, the brown thrush, the wood thrush, the hermit thrush, Swainson's thrush, the Alice thrush, the mocking-bird and Wilson's thrush or the Veery. The first four of these stay with us in this latitude during the summer; the others emigrate beyond our borders, except the mocking-bird, and that only reaches the southern third of the State in any considerable numbers. I have now carefully studied the food of three hundred and fifteen specimens of this family, shot in various parts of Illinois, and in all months from February to October.

Turdus migratorius, L. The Robin.

This bird, as familiar to every one as the domestic cat, is the most abundant of the thrushes, and plays so large a part in the economy of the farm and garden as to make the question of its food one of unusual importance. The species ranges from the Atlantic to the Pacific and from the Mexican plateau to the Arctic circle, at home in all the latitudes and longitudes of this vast and varied country. I cannot, of course, attempt to determine, at present, the food of the species throughout this immense area,

* For assistance of this sort, I am indebted above all others to Prof. C. V. Riley, Chief of the U. S. Entomological Commission at Washington, D. C. I have called upon him especially for the identification of larvæ, and my drafts have never been dishonored.

† The general reader is referred to the "recapitulations" and the discussions of "the economic relations" of each species for the most important facts of these papers.

but shall endeavor to show only what it eats under ordinary circumstances within the limits of Illinois. The species is not strictly migratory, but is reported as wintering, sometimes in considerable numbers, as far north as the White Mountains, in New Hampshire. It occurs but very rarely in winter in central or northern Illinois, as there is at that season not sufficient food to tempt it to brave our prairie winds. On the other hand, it is comparatively rare in southern Illinois in summer, but usually abundant there in autumn and winter, so that as far as this State is concerned, it is practically a migrant within our limits. In the latitude of Bloomington its advent depends on the forwardness of the season, but it usually appears not far from the first of March, and the last of the species are gone by October 15th or November 1st.

The nesting habit of this species is so varied that no special provision need be made by those wishing to encourage its multiplication. The lower branches of orchard trees are probably its favorite situation, but it selects the most various places and uses little art or caution in the concealment of its nest.

February.

The robin appeared at Bloomington, this year, in considerable numbers, about the middle of February, the spring being an unusually early and open one.

Eleven specimens were shot at Normal on the 27th and 28th, and their stomachs carefully searched for food. We first note that ninety-nine per cent. of the food of these birds was insects, the remaining one per cent. being spiders. About fourteen per cent. of the food of these early birds consisted of caterpillars, all of them eaten by three birds, while seventy-six per cent. taken by every bird, was the larva of a slow, torpid fly, abundant in early summer, closely related to the Tipulids or crane-flies (*Bibio albipennis*, Say). Prof. J. W. P. Jenks, now of Brown University, found this same larva to constitute about nine-tenths of the food of the robins examined by him in Massachusetts, in February and March, 1858—a

fact which indicates a remarkable fixity of food habits, unaffected by twenty years of time and a distance of a thousand miles. The caterpillars were partly cutworms, about one-third of them being recognized as the "speckled cutworm" (*Mamestra subjuncta*, G. & R.), a species supposed to be injurious to cabbages.* Coleoptera occurred in the stomachs of these birds only in small numbers, comprising about four per cent. of the food. Half of these were Carabidæ, eaten by six of the eleven birds, a fourth were scavenger beetles (*Aphodius inquinatus*) and a fourth were larvæ of Lampyridæ, including one of Chauliognathus. A few fragments of curculios were also found.

Grasshoppers were present in about the same quantity as beetles, but only two birds had eaten them. One had taken *Tragocephala infuscata* and another a Tettigidea.

The Hemiptera (one per cent.) were chiefly soldier-bugs (Pentatomidæ), eaten by five of the birds. The spiders had been taken by two birds, and one had eaten a small thousand-legs (Iulus).

The striking feature of the month is the great predominance of the larva of Bibio in the food, a fact which will seem of small or great importance according to our views of the habits of this larva. By Dr. Fitch, former state entomologist of New York, as quoted by Prof. Jenks,† it was believed to be especially injurious to grass lands, and the robin was therefore credited with an indispensable service to the farmer. Dr. Fitch gave no actual observations, however, and his opinion was apparently speculative. Mr. Walsh‡ and Prof. Riley have since reported that the larva feeds only on decaying vegetation and is therefore harmless, if not indeed useful. Prof. Riley has, in fact, reared it in rotten leaves where no living vegetation was accessible. Finding the robin feeding on it so excessively in spring, I took some specimens from among the roots of grass and weeds in a raspberry garden and others from the stomach of a robin, examined

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* Prof. Riley, by whom my specimens were determined, says that he reared the larvæ on cabbage, which it ate voraciously.

† Journal of the Massachusetts Horticultural Society, Boston, March, 1859, p. 152.

‡ The Practical Entomologist, Vol. 2, No. 4, p. 45, January, 1867.

the contents of the intestine with a microscope, and mounted the material for permanent preservation. These larvæ were filled with vegetation, some of which was recognized as the leaves and rootlets of the grass-like weeds of the vicinity, while the remainder evidently consisted of the leaves of net-veined plants, probably trees, by which the ground was overshadowed. The frequency with which these tissues were found penetrated by fungi showed that this vegetation was in a decaying condition. I next looked through my notes of the contents of the stomachs of meadow-larks shot at the very time when the robins were stuffing themselves with this Bibio larva, and found that the meadow-larks had not eaten so much as one. As they search the ground more closely than the robin, relying almost as fully on insect food, this seemed good evidence that the larva occurs here chiefly in situations frequented by the robin and not by the meadow-lark—that is, in gardens, groves and the like. It was only in such situations that I was able to find it myself. There is, therefore, no present evidence that this larva is now injurious even in the slightest degree, and the robin is not entitled to any very positive credit for its destruction. There is some probability, however, that if the insect were allowed to increase indefinitely, it would become injurious to living vegetation; and if so, the high rate of its multiplication would make it a seriously destructive pest. The immense numbers annually destroyed by the robin may be inferred from the fact that I have counted as many as one hundred and seventy-five from the stomach of a single bird; and as fully half of the food of the robin for a month consists only of this insect, fifty larvæ a day for each robin, or one thousand five hundred for the month, will be a very moderate estimate.

About five per cent. of the food of February consisted of beneficial insects.

March.

Nine birds were shot on four different days of March, between the 9th and 31st, six of them in McLean county, and three at Galena. Four of these had eaten Bibio larvæ again, which amounted to thirty-seven per cent. of the

food of the month. Four birds are to be credited with the thirty per cent. of caterpillars destroyed. About two-thirds of these were cutworms, among which *Agrotis messoria** was recognized. A few were the larvæ of Arctiidæ, probably Callimorpha. Eighteen per cent. of the food eaten by seven of the birds, was made up of Coleoptera, two-thirds of which were scavenger beetles (*Aphodius fimetarius* and *A. inquinatus*). Carabidæ and their larvæ made but two per cent. of the food. Harpalus was the only genus distinguished. A few Histeridæ, a few wireworms (larval Elateridæ), a soldier-beetle (*Telephorus bilineatus*), and traces of long-snouted curculios† were the remaining beetles. Hemiptera were found in somewhat larger number and variety than in the preceding month. Among these were the raptatorial species, *Coriscus ferus*, and also *Phytocoris lineolaris*, *Cœnus delius* and *Euschistus servus*. The soldier-bugs (Pentatomidæ) made about two-thirds of the three per cent. of Hemiptera taken in this month. Grasshoppers were present in about the same amount as before, and the same species appeared in the food. A few spiders and thousand-legs and berries of sumach (*Rhus glabra*) complete the list. The large percentages of cutworms, Bibio larvæ and dung-beetles are thus seen to be the principal features of the food of these birds. Excluding the Bibionidæ, about thirty-seven per cent. of the food was composed of injurious insects and six per cent. of beneficial species.

April.

The robin is represented in my notes of this month by seventeen birds shot at Normal, Warsaw, Elizabeth and Hanover (JoDaviess county), Waukegan and Evanston, at various dates between the 2d and 27th. The high insect averages are maintained. Caterpillars are nearly as

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* All the cutworms but one mentioned in this paper were determined by Prof. Riley.

† I have used throughout this paper the somewhat artificial divisions of Longirostres and Brevirostres as applied to the Rhynchophora, because nearly all the especially injurious species belong to the former section. In fact, I have not hesitated to use an obsolete classification wherever the groups thus formed correspond better to the differences of food habit or of economic value than those made by the highest modern authorities.

abundant as before and make about a fourth of the food. Arctiidæ and Phalænidæ (measuring-worms) appear in some quantity, but of unrecognized species. The larvæ of Bibio fall to eight per cent. and do not again appear in the food during the year.

A strong upward jump in the ratio of Coleoptera, which rise in this month to forty-two per cent., is doubtless due to the greater activity of beetles during this season of their amours. The effect is clearly seen by running along the line of averages for Coleoptera from February to October, viz.: 4, 18, 42, 44, 15, 9, 7, 5, 3. The upward swell which commences in March and dies away in June, corresponds to the time when the procreative impulse overcomes the usual discretion of these insects, and draws them out more freely into the open air. It is in this month that the bird makes its principal attack on the predaceous beetles, which are represented by an average of seventeen per cent., eaten by eleven of the birds. Thirteen heads of *Harpalus herbivagus*, for example, were taken from the stomach of a single robin. Other species of Harpalus, *Brachylobus lithophilus*, *Anisodactylus baltimorensis*, *Geopinus incrassatus*, Pterostichus and Amara were observed. Scarabæidæ also occur in unusual abundance at this time (fifteen per cent.), as might be anticipated by one who recalls the numbers in which they are now seen flying in the air. May-beetles (Lachnosterna) make about half of these, and Aphodii the other half. A single bird had happened upon an interesting store of water-beetles (Hydrophilidæ) which included a specimen of *Hydrocharis obtusatus*, several of *Philhydrus cinctus*, and a number of Helophori unknown to me. Rhynchophora amount to about three per cent. of the food. Only Centrinus and *Graphorhinus vadosus* were recognized. Minor items were the traces noticed of Elateridæ, Lampyridæ and Chrysomelidæ.

Hemiptera stand at about the ordinary average (three per cent.), as usual chiefly Pentatomidæ. *Coriscus ferus*, some indeterminable Reduviid, *Podisus modestus* and *Hymenarcys nervosa* were the principal forms. The Orthoptera (five per cent.) call for no especial remarks, neither

do the Arachnida (one per cent.). One bird had eaten a predaceous thousand-legs (Geophilus), and two had eaten earthworms (five per cent.) The infrequent occurrence of the last in the stomachs of robins surprised me. It is probably due partly to the greater digestibility of these soft worms as compared with the chitinized skins of insect larvæ, and partly to the fact that the greater part of those taken by the robin are fed to the young. A few sumach berries eaten by the woodland robins shot in northern Illinois complete the dietary of the month.

The April food of the robin is, therefore, especially noticeable for the greatly diminishing number of Bibio larvæ and the excessive number of beetles eaten, especially of the Carabidæ and Scarabæidæ.

May.

Fourteen birds were studied for this month, all but two of them from various parts of northern Illinois. The record of May is substantially a duplicate of the April list, except in a few particulars. The Bibio larvæ are replaced by seven per cent. of adult crane-flies (Tipulidæ) and the Carabidæ drop to four per cent., the balance being almost exactly replaced by the scavenger beetles and leaf-chafers added. Chlænius and *Agonoderus partiarius* are among the captures of these birds. Lachnosterna rises to its highest point in May, and is represented by seventeen per cent. of the food. Wireworms (Elateridæ) are likewise unusually abundant, for some unexplained reason, amounting to eight per cent. A single robin had eaten a single potato beetle (*Chrysomela* 10-*lineata*), and one had taken a specimen of *Prometopia* 6-*maculata*. *Cœnus delius* appears among the Pentatomidæ and Polydesmus among the thousand-legs; and sumach berries again occur.

June.

With June the robin revolutionizes his commissariat. The insect ratios, which have averaged ninety-five per cent. during the preceding months, now drop to forty-two, and remain at or below this point for the rest of the year; and this lack is compensated by the appearance of

fifty-five per cent. of cherries and raspberries. The loss falls chiefly upon the Diptera and Coleoptera, the former dropping from eleven per cent. to less than one, and the latter from forty-four per cent. to fifteen. Among the families of Coleoptera we see from the table that it is the Scarabæidæ which benefit chiefly by this diversion of the robin's activities; for, while the other families remain about as before, this family drops from twenty-two per cent. in the preceding month to one in this.

Taking up the details of the food of the thirteen June robins, ranging from the 10th to the 29th, all shot at Normal, we first notice the larger percentage of ants. These have hitherto occurred in but trifling numbers—(three per cent. in the preceding month)—but are now more than twice as common in the food. This fact is doubtless due to the same cause as the still greater relative abundance of the ants in June in the food of the bluebird—to the abundance of the winged perfect forms of some species at this time. Caterpillars stand at seventeen per cent., seven per cent. being cutworms. Carabidæ form six per cent. of the food. Among the adults were *Callida punctata*, *Cratacanthus dubius*, Agonoderus and Anisodactylus. Wireworms were again numerous, four per cent. being eaten by seven of the birds. Forty-seven per cent. of the food of these birds was cherries and eight per cent. raspberries.

July.

The fourteen July birds were evidently reveling in the fruit garden, raspberries, blackberries, and currants forming seventy-nine per cent. of the food.*

On the other hand, but twenty per cent. of the food was insects and one per cent. was spiders. The caterpillars furnish only four parts of the food, and beetles but nine parts, of which two-thirds were Carabidæ. Evarthrus, Pterostichus and Amara were noticed among these. Scarabæidæ, Elateridæ, and Rhynchophora each one per cent., a mere trace of Hemiptera, four per cent. of Orthoptera (chiefly crickets), eaten by two of the birds, and

* I have not ordinarily attempted to distinguish raspberries from blackberries in the stomachs of birds, but have set down either one or the other, according to the advancement of the season.

one per cent. each of Arachnida and Myriapoda are the remaining trivial details.

August.

This month is represented by twenty birds, all shot at Normal,* at repeated intervals from the fourth to the thirtieth. With the disappearance of blackberries, the food of this bird returns substantially to the status of June. Insects increase again to forty-three per cent. and fruits fall to fifty-six. Ants remain at the usual point of insignificance, caterpillars rise again to seventeen per cent., about two-thirds of them Noctuidæ. Coleoptera figure at seven per cent., only two per cent. being Carabidæ, Rhynchophora rise to four per cent., eaten by nine of the birds; and, except a stray Nepa picked up by one robin, Hemiptera appear in trifling quantity. Crickets and grasshoppers are more abundant, amounting to ten per cent. of the food.

The cherries made forty-four parts of the food of the month, eaten by fourteen of the birds, *but two-thirds of these cherries were wild.* Tame grapes make three per cent. of the food, berries of the mountain-ash about four per cent., and blackberries from the woods not far from five per cent.

September.

Twelve birds, all but one shot at Normal September 25th, and that one at Aurora on the 13th, show no more remarkable peculiarity than the substitution of ants for most of the caterpillars, the former composing now fifteen per cent. of the food, and the latter but five. The ants were largely winged, but of different species from those taken most freely in June.† The Carabidæ of this month were chiefly larvæ. Among the Hemiptera (three per cent.) were found *Mormidea lugens* and *Cœnus*

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* The general cessation of taxidermist's field work in midsummer has prevented the supply of any material for this month and the preceding, except that obtained by ourselves in McLean county.

† Examining the tables of food of the bluebird, brown thrush and robin, I find throughout a curious inverse relation between the ratios of ants and caterpillars, the latter falling away in June to about the same degree that ants increase during the time of their most conspicuous activity. I cannot even guess why ants should thus replace caterpillars in the food.

delius. No trace of spiders or myriapods was found, and only two per cent. of grasshoppers. The fruits stand at seventy per cent., fifty-two per cent. being grapes and the remainder berries of the mountain-ash and moonseed (Menispermum).

October and December.

The robin commences to withdraw to the south in October, and his operations in central Illinois have little interest during this month. At Normal the species became rare earlier than usual this year, and but three specimens were secured. These were feeding largely on wild grapes (fifty-three per cent.) and ants (thirty-five per cent.). Six per cent. of the food was caterpillars and two per cent. wireworms (Elateridæ). I have seen the bird eating apples in all the autumn months, but have never found the remains of this fruit in the stomach, and doubt if any special harm is done in this way.

A single bird shot at Cairo in December, piping loudly from a tree-top for company, the only one of the entire family seen during a week's winter shooting in southern Illinois, had evidently been feeding on the berries of the mistletoe. By the inhabitants of that region, troops of robins which commonly winter there were said to have gone south in November, a fact attributed by them to the failure of the wild grapes in the woods that year.

Recapitulation.

The food of the robin, as indicated by the stomachs of one hundred and fourteen specimens, consists almost entirely of insects from February to May inclusive, but from that time forward these make but little over a third of its food, the remainder (sixty-four per cent.) being composed of fruits, tame and wild, in varying proportions, according to the local situation and surroundings. Insects make almost precisely two-thirds of the food of the year, taken as a whole.

In early spring the bird depends chiefly for food upon the larvæ of a single species of fly (*Bibio albipennis*, Say), which it picks from among the leaves and roots of grass and weeds in gardens, and similar situations. In

February this made three-fourths of the food of eleven specimens, and in March more than a third of the food of nine. While this larva is not at present injurious, but feeds ordinarily on decaying vegetation, it might possibly do injury to meadows and pastures if allowed to multiply without restraint.

But few ants are eaten by this bird until late in the fall, when the swarming of the sexual forms of some of the species seems to attract its appetite, in the relative dearth of other insects.

Caterpillars make up, in March, April and May, fully a fourth of its food, about half of these being cutworms and other similar forms. Later, these are largely given up for fruit, and in the latter half of the season make only about one-tenth of the food. The average of caterpillars for the year is seventeen per cent.

Beetles, commencing at four per cent. in February, when but few specimens have yet been aroused from their cold winter's sleep, rise to forty-four per cent. in April and May, when their procreative energies are most active and urge them out into the air in swarms. With the appearance of the small fruits, beetles, also, are neglected by the robin, and the average for the last four months of the season falls away to six per cent., eighteen being that for the year.

This discrimination affects chiefly the scavenger beetles and the "June beetles," the other families maintaining about their original numbers throughout, with only an upward wave in April. The predaceous beetles average six per cent. of the food of the year, the leaf-chafers three per cent., the wireworms two per cent., and the snout-beetles one per cent.

The robin's depredations upon the true bugs (Hemiptera) are but trivial, amounting only to three per cent. of the food, but nearly all of these belong to species regarded more or less positively as beneficial.

The ratio of grasshoppers and crickets (four per cent.) seems trivial at first sight. We note, however, that these were eaten by twenty-six of the birds, and that, consequently, at least twenty-six of the insects must have been destroyed. Remembering that these figures are based

upon a single day's food, or even less, for each bird, we see that these robins were eating at an average rate of at least twenty-six grasshoppers or crickets a day, for seven months, giving us a minimum total of 5,500 Orthoptera for the year.

Only one per cent. of the food was spiders. Thousand-legs were eaten by eight of the birds, and by these in merely trivial quantity.

Coming now to the fruits, we find that tame cherries, blackberries, raspberries, currants and grapes, excluding wild fruit of all descriptions, make about one-fourth of the food of the species for the year, the wild fruits making another tenth. In the absence of the latter, the robins would doubtless attack the garden fruits more vigorously.*

Concerning these general statements, the all-important question is, of course, the sufficiency of their basis.

Granting that the observations have been exactly made and correctly generalized, how far may the conclusions reached be expected to hold good in the future? These conclusions actually rest upon the food of a hundred and fourteen birds for probably about half a day each. Can we safely reason from these to the food of the thousands and hundreds of thousands of robins of the State, day after day, the whole season through?

In a paper published last winter in the Transactions of the Illinois Horticultural Society, I made the following reply to substantially the same question:

"If the same species will eat substantially the same food, year after year, in the same situation, then, of course, a good deal may properly be inferred from comparatively few data; but if the food varies widely, either arbitrarily or under slight changes of condition, then we can infer but little. Upon this fundamental question I have two suggestions to make.

"First, if several species allied in structure, occupying the same territory at the same time, living side by

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* No man should needlessly sacrifice a wild cherry-tree or a fruiting vine or shrub of any kind. Ordinary common sense would teach the preservation of as much of the worthless natural food of frugivorous birds are possible, as a diversion from the cultivated fruits of the orchard and garden.

side, with the same sources of food supply open to them, are found, on the examination of a limited number of stomachs, to present several characteristic differences of food, so that the investigator can point out definite peculiarities of the food of each species, and finds these peculiarities reasonably constant, year after year, then we may say unquestionably, without going farther, that there is a fixity of food-habits in this group of birds which will allow us to reason from the data observed.

"Second, if there are any other habits of the species in which there does not seem to be any greater reason for invariableness than in those relating to the food, which are nevertheless found to be substantially unvarying, then we may, with considerable force, argue the probability of a like unvarying character in the habits of alimentation.

"Respecting the first of these tests, you will see, when I sum up the food of the family now under consideration and bring the data respecting the various species into comparison with each other, that I have made out certain very well-marked specific differences of food, even among those eating at the same table; that the different species of this group, while agreeing in many particulars of food as they do in structure, present also certain peculiarities, so marked that I can usually determine the species by the contents of three or four stomachs.

"For the second test we may properly use the nesting habit. There seems to be no more cogent reason why one species should select from the same storehouse different materials for its nest from those used by another closely allied species of nearly the same size and similar general habits, and building in the same locality, than why each should use a similar fixed discrimination in selecting its food. Yet no expert, scarcely a schoolboy even, will hesitate a moment between the nest of a robin and that of a catbird; and the descriptions of the two given in the books are so different as to enable any novice to distinguish between them at a glance. In fact, a friend mentions, as I write, two birds whose nests are much more easily distinguished than the birds themselves."

I have now to add what we may regard as a decisive crucial test of the conclusion implied above. In the paper quoted from, I gave the details and a summary of the food of forty-one robins in a table similar to those presented in this paper, and a comparison of the averages of that table with those of the table on pages 112, 113, 114, 115, may be easily made. While any serious differences in the averages of these two tables would not necessarily condemn the later one, but, at the worst, would leave its sufficiency in doubt, a substantial agreement of the two would be conclusive proof of the correctness of both. It is incredible that the averages of a hundred and fourteen specimens should agree essentially with those of forty-one, unless both were framed upon identical principles and were sufficiently true to the facts for all practical purposes. I will, therefore, place the principal averages of these tables side by side, premising that the later table not only includes nearly three times as many specimens as the earlier, but covers two months' more time.

The figures for the first and second tables, taken alternately, are as follows: Insects, seventy per cent, and sixty-five per cent.; caterpillars, eighteen per cent. and seventeen per cent.; Diptera, eighteen per cent. and seventeen per cent.; Coleoptera, nineteen per cent. and eighteen per cent.; Carabidæ, seven per cent. and five per cent.; Scarabæidæ, four per cent. and seven per cent.; Lachnosterna, two per cent. and three per cent.; Elateridæ, three per cent. and two per cent.; Rhynchophora, three per cent. and two per cent.; Chrysomelidæ, one per cent. and a trace; Hemiptera, four per cent. and three per cent.; Orthoptera, eight per cent. and four per cent.; Arachnida, a trace and one per cent.; Myriapoda, two per cent. and a trace; garden fruits, twenty-eight per cent. and twenty-nine per cent.

As I did not discriminate, in the former table, between tame and wild edible fruits, I have included the latter in both, and excluded the inedible fruits. I believe that the agreement in these figures, taking into account the earlier and later months covered by the second table, is quite remarkable, and can be explained only on the supposition that the fuller table presents a reasonably accurate sum-

mary of the food of the robin as a species in at least the northern half of the State, and under the ordinary conditions of the last five or six years. Of course, I had no idea how these averages were coming out until my notes were finished and the ratios were calculated for the whole.

Economic Relations.

We come now to the intricate, delicate and difficult question of the economic relations of this species—a question rendered less important by the general considerations urged elsewhere, but, nevertheless, deserving careful attention. While it is true that every insectivorous bird must be respected, whatever its other habits, at least until we clearly understand its function in the general order and are certain that its removal will do no harm which we cannot remedy or endure better than we can support its injuries, yet an idea of the relative importance of edible fruits and insects of both the beneficial and injurious classes in the diet of the bird is necessary as a step to this clear and complete understanding of the matter.

Glancing at the bottom of the table of the food of the species on page 115, the reader will see three lines of figures running across the page, showing for each month the percentages of beneficial, injurious and neutral species of insects and fruits eaten by these birds. The figures at the right give similar percentages for all the birds for the entire year. Following the upper line, we note the small percentages of injury done in the early spring, the marked increase of injury in April, due to the excessive destruction of predaceous beetles, and the heavy percentages of the fruiting months. The general average of beneficial elements destroyed for the year is thirty-six per cent. On the second line we notice an inverse variation. Commencing with a ratio of ninety-four per cent. of injurious elements eaten in February (if we include the larva of Bibio in these), the record runs down to seven per cent. in September, the general average for the year being forty-three per cent.

This comparison, however, is merely a quantitative one. Injurious or beneficial elements are balanced against each

other according to their bulk and not their quality. A quart of caterpillars counts as the equivalent of a quart of blackberries, and, on the other hand, as the equivalent, also, of a quart of predaceous beetles. It is evident, therefore, that we cannot get at any close estimate of the economic values of this species in this indiscriminate way.

A nearer approximation to the truth may be made by critically comparing the general averages for the year found in the vertical column at the right of the table. Here we have the following totals of injurious and beneficial species: Of the first, caterpillars, seventeen parts (including eight parts cutworms); Bibio larvæ, fifteen parts; leaf-chafers, three parts; wireworms, two parts; snout-beetles, two parts; crickets and grasshoppers, four parts. Of the second predaceous beetles, six parts; predaceous bugs, three parts; garden fruits, twenty-four parts. Now, the opinions of entomologists would probably be found to differ somewhat widely on the question of the relative values of these various elements, and each must form his own opinion from the data given.* My own judgment is that, taking into consideration only the immediate present effect of the robin upon the fruits and insects of the State, ignoring for the moment the important secondary disturbances likely to arise if the number of the species were greatly lessened, and balancing these elements carefully against each other (applying to them, in fact, the operation of cancellation in arithmetic), we can reduce the question finally to about this form: Will the destruction of seventeen quarts of average caterpillars, including at least eight quarts of cutworms, pay for twenty-four quarts of cherries, blackberries, currants and grapes?

To this question I, for my own part, can only reply that I do not believe that the horticulturalist can sell his small fruits anywhere in the ordinary markets of the world at so high a price as to the robin, provided that he uses

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* Concerning the value of predaceous beetles, the reader is especially requested to examine the papers on that subject in the present bulletin. It is probable that their services have been greatly overestimated.

proper diligence that the little huckster doesn't overreach him in the bargain. In other words, while the bird is far too valuable to exterminate, at least until we are sure we can replace him by some cheaper assistant, yet he is not so precious that we need hesitate to protect our fruits from outrageous injury. Indeed, it seems likely that the ordinary destruction of robins by gardeners does not more than compensate for the destruction of birds of prey in the interests of the poultry yard—removing that excess of robins which, in the more natural order, would fall victims to the hawks and owls.

TABLE OF THE FOOD OF THE ROBIN. (*Turdus migratorius* L.)

	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL	Ratio of each element to whole of food
Number of specimens.....	...	11	9	17	14	13	14	20	12	3	...	1	114	
KINDS OF FOOD.	Number of specimens, and ratios in which each element of food was found.													
I. MOLLUSKS.....	...	...	...	1 .01	1 †	...	...	...	...	...	...	...	2	....
II. INSECTS	...	11 .99	9 .97	17 .91	14 .94	13 .42	13 .20	18 .43	9 .30	3 .44	...	...	107	.65
1. *Hymenoptera*.....	...	...	1 †	5 .02	7 .03	6 .07	3 .01	10 .03	7 .15	2 .35	...	...	41	.04
Apidæ.....	...	...	...	1 †	...	...	1 †	...	...	...	...	...	2	....
Formicidæ	...	...	...	4 .02	7 .03	6 .07	3 .01	7 .02	7 .15	2 .35	...	...	36	.04
Ichneumonidæ	...	...	...	...	...	...	...	1 †	...	...	...	...	1	....
Chalcididæ.....	...	...	1 †	...	...	...	...	...	...	...	...	...	1	....
2. *Lepidoptera* (larvæ).....	...	3 .14	4 .30	12 .24	11 .23	8 .17	3 .04	11 .17	2 .05	2 .06	...	...	56	.17
Arctiidæ.....	...	...	1 .01	3 .02	...	...	...	...	...	...	...	...	4	....
Noctuidæ	...	1 .05	3 .19	1 .04	6 .15	4 .07	...	7 .12	1 .01	...	...	...	23	.08
Phalænidæ	...	...	...	1 .05	...	...	...	...	...	...	...	...	1	....
3. *Diptera*.....	...	11 .76	4 .38	6 .12	4 .11	1 †	1 .01	1 †	...	...	...	...	28	.17
Tipulidæ.....	...	...	...	...	2 .07	...	...	...	...	...	...	...	2	.01
Bibionidæ	...	11 .76	4 .37	3 .08	...	...	...	...	...	...	...	...	18	.15

TABLE OF THE FOOD OF THE ROBIN. (*Turdus migratorius*, L.)—Continued.

KINDS OF FOOD.	Number of specimens, and ratio in which each element of food was found.													Ratio of each element to whole of food.
	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL	
Number of specimens.....	...	11	9	17	14	13	14	20	12	3	...	1	114	
		8	7	16	11	11	8	14	3	3				
4. *Coleoptera*.....	...	.04	.18	.42	.44	.15	.09	.07	.05	.03	...	...	81	.18
		6	5	11	6	6	3	7	2	1				
Carabidæ.....	...	.02	.02	.17	.04	.06	.06	.02	.03	.01	...	...	47	.05
		4	4	11	6	5	2	5	2	1				
Harpalidæ.....	...	.01	.02	.16	.04	.01	.06	.02	.03	.01	...	...	40	.05
			1			1	2		1					
Larvæ.....	...	...	.01	...	...	†	.01	...	.02	...	...	...	5	....
								1						
Dytiscidæ.....	...	...	...	...	...	...	...	†	...	...	...	...	1	....
				1										
Hydrophilidæ.....	...	...	...	.01	...	...	...	...	...	...	...	...	1	....
					1									
Staphylinidæ.....	...	...	...	...	.01	...	...	...	...	...	...	...	1	....
			1		8	1		1						
Histeridæ.....	...	...	.01	...	.05	†	...	†	...	...	...	...	11	.01
								1	1					
Nitidulidæ.....	...	...	...	...	...	...	...	†	†	...	...	...	2	....
		3	4	13	12	4	3	1						
Scarabæidæ.....	...	.01	.12	.15	.22	.01	.01	.01	...	...	...	...	40	.07
				2	6	1	1							
Lachnosterna.....	...	...	...	.07	.17	†	†	...	...	...	...	...	10	.03
			2	2	4	7	2	1	1	1				
Elateridæ.....	...	...	.01	†	.08	.04	.01	†	†	.02	...	...	20	.02
		2	1	1		1								
Lampyridæ.....	...	.01	.01	†	...	.02	...	...	...	...	...	..	5	....
		2	2	5	7	4	1	9						
Rhynchophora.....	...	†	.01	.03	.02	.01	.01	.04	...	...	...	...	30	.02
				3	4									
Brevirostres.....	...	...	...	.02	.01	...	...	...	...	...	...	...	7	....
		1	2	3	4			2						
Longirostres.....	...	†	.01	.01	.01	...	...	.02	...	...	...	...	12	....
				1	2	2		1		1				
Chrysomelidæ.....	...	...	...	†	.01	.01	...	†	...	†	...	...	7	....
					1									
Doryphora.....	...	...	...	...	.01	...	...	...	...	...	...	...	1	....
		5	3	5	6	3	2	6	5					
5. *Hemiptera*.....	...	.01	.03	.03	.05	.01	†	.06	.03	...	...	...	35	.03
								1						
Nepa.....	...	...	...	...	...	...	...	.05	...	...	...	...	1	....
			1	1	1			1						
Coriscus.....	...	...	†	†	†	...	...	†	...	...	...	...	4	....
				1	1	1	1	2						
Reduviidæ.....	...	...	...	†	†	†	†	†	...	...	...	...	6	....
			1					1						
Phytocoreidæ.....	...	...	†	...	...	...	...	†	...	...	...	...	2	....

TABLE OF THE FOOD OF THE ROBIN. (*Turdus migratorius*, L.)—Continued.

KINDS OF FOOD.	Number of specimens, and ratio in which each element of food was found.													Ratio of each element to whole of food.
	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL	
Number of specimens.....	...	11	9	17	14	13	14	20	12	3	...	1	114	
Lygæidæ (Blissus).....	...	...	...	...	...	...	...	...	1 †	...	...	...	1	....
Coreidæ.....	...	1 †	1 †	...	...	...	...	...	...	...	...	...	2	....
Pentatomidæ.....	...	5 .01	3 .02	5 .03	4 .04	1 †	1 †	3 †	4 .02	...	...	...	26	.02
6. *Orthoptera*.....	...	2 .04	2 .05	6 .05	5 .04	1 .01	2 .04	6 .10	2 .02	...	...	...	26	.04
Gryllidæ.....	...	...	...	1 .01	...	...	1 .03	3 .06	...	...	...	...	5	.01
Acrididæ.....	...	2 .04	2 .05	3 .03	5 .04	1 .01	2 .01	3 .04	2 .02	...	...	...	20	.03
III. ARACHNIDA.....	...	2 .01	1 .01	3 .01	1 †	...	4 .01	3 .01	...	...	...	...	14	.01
IV. MYRIAPODA.....	...	1 †	3 .01	3 .01	1 .02	...	...	...	...	...	...	...	8	....
Geophilus.....	...	...	1 †	1 .01	...	...	...	...	...	...	...	...	2	....
Polydesmus.....	...	...	...	...	1 †	...	...	...	...	...	...	...	1	....
Iulidæ.....	...	1 †	2 .01	2 †	1 .01	...	...	...	...	...	...	...	6	....
V. EARTHWORMS (*Lumbricus*)	...	...	...	2 .05	...	...	...	...	...	...	...	...	2	....
VI. FRUITS AND SEEDS	...	1 †	2 .01	1 .01	3 .04	13 .58	14 .79	17 .56	11 .70	3 .56	...	1 100	65	.34
Blackberries.....	...	...	...	...	...	...	12 .56	...	...	...	...	...	12	.07
Raspberries.....	...	...	...	...	...	3 .08	1 .05	...	...	...	...	...	4	.02
Cherries.....	...	...	...	...	...	10 .47	...	[a]14 .44	...	...	...	...	24	.11
Currants.....	...	...	...	...	...	...	6 .17	...	...	...	...	...	6	.02
Grapes.....	...	...	...	...	...	...	...	1 .03	7 .52	[b]2 .53	...	...	10	.07
Mistletoe (Phorodendron)	...	...	...	...	...	...	...	...	...	...	...	1 100	1	....
Mountain-ash.....	...	...	...	...	...	...	...	1 .04	1 .08	...	...	...	2	.01
Sumach (Rhus).....	...	...	2 .01	1 .01	2 .04	...	...	...	...	...	...	...	5	.01
Hackberry (Celtis).....	...	...	...	...	...	...	...	1 .05	...	...	...	...	1	....

[a] 28 per cent. wild, [b] All wild.

TABLE OF THE FOOD OF THE ROBIN. (*Turdus migratorius*, L.)—Concluded.

	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL	Ratio of each element to whole of food.
Number of specimens.....	...	11	9	17	14	13	14	20	12	3	...	1	114	
KINDS OF FOOD.	Number of specimens, and ratio in which each element of food was found.													
Moonseed (Menispermum)	...	...	...	...	...	...	...	...	2 .04	...	...	...	2	....
Polygonum.....	...	...	1 †	...	...	...	...	...	...	...	...	...	1	....
Grass.....	...	1 †	...	...	1 †	1 .02	...	...	...	...	...	...	3	....
Corn.....	...	...	...	...	...	1 .01	...	...	...	...	...	...	1	....
	Percentages for each month													Ratios.
Beneficial species.....	...	05	06	21	09	°64	°85	°50	°57	...	...	...	...	36
Injurious species.....	...	*94	*74	*47	55	24	10	31	07	...	...	...	...	43
Neutral species.....	...	01	20	‡32	‡36	‡12	‡05	‡19	‡36	...	...	...	...	21

*Includes Bibio. ‡Includes ants. ° Includes fruits.

[NOTE.—In the foregoing tables, the integers indicate the number of birds found to eat the element against which they are placed, and the decimals express the ratio of this element to the whole food of the month. October and December were omitted in computing the general averages for the year, on account of the small number of birds for those months.]

MIMUS CAROLINENSIS, L. THE CATBIRD.

This bird, scarcely less abundant than the robin, arrives later and makes a shorter stay, coming late in April or early in May, and disappearing from this latitude usually in September. It also occupies a larger territory in the State in midsummer than the robin, being not at all rare in extreme southern Illinois in July and August. I do not know that it ever winters northward. Its habits and favorite haunts are so similar to those of the robin that one might not unreasonably anticipate that, respecting their food, both could be considered as one species; but we shall see proof that there are specific food characteristics to separate them.

How indefinite and uncertain is the present knowledge of the food of this especially notorious species, may be seen by comparing my notes with the statement made in the recent and elaborate work of Baird, Brewer and Ridgway.

"The food of the catbird is almost exclusively the larvæ of the larger insects. For these it searches both among the bushes and the fallen leaves, as well as the furrows of newly-plowed fields and cultivated gardens. The benefit it thus confers upon the farmer and upon the horticulturist is very great, and can hardly be overestimated."

My observations of this bird cover the five months from May to September, inclusive.

May.

The specimens of this month range from the 1st to the 31st, and from Warsaw and Normal, in central Illinois, to Savanna, McHenry and Waukegan in the northern part of the State. Five of the birds of the month were taken in northern Illinois and seventeen in the central part of the State. All of these birds had eaten insects, which amounted to eighty-three per cent. of the food, the remainder consisting of spiders, three per cent.; thousand-legs (Myriapoda), seven per cent.; and seven per cent. of the dry berries of the sumach (*Rhus glabra*). Among the insects were about equal ratios of ants, crane-flies and beetles, the first composing eighteen per cent. of the food, the second nineteen and the third twenty-three. Caterpillars formed twelve per cent. of the food, and about one-sixth of these were distinctly recognizable as cutworms (Noctuidæ). More than one-third of the beetles were Carabidæ including specimens of Platynus and *Harpalus pennsylvanicus*. Only one per cent. of the food consisted of Scarabæidæ, and five per cent of snout-beetles (Rhynchophora). Nearly all of the latter belonged to the section Brevirostres, in which are found few of the injurious species of the group. Those recognized were *Epicærus imbricatus* and *Ithycerus noveboracensis*. Among the one per cent. of plant-beetle (Chrysomelidæ) only *Gastrophysa polygoni* was specifically de-

terminable. Minor items among the Coleoptera are the water-beetles, including *Colymbetes biguttatus* and an undetermined species of Hydrobius. The Hemiptera amounted to only one per cent. of the food, and all of these were Pentatomidæ. The Orthoptera, including a few specimens of the white cricket (Œcanthus) and of the common spring grasshoppers, amounted in all to four per cent. of the food. A single specimen of the young of the walking-stick (*Diapheromera femorata*) had been eaten by one of the birds. Spiders amounted to three per cent. of the food. The Myriapoda included several specimens of Lithobius and three species of Polydesmus, viz.: *P. serratus, P. virginiensis* and *P. canadensis.*

It will be seen at once that the striking feature of the food of this bird in May, as compared with that of the robin, is the abundance of ants and crane-flies, a characteristic which we shall find persistent until the opening of the fruit season revolutionizes the food of both species.

June.

The food of June undergoes so complete a change when the small fruits begin to ripen that the record may best be given in two divisions, the first of which agrees closely with that of May, while the second approaches more nearly to that of July. In the first part of the month ants were eaten by the nineteen birds examined in about the same ratio as in May. Crane-flies appear in the food only in the early days of the month. Among the Coleoptera the principal peculiarity is the greater importance of the May-beetles (Lachnosterna). A few strawberries and cherries were eaten by this bird previous to the fifteenth of the month, but these fruits were not taken in sufficient amount materially to influence the averages. After the seventeenth, however, only one per cent. of the food consisted of ants, and only about three per cent. of caterpillars. The May-beetles disappear almost entirely, and the other insect elements are reduced to equal insignificance, while the same fruits constitute by far the larger part of the food. These include currants and cherries in about equal parts, and about twice as many raspberries as of both the others taken together. Treating the food of the

month as a whole, we find that forty-nine per cent. of it consists of insects, three per cent. of spiders and three per cent. of thousand-legs, while forty-five per cent. consists of fruits, twenty-one per cent. being raspberries, twelve per cent. cherries, three per cent. strawberries and eight per cent. currants. The ants of the month amounted to but eleven per cent. and the craneflies to seven per cent. The Lepidoptera stand at ten per cent. and the Coleoptera at seventeen—nearly one-third of the latter being Carabidæ. The Hemiptera made about one per cent. of the food and the Orthoptera two per cent. A single bird-louse (Mallophaga) was found in the stomach of one of these birds.

July.

The record of this month rests upon eleven specimens, all from central Illinois, taken from the first to the twenty-third of the month. These indicate most clearly an eminent preference of the species for the small fruits, which composed three-fourth of their food, sixty-four per cent. being blackberries alone. Spiders and myriapods, are found in about the same ratio as in June. The latter are all Iulidæ, a part of them, at least, belonging to the genus Iulus. The only Orthoptera noted were specimens of the large black cricket of the fields (*Gryllus abbreviatus*), eaten by a single bird. The Hemiptera almost disappear, a single Thrips being the only representative of the order. The Coleoptera amounted only to nine per cent. of the food, and more than two-thirds of these were predaceous beetles, eaten by eight birds; among these were noted *Cicindela lecontei*, Pterostichus, Evarthrus, *Cratacanthus dubius*, *Anisodactylus baltimorensis* and Harpalus. Only a single bird had taken caterpillars, which constituted three per cent. of the food of the month. No trace of Diptera was found in the stomachs of these birds, and only four had eaten ants, which made two per cent. of the total food. Insects proper thus amounted to eighteen per cent. of the whole.

It is clear, from the foregoing, that the catbird in midsummer eats only such insects as come in its way while regaling itself on the smaller fruits.

August.

Twelve birds were obtained in this month, the first on the 7th and the last on the 30th, all from McLean and adjoining counties. Three of these were young, but as no difference of food was noticed corresponding to age, these are not treated separately.

The food record of August resembles that of June, owing, doubtless, to the diminution of the smaller garden fruits at this time and to the fact that the wild fruits have not yet generally come into bearing. The insect percentages are, therefore, much larger than in July, and it is instructive to notice that this increase is first apparent and most evident in the ratios of ants—an indication of the positive preference of the catbird for this food. Nearly one-half of the forty-six per cent. of insects eaten in this month were ants. A bee, a gall-fly and an ichneumon were noticed among the other Hymenoptera. Forty per cent. of the food was caterpillars, a considerable proportion of which were cutworms. Only six per cent. of the food was Coleoptera, and the only predaceous beetle taken by these birds was one specimen of *Cratacanthus dubius*. Three per cent. of the food was scavenger-beetles, including Geotrupes and *Bolbocerus farctus*. It is in this month that the Meloidæ appear abundantly on goldenrods and other Compositæ, but only a single Epicauta was found in the food of one of these birds. The few plant-beetles noticed included a single *Diabrotica vittata*. Seven per cent. of Hemiptera were eaten; largely chinch-bugs, taken by one of the birds. This fearful pest of the grain-fields was sufficiently abundant in the vicinity of Normal this year sensibly to injure the crops of grain. Nearly all the species of birds examined were found to eat them to some extent, but in quantities so trifling as probably to have little or no effect upon their multiplication. It is evident, however, that the birds have no especial prejudice against them. The remainder of the Hemiptera were the ordinary "soldier-bugs", belonging to the genus Euschistus.

Orthoptera appear in somewhat larger ratio, amounting to seven per cent. of the food, an indication, doubt-

less, of the commencement of the autumnal multiplication of this order which will be found reflected to a very notable degree in the food of the bluebird further on. Only traces of spiders and thousand-legs were discovered. Fifty-four parts of fruit were eaten, sixteen of which were wild. Nearly all of the garden fruits were blackberries—cherries constituting but three per cent. of the food for the month.

September.

The catbird leaves our latitude in September, and only six specimens were secured—all of them on or before the 17th, in the vicinity of Normal and Bloomington. The chief peculiarity of the food of the month is the substitution of cherries and wild fruits for blackberries. Seventy-six per cent. of the food at this time consisted of fruits, all wild but the grapes, which amounted to fourteen per cent. Elderberries, wild cherries and the fruit of the Virginia creeper were the most important elements. Carnivorous thousand-legs amounted to three per cent. of the food and insects proper to twenty-one per cent., nearly half of which were ants. But few caterpillars had been eaten by these birds, and only seven per cent. of Coleoptera—five per cent. being Harpalidæ. The lower orders of insects were conspicuous only by their absence.

We are now prepared for the review of the general averages of the season, and the indications which these afford of the economic value of the catbird. Taking the record of the year together as found in the vertical column at the right of the table on pages 125, 126, 127, the seventy birds of the species examined are found to have eaten forty-three parts of insects, two parts of spiders and harvestmen, three parts of thousand-legs and fifty-two parts of fruits. Only thirty-three per cent. of the food consisted of tame fruits, four per cent. being raspberries, twenty per cent. blackberries, one per cent. currants, four per cent. tame cherries, one per cent. strawberries and three per cent. grapes. Scrutinizing more closely the details of the insect food, we find that ants form twelve per cent. of the total for the season; Diptera, chiefly crane-flies, about five per cent.; Lepidoptera six per

cent.; and beetles twelve per cent., one-third of which are Carabidæ. The scavenger beetles and leaf-chafers are three per cent. of the food; plant-beetles, one per cent., and snout-beetles, belonging chiefly to the leaf-eating Brevirostres, likewise one per cent. Two parts of Hemiptera and three of Orthoptera are the only other items that we need notice. It will be seen that ants and beetles occur in about equal ratios, and that these are the most important insect elements in the food. Diptera and Lepidoptera taken together about equal one of the former elements.

Recapitulation.

In the catbird as in the robin the insect averages are highest in the early months, and fall rapidly away from May to July—rising again in August and declining in September. The ratios of insects taken for the five months covered by this table are as follows: 83, 49, 18, 46, 21. The same double curve is especially apparent in the averages of ants, the corresponding ratios for which are 18, 11, 2, 20, 9. Beetles gradually diminish to July and then remain tolerably constant for the season. The predaceous ground-beetles maintain themselves at nearly uniform figures throughout. The Scarabæidæ are, of course, most abundant in May and June, when the leaf-chafers are abroad. The snout-beetles observed were all taken in the months of May and June, and belonged chiefly to species whose injuries are confined to the leaves of trees. Only trifling ratios of plant-beetles were eaten by these birds. Hemiptera also occur in insignificant quantity, the only notable fact being the presence of chinch-bugs in the food of one bird. Orthoptera seemed to be most abundant in the late and early months, diminishing in June and July. Considerable numbers of Arachnida and Myriapoda are eaten by the catbird—a point in which it contrasts notably with the robin. No earthworms were detected in the food. With respect to the fruits taken by this bird, we find that the general ratios for the corresponding months agree closely with those of the robin. Berries of the sumach are eaten in May, but raspberries and blackberries are the most prominent

elements of June, July and August. Wild cherries take the place of these fruits in September, and grapes are then eaten to some slight extent.

A comparison of the statements of this paper with the report published in the Transactions of the Illinois Horticultural Society for 1879, will give some interesting results. The former paper relates to thirty-seven specimens, obtained during the three months of May, June and July; and the present paper relates to seventy birds, taken during five months from May to September. As both the additional months extend the fruit season, we should expect the insect averages would now be smaller than before and that the averages of fruit would show a corresponding increase. This I find to be the principal difference between these tables. The various insect elements stand in about the same ratio to each other as before, except the ants (whose swarming in autumn accounts for their greater prominence in the food), and the Hemiptera and Orthoptera. The first of these orders figures more largely in the general averages for 1880 because this was a "chinch-bug year" in central Illinois; and the second because grasshoppers, locusts and crickets greatly increase in numbers during the later months. In the earlier table, insects amount to fifty-six per cent. of the food; in the later, only to forty-three; ants are respectively ten and twelve, Diptera thirteen and five, Lepidoptera ten and seven, Coleoptera nineteen and twelve, Carabidæ eight and five, leaf-chafers four and three, snout-beetles three and one, Hemiptera one and two, Orthoptera two and three, Arachnida three and two, Myriapoda six and three and the edible fruits twenty-seven and forty-one.

The Catbird and the Robin.

In order to a more exact comparison of the food-habits of the catbird and the robin, I have computed the averages of the principal elements of the robin's food for the period of five months covered by the catbird's record, and give these here alternately with the corresponding averages of the catbird. The ants eaten by the robin

during these months amounted to five per cent. of the food, and those by the catbird to twelve per cent. Diptera were two per cent. and five per cent., Lepidoptera thirteen per cent. and seven per cent., Coleoptera thirteen and twelve, Carabidæ four and five, leaf-chafers three and two, wireworms three and a trace, snout-beetles two and one, Hemiptera three and two, Orthoptera four and three; Arachnida a trace and two, Myriapoda a trace and three; raspberries and blackberries fourteen and twenty-four, cherries eighteen and twelve, currants three and one, grapes eleven and three, and strawberries—none by the robin and one per cent. by the catbird. From this it will be seen that the notable differences in the food-habits of these birds are the much larger ratios of ants, Diptera and berries eaten by the catbird; and of Lepidoptera, wireworms, cherries and grapes eaten by the robin. It also appears that the catbird has a much more hearty appetite for spiders and thousand-legs than the robin.

It is not likely that there is any such active competition for food between these two species as this close agreement in the kinds taken at the same place and season would imply. The stress of the robin's struggle for subsistence evidently comes in early spring, before the advent of the catbird; and by the time the latter appears there is probably an abundance of food for both species. The earlier departure of the catbird likewise prevents any stringent competition in the later months.

Economic Relations.

Remembering that the chief economic service of the robin is done before and after the midsummer wealth of fruits tempts it from the chase of insects, we find it not unreasonable that the catbird, coming later and departing earlier, scarcely anticipating the garden fruits in its arrival and disappearing when the vineyard and orchard are at their best, should be a much less useful bird than its companion. The credit I have given it must be still further reduced because of its serious depredations in the apple orchard. I have often seen it busily scooping

out the fairest side of the ripest early apples, unsurpassed in skill and industry at this employment by the red-headed woodpecker or the blue jay.

At the bottom of the table of food given on page 127 a set of percentages will be seen similar to those previously mentioned in the discussion of the food of the robin. The beneficial elements eaten by this bird, including fruits and the carnivorous insects, run as follows, from May to September: 13, 53, 75, 45 and 19, the average for the season being forty-one per cent. The corresponding ratios of injurious elements are 29, 21, 7, 16 and 4, giving a general average of 15 per cent. for the year. Referring to the vertical column of figures at the right of the table we find the injurious insects of this bird's food as follows: saw-flies one per cent., Lepidoptera seven, leaf-chafers two, snout-beetles one, plant-beetles one, chinch-bugs one and Orthoptera three; while the beneficial insects in the same column are—predaceous beetles five, predaceous Hemiptera one, and Arachnida two. A careful comparison of these elements with each other will probably convince the intelligent reader that these insect averages balance each other fairly well, and that the injury done in the fruit-garden by these birds remains without compensation unless we shall find it in the food of the young. This statement is made upon the hypothesis that ants are to be regarded as neutral insects; and the entire question of the *immediate* value of this species, aside from the still unsettled question of the food of the young, may be reduced apparently to the following form: Will the destruction of a given quantity of ants pay for three times that quantity of the smaller garden fruits?

TABLE OF THE FOOD OF THE CATBIRD. (*Mimus carolinus*, L.)

	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL	Ratio of each element to whole of food.
Number of specimens..	..	..	..	..	22	19	11	12	6	..	..	..	07	
KINDS OF FOOD.	Number of specimens and ratio in which each element of food was found													
					22	19	10	12	6					
I. INSECTS.....	..	..	..	..	.83	.49	.18	.46	.21	..	..	..	69	.43
					20	13	7	12	6					
1. *Hymenoptera*.....	..	..	..	..	.22	.12	.04	.21	.09	..	..	..	58	.13
					20	13	4	11	6					
Formicidæ...	..	..	..	..	.18	.11	.02	.20	.09	..	..	..	54	.12
								1						
Ichneumonidæ	..	..	..	..	...	...	...	†	...	..	..	..	1	.....
					2	1	1							
Tenthredinidæ	..	..	..	..	.02	.01	.02	...	...	..	..	..	4	.01
					11	8	1	3	1					
2. *Lepidoptera*	..	..	..	..	.14	.10	.03	.04	.04	..	..	..	24	.07
					10	4		2						
Caterpillars	..	..	..	..	.12	.05	...	.03	...	..	..	..	16	.04
					1	2		1						
Noctuidæ	..	..	..	..	.02	.02	...	.02	...	..	..	..	4	.01
					7	5								
3. *Diptera*	..	..	..	..	.20	.07	...	...	...	..	..	..	12	.05
					6	3								
Tipulidæ	..	..	..	..	.19	.07	...	...	...	..	..	..	9	.05
	..	..	..	..	...	1								
Bibionidæ.....	..	..	..	..	...	†	...	...	...	..	..	..	1	.....
					13	18	8	6	4					
4. *Coleoptera*.....	..	..	..	..	.23	.17	.09	.06	.07	..	..	..	49	.12
							1							
Cicindela.....	..	..	..	..	...	...	†	...	...	..	..	..	1	.....
					7	3	6	2	1					
Carabidæ	..	..	..	..	.09	.05	.07	.01	.05	..	..	..	19	.05
					2									
Dytiscidæ.....	..	..	..	..	.01	...	...	...	...	..	..	..	2	.....
					2									
Hydrophilidæ.....	..	..	..	..	.03	...	...	...	...	..	..	..	2	.01
					1	1								
Staphylinidæ:.....	..	..	..	..	†	†	...	...	...	..	..	..	2	.....
					1									
Phalacridæ.....	..	..	..	..	†	...	...	...	...	..	..	..	1	.....
						1	1							
Nitidulidæ	..	..	..	..	...	†	†	...	...	..	..	..	2	.....
					1									
Heteroceridæ	..	..	..	..	†	...	...	...	...	..	..	..	1	.....
					3	1								
Histeridæ.....	..	..	..	..	.01	†	...	...	...	..	..	..	4	.....
					1	9	3		1					
Scarabæidæ.....	..	..	..	..	.01	.10	.03	...	.01	..	..	..	14	.03

TABLE OF THE FOOD OF THE CATBIRD. *(Mimus carolinus*, L.)—Continued.

KINDS OF FOOD.	Number of specimens and ratio in which each element of food was found													Ratio of each element to whole of food.
	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL	
Number of specimens. .	..	.	..	..	22	19	11	12	6	..	..	..	70	
Melolonthinæ . . .	..	..	..	..	1 .01	5 .07	...	...	...	..	..	..	6	.02
Euryomia	..	..	..	..	1 †	...	...	...	...	..	..	.	1	.....
Elateridæ.	..	..	..	..	1 †	...	...	...	...	..	..	..	1	.....
Lampyridæ	..	..	..	..	3 .01	1 †	...	...	...	..	..	..	4	.....
Tenebrionidæ	..	..	..	..	1 †	1 †	...	...	...	..	..	..	2	.....
Meloidæ	..	..	..	..	...	...	1 .01	...	...	..	..	..	1	.....
Rhynchophora. . .	..	..	..	..	6 .05	2 .01	...	...	...	..	..	..	8	.01
Brevirostres	..	..	..	..	4 .04	...	...	...	...	..	..	..	4	.01
Longirostres.	..	..	..	..	2 .01	...	...	...	...	..	..	..	2	.....
Chrysomelidæ	..	..	..	..	3 .01	2 .01	2 .01	...	...	..	..	..	7	.01
Coccinellidæ	..	..	..	..	...	1 †	...	...	...	..	..	..	1	.....
5. *Hemiptera*.	..	..	..	..	2 †	2 .01	1 †	7 .07	...	..	..	..	12	.02
Blissus.	..	..	..	..	...	...	...	1 .05	...	..	..	..	1	.01
Pentatomidæ.	..	..	..	..	2 †	2 .01	...	2 .02	...	..	..	..	6	.01
6. *Orthoptera*	..	..	..	..	6 .04	3 .02	1 .01	5. .07	...	..	..	..	15	.03
Diapheromera.	..	..	..	.	1 †	...	...	...	...	..	..	..	1	.....
Gryllidæ	..	..	..	..	1 †	...	...	...	...	..	..	..	1	.....
Acrididæ.	..	..	..	..	3 †	3 .02	...	4 .07	...	..	..	..	10	.02
Neuroptera	..	..	..	..	...	1 †	...	...	1 .01	:	..	..	2	.....
II. ARACHNIDA	..	..	..	..	7 .03	3 .03	2 .04	1 †	...	..	..	..	13	.02
III. MYRIAPODA	..	..	..	..	6 .07	2 .03	4 .04	1 †	2 .03	..	..	..	15	.03
Chilopoda.	..	..	..	..	1 †	...	...	...	...	..	..	..	1	.....

TABLE OF THE FOOD OF THE CATBIRD. (*Mimus carolinus*, L.)—Concluded.

	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL	Ratio of each element to whole of food.
Number of specimens..	..	..	..	..	22	19	11	12	6	..	..	..	70	
KINDS OF FOOD.	Number of specimens and ratio in which each element of food was found.													
Diplopoda.....	..	..	..	..	6 .07	2 .03	4 .04	1 †	2 .03	..	..	...	15	.03
IV. FRUITS	..	..	..	..	2 .07	13 .45	10 .74	12 .54	6 .76	..	..	..	43	.52
Strawberries.....	..	..	.	..	...	2 .03	...	...	...	..	..	..	2	.01
Raspberries.....	..	..	..	..	...	9 .21	...	...	...	..	..	..	9	.04
Blackberries	..	..	..	..	...	...	10 .64	8 .35	...	..	..	..	18	.20
Currants	..	..	..	..	...	1 .04	...	...	...	..	..	..	1	.01
Cherries.....	..	..	..	..	...	6 .16	...	1 .03	3 .40	..	..	..	10	.12
Grapes.....	..	..	..	..	...	...	...	. .	1 .14	..	..	..	1	.03
Sumach.....	..	..	..	..	2 .07	...	...	...	...	..	..	..	2	.01
Ampelopsis	.	..	..	..	...	...	...	1 .02	1 .04	..	..	..	2	.01
Elderberries	.	..	..	..	...	...	...	...	3 .15	..	..	..	3	.03
	Percentages for each month.													
Beneficial elements....	..	..	..	..	13	53	75	45	19	..	..	..	....	41
Injurious elements.....	..	..		..	29	21	07	16	04	..	..	..	....	15
Neutral elements.....	..	..	..	..	58	26	18	39	77	..	..	..	....	44

HARPORHYNCHUS RUFUS, L. BROWN THRUSH.

The brown thrush, although not so common a bird as the two preceding species, is still abundant enough to make its habits a matter of economic interest, both to the gardener and the farmer. It is reported by Baird, Brewer and Ridgway to reside and breed all over the United States east of the Rocky Mountains, but in this State it is, like the robin and catbird, practically a strict migrant. Mr. E. W. Nelson reports its occasional occurrence in southern Illinois in midsummer. It reaches Bloomington

a little earlier than the catbird, and, like that species, leaves us in September. It is a shyer bird than either of the preceding, shrubbery and thickets being its favorite haunts and nesting-places.

April.

The record opens with fourteen specimens taken from the 8th to the 28th of April. Five of them were from central Illinois and nine from the northern part of the State in Lake and JoDaviess counties. Fifty-one per cent. of the food of these birds consisted of insects, two per cent. of spiders and six per cent. of thousand-legs. Seven per cent. of the food was Hymenoptera, nearly all ants; five parts were caterpillars and five were grubs of Diptera—apparently crane-flies. Beetles make about one-fourth of the food, and one-fifth of these were Carabidæ. Platynus, Agonoderus and Harpalus were the only genera recognized. A remarkable feature of the food was the occurrence of four per cent. of carrion-beetles, chiefly *Silpha lapponica* and *S. americana.* Thirteen per cent of the food of the month consisted of Scarabæidæ, about three-fourths of these belonging to the genus Euryomia, which eats the leaves of fruit trees later in the season. A few June beetles were also taken at this time. A trace of wireworms, three per cent. of snout-beetles (about two-thirds of them Brevirostres), one per cent. of Hemiptera and two per cent. Orthoptera were the remaining insect elements. We come next to the distinctive feature of the food of this bird among all the thrushes. Forty-one per cent. of the food consisted of seeds and fragments of grain, of which about one-seventh was acorns taken by woodland specimens, and nearly all the remainder corn. The appearance and odor of the contents of these stomachs left no doubt that the fragments mentioned were picked from the excrement of animals.

May.

The month of May is represented also by fourteen specimens, taken at various dates from the 1st to the 27th, chiefly early in the month. Eleven of these were shot in the northern part of the State, between Galena and Wau-

kegan. The large percentage of insect food in May reminds us of the corresponding rise, in this month, of the insect averages of the food of the robin and the catbird. Seventy-nine per cent. of the food of these birds consisted of insects proper, only one per cent. of spiders and three per cent. of thousand-legs. Ants now amount to four per cent., caterpillars to twelve per cent. (one-third of them distinguishable as cutworms), and Coleoptera to precisely one-half the food, one-tenth of it being Carabidæ.

Scarabæidæ rise to thirty-five per cent., chiefly June-beetles of the genus Lachnosterna, wireworms to three per cent. and Hemiptera and grasshoppers likewise to three per cent. The Hemiptera were all soldier-bugs. Among the predaceous beetles Pterostichus, Anisodactylus and Harpalus were recognized. A single specimen of *Cytilus sericeus* was the only representative of the family Byrrhidæ found in the food of any of these birds. Corymbetes and *Monocrepidius auritus* were among the spring-beetles taken. In this month, as in the preceding, the snout-beetles were chiefly Brevirostres. The Scarabæidæ included *Onthophagus hecate, Aphodius fimetarius, inquinatus* and *granarius*, and *Euryomia inda*. Seventeen per cent. of the food of the month consisted of fragments of grain.

June.

The birds of June, fifteen in number, taken from the 1st to the 29th, all from the northern part of the State but two, had eaten about equally of insects and vegetable substances. Ants rise in this month to eleven per cent., caterpillars fall to three, about one-third of these being cutworms. Diptera fall to one, and Coleoptera to twenty-seven per cent., and Carabidæ drop likewise to four per cent. Scarabæidæ return to seventeen, thirteen of these being leaf-chafers; wireworms fall to one, snout-beetles rise to four, and plant-beetles are represented by a single *Chrysomela suturalis.* Among the snout-beetles occur *Sphenophorus parvulus* and *S. sculptilis.* Several specimens of*Epicærus imbricatus* were eaten by three birds. *Phanæus carnifex, Onthophagus hecate* and *Aphodius*

fimetarius appear among the Scarabæidæ. The commencement of the fruit season is here distinctly discernible. Twenty-two per cent. of the food of these birds consists of raspberries, five per cent. of strawberries and one per cent. of cherries, making a total of twenty-nine per cent. of fruits. Fragments of corn and oats amount to nineteen per cent.

July.

But seven birds were examined in July; all from the vicinity of Normal. All of these had eaten insects, which amounted to only about one-fourth of the food. Both ants and caterpillars were present in trifling quantity. Only about half as many Coleoptera had been taken as in the month preceding. Hemiptera and Orthoptera each make up four per cent. of the food, and Arachnida and Myriapoda are entirely wanting. Carabidæ stand at four per cent., as in June, spring-beetles continue at three and snout-beetles amount to two per cent. *Evarthrus colossus* was found among the Carabidæ. *Heteraspis pubescens, Colaspis brunnea* and *Diabrotica* 12-*guttata* represented the plant-beetles. The fruits of July amounted to sixty-two per cent. of the food—all blackberries. Twelve per cent. consisted of fragments of corn.

August.

Twelve birds were shot in August, all from McLean county, at various times in the month from the 7th to the 30th. The insect averages rally again in August, returning now to fifty-one per cent. Hymenoptera rise to fourteen per cent.—the highest average of the season—a fact due doubtless to the swarming of certain species of ants at this time of the year.

Caterpillars amount to eleven per cent. of the food; Coleoptera fall away to ten, and all but one of these are Carabidæ. *Cratacanthus dubius* seems to be especially abundant in the later summer and early autumnal months. Four per cent. of the food of these birds consists of this species, and it has likewise been found prominent in the food of the bluebird and the catbird at the same season of the year. A small percentage of snout-

beetles and plant-beetles call for no special remark. Hemiptera now make one-tenth of the food—an exceptional occurrence due to the fact that this was one of the chinch-bug years in central Illinois and that three of these birds had eaten freely of that insect. Orthoptera stand at six per cent., about equally distributed between the three families of the crickets, locusts and grasshoppers. A specimen of Tridactylus was noticed among the first and one of the common katydids among the second. The fruits of this month amount to thirty per cent., eaten by nine of the birds. Half of these were cherries, and the remainder were blackberries, grapes, elderberries, and the berries of the mountain-ash. Fragments of corn amounted to eighteen per cent. of the food.

September.

But two birds were shot in September, too few to give any correct idea of the food of the month. It is only necessary to say that these had eaten more largely of grasshoppers than the birds of the preceding month, and to about the same extent of fruits, all of which were grapes.

Summary for the Year.

Taking the food of the year together, we find that almost precisely one-half of it consisted of insects. Spiders amounted to but one per cent. and thousand-legs to but three. The remainder of the food consisted equally of the smaller garden fruits and the fragments of seeds and grain. Thirteen per cent. of the food of these sixty-four birds consisted of blackberries, four per cent. of raspberries, one per cent. of strawberries and three per cent. of cherries. The ants of the year stand at seven per cent., caterpillars at six, and Diptera at only one. Coleoptera amounted to precisely one-fourth of the food, predaceous beetles to six per cent. and Scarabæidæ to thirteen per cent., nearly all of these being leaf-chafers. Spring-beetles and snout-beetles each average two per cent., and Hemiptera and Orthoptera each stand at four.

In the paper previously cited, published in the Transactions of the Illinois Horticultural Society for 1879, I

gave a table of the food of this species based upon twenty-eight specimens shot in April, May, June and July. A test of the substantial correctness of the conclusions of the present paper may be made by comparing the averages of the table printed herewith with the table on page 150 of the Transactions cited. If the important ratios of the present table, covering the food of sixty-four specimens, shot during six months of the year, agree substantially with that table of the food of twenty-eight specimens, covering but four months of the year, this will be sufficient evidence of their general correctness. I will give these averages alternately, first for the former table and then for the present. The twenty-eight specimens of 1879 had eaten insects to the amount of fifty-nine per cent., and sixty-four specimens of the table of 1880 had eaten insects to the amount of fifty-one per cent. Hymenoptera are seven in the first and eight in the second; ants are seven in the first and also in the second; Lepidoptera seven and seven, Diptera a trace and one, Coleoptera twenty-nine and twenty-five, Carabidæ six and six, Silphidæ two and one; leaf-chafers nine and ten, spring-beetles one and two, snout-beetles three and two. Hemiptera two and four, Orthoptera four and four, Arachnida one and one, Myriapoda four and three, and fruits twenty-two and twenty-four. A larger percentage of Hemiptera is due to the much greater abundance of chinch-bugs in 1880.

Recapitulation.

The brown thrush, arriving in April, finds nearly one-half of its food in fragments of corn and other grains and seeds picked from the droppings of animals. This curious habit it maintains throughout the year, evidently taking this food from preference as well as from necessity. In fact I have often found these vegetable fragments associated with blackberries in the food.

After April this element averages about sixteen per cent. throughout the season. Insects amount to about half the food for each month, except in May when they rise to three-fourths and in July when they drop to one-fourth. The excess in May occurs at the time of the

greatest number and activity of the beetles, and the diminution in July coincides with the period of the greatest abundance of the small fruits. One-half the insects eaten are beetles, which stand at one-fourth of the food in April and June, rise to one-half in May and fall to about one-eighth in July and August. Half the beetles of the year are Scarabæidæ, chiefly June beetles and Euryomia, all taken previous to July. Nearly one-fourth of the beetles are Carabidæ, which remain at about five per cent. of the food, except in May, when they rise to ten per cent. Although the ratios of spring-beetles and snout-beetles are but two per cent., the numbers eaten are of some significance. My notes show that these birds were eating each at the daily rate of about 1½ curculios, and consequently had averaged a total of about 250 to each thrush for the season. The brown thrush takes ants more freely than the robin, but eats comparatively few caterpillars; seven per cent. of each were found in the food of the year. Diptera are taken in very trivial quantity and Hemiptera in moderate number only. This bird eats thousand-legs more freely than the robin, especially in the early spring. In the garden it plays a part very similar to that of the other thrushes, but is less mischievous, on the whole. Its average of the edible fruits for June, July and August is thirty-eight percent. as against sixty per cent. of the robin and forty-nine per cent. of the catbird. It relishes the whole list of garden fruits, and later in the season resorts, like the other thrushes, to the wild fruits of the woods and thickets. Compared with the robin, this bird is seen to be especially peculiar in the coprophagous habit already mentioned as distinguishing it from all the other thrushes. It takes about one-half as many Lepidoptera, about half as many again Coleoptera, nearly twice as many Carabidæ and three times as many leaf-chafers; but eats comparatively few grapes and cherries. From the catbird it is further distinguished by taking half as many ants, a trivial number of Diptera, twice as many Coleoptera and twice as many Carabidæ, five times as many leaf-chafers and more spring-beetles, snout-beetles, Hemiptera and Orthoptera.

It eats two-thirds as many berries and one-third as many cherries and grapes as the catbird.

Economic Value.

Compared with the robin for corresponding months, this species seems to show very similar economic relations. In both, the totals of beneficial elements eaten during this period are to the injurious about as four to three; but with the brown thrush as with the catbird, its later arrival and earlier departure are to its disadvantage. Balancing as carefully as I can its seven parts of Lepidoptera, ten of leaf-chafers, two of spring-beetles, two of snout-beetles, one of chinch-bugs and four of Orthoptera on the one hand, against its six parts of Carabidæ, two of predaceous Hemiptera, one of spiders, one of predaceous thousand-legs and twenty-one of small fruits on the other, I cannot see that, so far as the *immediate* consequences of its food habits are concerned, it does more good than harm. In short, its Orthoptera must pay for its garden fruits; that is to say, eliminating these two elements, I judge that the predaceous insects eaten would destroy during the year about as many injurious insects as the bird itself has taken. However, I must repeat the suggestion that they could hardly destroy the *same kinds* as the bird, and that, if allowed to live, they would probably decimate some species already sufficiently restricted by existing checks, and permit an unrestrained increase of others now kept down by the thrush. That the disturbances thus set up would soon lead us to regret this bird if its numbers were greatly lessened, is therefore very probable, and I believe the species should be preserved. We must not overlook the special services of the brown thrush in devouring a much larger number of June-beetles than any other of the species examined.

TABLE OF THE FOOD OF THE BROWN THRUSH. (*Harporhynchus rufus*, L.)

	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL	Ratio of each element to whole of food.
Number of specimens..	..	..	..	14	14	15	7	12	2	..	..	..	64	
KINDS OF FOOD.	Number of specimens and ratio in which each element of food was found													
I. MOLLUSCA	..	..	..	...	1 †	...	...	1 †	..	..	..	..	2	†
II. INSECTA.....	..	..	..	14 .51	14 .79	15 .49	7 .26	12 .51	..	..	..	..	62	.51
1. *Hymenoptera*	..	..	..	9 .07	10 .04	11 .12	4 .02	11 .14	..	..	..	..	45	.08
Formicidæ...	..	..	..	8 .06	10 .04	10 .11	3 .02	11 .14	..	..	..	..	42	.07
Ichneumonidæ	..	..	..	2 †	...	1 †	...	...	..	..	..	..	3	....
2. *Lepidoptera*	..	..	..	6 .05	12 .12	6 .03	2 .03	7 .11	..	..	..	..	33	.07
Caterpillars	..	..	..	6 .05	12 .12	4 .02	...	7 .11	..	..	..	..	29	.06
Noctuidæ	..	..	..	...	4 .04	2 .01	...	...	..	..	..	..	6	.01
3. *Diptera*	..	..	..	1 .05	...	2 .01	...	...	..	..	..	..	3	.01
4. *Coleoptera*.....	..	..	..	12 .26	14 .50	14 .27	7 .13	9 .10	..	..	..	..	56	.25
Carabidæ	..	..	..	9 .05	7 .10	5 .04	3 .04	5 .09	..	..	..	..	29	.06
Silphidæ.....	..	..	..	3 .04	...	...	...	...	..	..	..	..	3	.01
Nitidulidæ.....	..	..	..	...	...	...	1 .02	...	..	..	..	..	1	†
Staphylinidæ.....	..	..	..	...	1 †	...	...	...	..	..	..	..	1	†
Histeridæ.....	..	..	..	2 †	3 .01	1 †	...	1 †	..	..	..	..	7	†
Byrrhidæ	..	..	..	...	1 †	...	...	...	..	..	..	..	1	†
Scarabæidæ.	..	..	..	9 .13	11 .35	8 .17	...	1 †	..	..	..	..	29	.13
Melolonthinæ ...	..	..	..	2 .01	6 .26	4 .13	...	...	..	..	..	..	12	.08
Euryomia.....	..	..	..	2 .09	2 .03	...	...	...	..	..	..	..	4	.02
Buprestidæ..	..	..	..	...	...	1 †	...	...	..	..	..	..	1	†
Elateridæ.	..	..	..	1 .01	8 .03	3 .01	3 .03	...	..	..	..	..	15	.02
Tenebrionidæ.....	..	..	..	...	...	...	1 .01	...	..	..	..	..	1	†

TABLE OF THE FOOD OF THE BROWN THRUSH. (*Harporhynchus rufus*, L.)
Continued.

	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL	Ratio of each element to whole of food.
Number of specimens. .	..	..	..	14	14	15	7	12	2	..	..	..	64	
KINDS OF FOOD.	Number of specimens and ratio in which each element of food was found													
Lampyridæ	..	..	..	...	...	1 †	...	...	..	..	..	...	1	†
Rhynchophora	..	..	..	7 .03	5 .01	7 .04	3 .02	3 .01	..	..	.	...	25	.02
Brevirostres.....	..	..	..	3 .02	...	3 .02	1 .01	2 .01	..	..	..	...	9	.01
Longirostres.....	..	..	..	3 .01	1 †	2 .01	...	1 †	..	..	..	...	7	†
Brenthidæ	..	..	..	...	...	1 †.	...	...	..	..	..	...	1	†
Chrysomelidæ.....	..	..	..	...	...	1 †	2 .01	1 †	..	..	..	...	4	.01
5. *Hemiptera*.....	..	..	..	3 .01	6 .03	1 .01	5 .04	6 .10	..	..	..	...	21	.04
Blissus.....	..	..	..	...	...	...	...	3 .06	..	..	..	...	3	.01
Pentatomidæ.....	..	..	..	...	6 .03	1 .01	3 .02	...	..	..	..	...	10	.01
6. *Orthoptera*	..	..	..	1 .02	4 .04	3 .05	2 .04	4 .06	..	..	..	...	14	.04
Gryllidæ.....	..	..	..	...	...	...	1 .02	1 .02	..	..	..	...	2	.01
Locustidæ.....	..	..	..	...	...	...	...	1 .01	..	..	..	...	1	†
Acrididæ.....	..	..	..	1 01	3 .03	3 .04	...	1 .01	..	..	..	...	8	.02
III. ARACHNIDA	..	..	..	3 .02	1 .01	1 .01	...	...	..	..	..	...	5	.01
IV. MYRIAPODA.....	..	..	..	6 .06	7 .03	5 .03	...	1 .01	..	..	..	...	19	.03
Geophilidæ	..	..	..	1 .01	...	...	...	1 .01	..	..	..	...	2	.01
Iulidæ	..	..	..	5 .05	7 .03	5 .03	...	...	..	..	..	...	17	.02
V. FRUITS	..	..	..	...	...	9 .29	6 .62	9 .30	..	..	..	...	24	.24
Blackberries	..	..	..	...	...	...	6 .62	1 .05	..	..	..	...	7	.13
Raspberries.....	..	..	..	...	...	6 .22	...	...	..	..	..	...	6	.04
Strawberries.....	..	..	..	...	...	3 .05	...	...	..	..	..	...	3	.01
Grapes.....	..	..	..	...	...	...	...	2 .02	..	..	..	...	2	†

TABLE OF THE FOOD OF THE BROWN THRUSH. (*Harporhynchus rufus*, L.)
Concluded.

	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL	Ratio of each element to whole of food.
Number of specimens..	..	..	..	14	14	15	7	12	2	..	..	..	64	
KINDS OF FOOD.	Number of specimens and ratio in which each element of food was found.													
Cherries.....	..	..	..	...	...	1 .01	...	3 .15	..	..	..	..	4	.03
Elderberries	..	..	..	...	...	...	...	1 .04	..	..	..	..	1	.01
Mountain-ash.....	..	..	..	...	...	...	...	1 .03	..	..	..	..	1	.01
VI. SEEDS AND GRAIN.	..	..	..	12 .41	7 17	9 .18	1 .12	5 .18	..	..	..	..	34	.21
Acorns.....	..	..	..	2 .06	...	...	...	...	..	..	..	..	2	.01
Oats	..	..	..	...	...	2 .01	...	...	..	..	..	..	2	†
Corn.....	..	..	..	9 .34	...	6 .17	1 .12	5 .18	..	..	..	..	21	.16
Wheat.....	..	..	..	1 .01	...	...	...	...	..	..	..	..	1	†
Buckwheat.....	..	..	..	1 †	...	...	...	...	..	..	..	..	1	†
	Percentages for each month.													
Beneficial elements....	..	..	..	9	14	34	70	36	...	..	..	..	....	33
Injurious elements.....	..	..		21	49	25	13	24	..	..	..	..	....	26
Neutral elements.....	..	..	..	70	37	41	17	40	..	..	..	..	....	41

TURDUS MUSTELINUS, Gm. WOOD THRUSH.

The remaining members of this family are much less important than the preceding species, and their food is of relatively little interest. I shall therefore treat them much more briefly, especially as I have comparatively few specimens of them. The wood thrush is essentially a woodland bird, but occurs not infrequently in groves and gardens and in other situations where trees and shrubbery are accessible. It reaches central Illinois in April, and retires usually in October, spending its winter in the Southern States. I have studied the food of but twenty-two specimens of this species, ranging from

April to September. Two of these birds were taken in April, five in May, six in June, six in July, two in August and one in September. I shall not attempt to follow the food of the species through these months, or to give its seasonal variations; but will content myself with a general statement of the food of the year as indicated by the contents of the stomachs of these twenty-two birds. Seventy-one per cent. of their food consisted of insects and twenty per cent. of fruit, a small ratio of spiders and mollusks and an unusually large percentage of Myriapoda making up the remainder. The four higher orders of insects occur in about equal quantities, the proportion of ants and crane-flies being extraordinary. Blackberries, strawberries, cherries and gooseberries appear among the fruits. Myriapoda amount to twelve per cent.—nearly all Polydesmus and Iulus. The two parts of Arachnida included a few harvest-men. Orthoptera and Hemiptera are respectively six and one per cent.; and snout-beetles and wireworms thirteen per cent. A few June-beetles had been taken, and one of the birds from northern Illinois had stuffed itself with rose-beetles (*Macrodactylus subspinosus*). Geotrupes and Onthophagus were noticed among the other Scarabæidæ. The Carabidæ amounted to six per cent. of the food, including Evarthrus, Pterostichus, Harpalus, Anisodactylus and Bradycellus. Coleoptera make eighteen per cent. of the food and Diptera twelve per cent., chiefly crane-flies and the larvæ of *Bibio albipennis*. Lepidoptera were taken in about the same amount, one-third being recognized as cutworms, while ants reached the unusual average of fifteen per cent. *Helix labyrinthica*, *Pupilla fallax* and a few other univalve mollusks made one per cent. of the food. Compared with other Turdidæ we find the general insect average unusual, exceeding that of the robin. It agrees with, and even surpasses, the catbird in its preference for ants; and with the robin in the ratios of Lepidoptera, Diptera, Coleoptera, Carabidæ and Scarabæidæ. It differs from the robin in its taste for ants and in the smaller ratio of fruits; and far surpasses all the other thrushes in the number of

Myriapoda eaten in spring. In fact, the midsummer fruits seem to replace these spring Myriapoda, instead of insects proper as in the species already discussed. This bird apparently contrasts more directly with the brown thrush in food than with any other member of the family. The large percentage of Orthoptera is misleading, being due to the fact that a single bird had taken nothing but grasshoppers and locusts. This species seems to do more good and less harm than the preceding thrushes, having the lowest fruit ratio and eating the highest number of insects, with only the average of predaceous species. Its advances, therefore, are to be cordially encouraged by the gardener and farmer—a fact which must be especially agreeable to every lover of bird music, who has learned to recognize the full, clear, rich and exquisite strains of this songster.

HYLOCICHLA PALLASI, Cab. HERMIT THRUSH.

The hermit thrush is strictly a migrant, passing us in May and October. It is reported by Mr. Ridgway as a rare winter resident in southern Illinois, but otherwise appears in the State only during its passage to and fro. Considering the fact, however, that all these birds travel slowly the whole length of the State, merely keeping pace with the advancing and retreating seasons, and also that the species is a very abundant one at the period of the migrations, it will be seen that its food has great economic significance. There is reason to suppose that these migrants, in passing north and south, follow, year after year, about the same route; do not vary, that is, far to the east or west. Consequently, occupying as we do a state that lies in five and one-half degrees of latitude, we can do much to protect this species in its wanderings, or can, if we choose, almost entirely eliminate that part of it passing over our territory. Twenty-one hermit thrushes were taken during the year, two in October and the remainder during the spring migrations. All but five of these birds were shot in extreme northern Illinois, at Waukegan, Evanston and Blue Island. Eighty-four per cent. of the food consisted of insects, four per cent. of

spiders and twelve per cent. of thousand-legs. Ants amounted to fifteen per cent., Lepidoptera to nineteen per cent., including a few Phalænidæ, and Diptera only to three—chiefly the larvæ of Bibio. Coleoptera make thirty per cent. of the food, eleven per cent. being Carabidæ. *Dyschirius globulosus*, Platynus, Evarthrus, Pterostichus, Amara, *Anisodactylus discoideus*, Bradycellus and Stenolophus are mentioned in my notes. Four per cent. are water-beetles, five per cent. scavenger-beetles, two per cent. curculios and two per cent. plant-beetles. Leaf-chafers and spring-beetles amount to one per cent. each —the latter chiefly of the genus Melanotus. *Lixus concavus* and *Listronotus inæqualipennis* occur among the curculios, and *Chrysomela suturalis*, *Gastrophysa dissimilis* and *Plagiodera viridis* among the plant-beetles. Eight per cent. of the food was Hemiptera, nearly all of which were predaceous. *Podisus spinosus* was the only species determined. Grasshoppers (Tettix and Tettigidea) make seven per cent. of the food. Respecting the number of beetles eaten by this bird, we have to remember that it passes us at the time of that great outpouring of insect life connected with the pairing of the spring Coleoptera which we have already seen to have a very significant relation to the food of birds. It rides northward, in fact, on the crest of this Coleopterous wave, and we find the same excess of predaceous Coleoptera in its food which occurs in the food of the other thrushes at the same season. Concerning the two October specimens taken in northern Illinois I need only say that they had eaten ants, caterpillars, Carabidæ, curculios, Pentatomidæ and Orthoptera, spiders, Iulidæ and the larvæ of Bibio. The habits of this bird suggest that the principal drain on the numbers of predaceous beetles may be due to the depredations of the migrants, at the season of the greatest exposure of these insects; and that the complete destruction of resident birds would affect the number of these carnivorous insects much less than would at first seem likely. The reader curious to see the points in which this species contrasts with the other thrushes, may consult the table of the food of the family on page 147.

TURDUS ALICIÆ, Bd. ALICE THRUSH.

The Alice thrush is a bird of frequent occurrence during the migrations. It breeds far to the north, rare summer stragglers occurring in northern Illinois, according to Mr. E. W. Nelson, and probably winters quite beyond our limits. By Dr. Coues this is regarded merely as a variety of the following species. I have ten specimens of this bird shot in May, but none from the fall migration. This number is probably sufficient, however, to give a fairly correct idea of its food in spring. Five per cent. of the food of the month consisted of mollusks, chiefly Succinea and *Helix labyrinthica;* ninety-three per cent. was insects and nearly half of these were ants, which reached the astonishing ratio of forty-three per cent., eaten by every one of the birds. Fifteen per cent. of the food was caterpillars; nine per cent. consisted of crane-flies and their larvæ; Coleoptera amounted to eighteen per cent. (one-half Aphodiidæ), and the remainder were wire-worms, curculios and plant-beetles. Carabidæ amounted only to one per cent., the lowest average of these beneficial insects found in the food of any thrush. Among the species of Coleoptera we find *Stelidota geminata, Onthophagus janus, Conotrachelus anaglypticus, Chrysomela suturalis* and *C. similis.* Grasshoppers make three per cent. of the food and Myriapoda two per cent., all *Polydesmus serratus* and undetermined Iulidæ. Of spiders merely a trace was found in the stomachs of two birds. The striking feature of the food of this bird is evidently its enormous appetite for ants, its high insect average and the almost total absence of beneficial elements in its food giving to this little thrush an enviable status in relation to the farm and garden.

TURDUS SWAINSONI, Cab. SWAINSON'S THRUSH.

This is a migrant of which I have too few specimens for generalization. Six in April and May were taken at Warsaw, Waukegan and Normal, and five in September from the vicinity of Cairo, in extreme southern Illinois, and northern Kentucky. The food in spring is very like that of the preceding species, its especial features being the large number of ants and caterpillars and Coleoptera. The September specimens, on the other hand, were

feeding largely upon fruits, which constituted sixty per cent. of their food. Wild grapes, wild cherries, elderberries and blackberries were all eaten by them, grapes alone making more than half their food. Hymenoptera amounted to nineteen per cent. of the whole; ants to seven, caterpillars to twelve, crane-flies to four, and Coleoptera to eighteen per cent.; five per cent. were Carabidæ (including Anisodactylus), three per cent. were leaf-chafers and two per cent. were curculios. One of the birds, taken at Warsaw in April, had eaten little else than *Scolytus muticus*. Two per cent. of the food was Hemiptera, chiefly Pentatomidæ and Reduviidæ; Rhynchophora and Hemiptera made two and one per cent. respectively. Of spring-beetles and Aphodiidæ, only a trace had been eaten by two of the birds.

MIMUS POLYGLOTTUS, L. MOCKING-BIRD.

This famous bird, not many years ago regarded as a rarity in the State, is evidently becoming more abundant, and is also extending its habitat northward. Collectors in the southern part of the State agree to its increasing numbers there. Three specimens were seen this year in the vicinity of Bloomington, two of which were secured. One of these, shot in August, was of this year's brood, and as the other two seemed thoroughly habituated, it is likely that they had nested in this vicinity this season. It may be worth while to note that sixty per cent. of the food of these two specimens consisted of Orthoptera, including the climbing cricket (Œcanthus). Besides these, they had eaten spiders and harvest-men, Coleoptera, Hemiptera and ants. Among the Coleoptera were specimens of Onthophagus, *Epicauta vittata* and long-snouted curculios. The Hemiptera were undetermined Coreidæ and Pentatomidæ. These birds had not eaten fruit, although the species is reported to be especially fond of grapes.

CONCLUSION.

As a very general statement of the peculiarities of the food of the resident species, we may say that the robin is characterized by its destruction of caterpillars (especially cutworms) and the larvæ of Bibio, by its neglect of

ants, spiders and Myriapods, and by its taste for blackberries, grapes and especially cherries; that the catbird is distinguished by the large number of ants, blackberries and cherries eaten, and by the small number of insects generally, and of Lepidoptera, Coleoptera and Hemiptera in particular; that the brown thrush is noted for its coprophagous habit, for the small number of caterpillars and Diptera taken, for the large percentage of phytophagous Scarabæidæ and the moderate ratio of small fruits; and that the wood thrush differs from the others chiefly in the large percentage of insects (especially ants, caterpillars and crane-flies), its indifference to Hemiptera and preference for Orthoptera and Myriapoda, and its smaller ratios of fruits.

The migrants can be properly compared only with the residents during the migrating season. I have consequently made a table of the percentages of the food of the four resident species for April and May in comparison with the spring food of the three migrants. From this we learn that the hermit thrush is distinguished at this season by the moderate ratio of ants and Coleoptera, the large number of Lepidoptera, Hemiptera, Orthoptera, spiders and Myriapoda, and the small percentage of Diptera taken. The Alice thrush eats mollusks,. an enormous number of ants, a moderate number of Lepidoptera, Diptera and Scarabæidæ, and a small number of Carabidæ and Coleoptera generally, while Hemiptera are almost wanting in its food. Swainson's thrush takes large ratios of ants, Lepidoptera and Coleoptera, and small ratios of Hemiptera, Orthoptera, Arachnida and Myriapoda. It is not to be supposed that the number examined of the last two species is sufficient to give more than an approximate and doubtful outline of the food.

Indeed the reader may not unlikely receive with incredulity the precise statements made concerning the food characteristics of the resident species, and ask how it can be known that these peculiarities are specific and constant instead of local and accidental. To this very reasonable query I am able to make a definite answer. In the paper already frequently cited, I published a comparative table of food of the species of this family, based on

the contents of the stomachs of one hundred and forty-nine birds,* upon which table certain differences of food are clearly shown. Now, if these differences were local and accidental, they would undoubtedly tend to disappear when larger numbers of specimens were examined; but if they are specific and constant, they should be made the more evident, on the whole, the larger the number of specimens taken. The table on page 147 presents data derived from three hundred and fifteen specimens, covering considerably more time and area than the table in the Transactions. If the difference between the food records of the various species are now greater than before, we may conclude that the differences noted are real and not artificial. If they are less, on the other hand, the whole question is still unsettled. The differences apparent in the later table may be specific, but there is no proof of it. In order to apply this crucial test as fully as possible, I have selected twelve food elements in which the differences were most apparent, and, taking the species in pairs, have ascertained the sum of the differences of the ratios of these elements for each pair separately, first from the old table and then from the new. In every case but one the sum of these differences has been much larger by the new table than by the old, thus proving conclusively that the species appear to diverge in food habits the more widely the greater the number of specimens studied. For example, the differences of the selected elements as shown in the original table of seventy-eight robins and catbirds, amounted to sixty-four per cent.; and by the new table of one hundred and eighty-four birds, to eighty-two per cent. A similar comparison of the food of the catbird and hermit thrush gives one hundred and twenty-five as the sum of the differences of the old table of fifty-five birds, and one hundred and fifty-five as the sum of the differences of the new table of ninety-one birds. Taking the catbird and the brown thrush, we have sixty-four and ninety-nine parts for the old and new tables respectively, the first for sixty-five birds and the second for one hundred and thirty-four; while the brown thrush and wood thrush give seventy-eight and eighty-

* Trans. Ill. Hort. Society, 1879, N. S., Vol. 13, p. 163.

eight parts for thirty-nine and eighty-six birds respectively, and the catbird and wood thrush give seventy parts for eighty-five birds and eighty-three parts for ninety-two birds. It is not until we reach the last two migrants that we find any exception to these results; and of these, as already said, probably too few have been examined, even yet, to justify settled conclusions.

Finally, we must consider the family as a unit, must discuss the actual effect of the thrushes as a group upon the plants and animals of the State. A determination of this interesting question involves three elements; the average character of the food of each species as shown by the preceding calculations, the comparative abundance of the species, and the length of its stay in Illinois. I find the estimates of the second of these elements, as made by various collectors, to differ rather widely; and on this account only an approximate conclusion can be reached. Using the figures most satisfactory to myself, I present the following as a tolerably fair statement of the general food of the family: Sixty-one per cent. of the food consists of insects, one per cent. of spiders, two per cent. of Myriapods, and thirty-two per cent. of fruits, eleven per cent. being blackberries, eight per cent. cherries, one per cent. currants and five per cent. grapes. The fragments of grain eaten by the brown thrush will amount to four per cent. of the food of the family, and ants compose eight per cent. Lepidoptera, Diptera and Coleoptera are eaten in about equal ratios, the first forming thirteen, the second eleven and the third twelve per cent. of the entire food. Carabidæ amount to five per cent., June beetles to four per cent., wireworms to two per cent. and snout-beetles to two per cent. Hemiptera stand at three per cent., about two-thirds of them predaceous, and Orthoptera at four per cent. Five per cent. of the food was recognized as cutworms. More briefly, thirty parts of the food consist of injurious insects, including the larvæ of Bibio, and eight parts of beneficial species, while twenty-six parts consist of edible fruits; or we may say that injurious insects compose about one-third, the edible fruits about one-fourth and the beneficial insects about one-twelfth of the food of the family, the remaining elements being of neutral value.

TABLE OF THE FOOD OF THRUSHES IN APRIL AND MAY.

	Robin	Catbird	Brown Thrush	Wood Thrush	Hermit Thrush	Alice Thrush	Swainson's Thrush
No. of specimens examined	31	22	28	8	18	10	6
KINDS OF FOOD.	Ratio in which each element of food was found.						
1. MOLLUSCA	.01	....	....	†	....	.05	....
2. INSECTA	.93	.83	.65	.84	.87	.95	.98
Hymenoptera.	.03	.22	.05	.20	.16	.47	.31
Ants	.03	.18	.05	.20	.13	.43	.28
Lepidoptera	.24	.14	08	.21	.19	.15	.22
Noctuidæ	.09	.02	.04	.08	....	.02	....
Diptera.....	.12	.20	.03	.15	.01	.09	.07
Tipulidæ	.03	.19	....	.15	....	.08	.07
Bibionidæ	.04	....	....	....	.....	....	....
Coleoptera.	.43	.23	.38	.23	30	.18	.30
Carabidæ	.11	.09	.07	.09	.11	.01	.05
Scarabæidæ	.19	.01	.24	.06	.06	.10	.06
Coprophagous	....	....	....	....	.05	.10	....
Phytophagous	.12	.01	.19	.02	.01	....	.06
Elateridæ	.04	†	.02	.06	.01	.02	†
Rhynchophora	.03	.05	.02	.02	.02	.03	.03
Chrysomelidæ	.01	.01	....	....	.02	.01	.02
Hemiptera.	.04	†	.02	.01	.08	....	....
Predaceous.....	.03	†	.02	....	.06	....	....
Herbivorous.....	....	....	....	....	....	....	....
Orthoptera.....	.05	.04	.03	.03	.08	.03	....
3. ARACHNIDA.....	.01	.03	.02	.01	.04	†	.01
4. MYRIAPODA.....	.01	.07	.04	.13	.09	.02	.01
5. FRUITS AND SEEDS.....	.03	.07	....	....	....	....	....
6. FRAGMENTS OF GRAIN	....	....	.29	....	....	....	....

TABLE OF FOOD OF FAMILY TURDIDÆ. (THE THRUSHES.)

	Robin	Catbird	Brown Thrush	Wood Thrush	Hermit Thrush	Alice Thrush	Swainson's Thrush	Mocking-bird	TOTAL	Corrected average
No. of specimens examined	114	70	64	22	21	11	11	2	315	..
KINDS OF FOOD.	Ratio in which each element of food was found.									
1. MOLLUSCA	....	....	....	....	....	.05	....	...	...	...
2. INSECTA	.65	.43	.51	.72	.84	.93	.62	...	...	.61
Hymenoptera	.04	.13	.08	.15	.16	.47	.19	...	...	.09
Ants	.04	.12	.07	.15	.13	.43	.17	...	...	.08
Lepidoptera	.17	.07	.07	.13	.18	.15	.12	...	...	.13
Noctuidæ	.08	.01	.01	.04	....	.04	....	...	...	.05
Diptera	.17	.05	.01	.12	.04	.09	.04	...	...	.11
Tipulidæ	.01	.05	....	.12	....	.08	.04	...	...	.03
Bibionidæ	.15	....	....	....	....	....	....	...	...	.07
Coleoptera	.18	.12	.25	.18	.29	.18	....	...	...	.12
Carabidæ	.06	.04	.06	.06	.14	.01	.05	...	...	.05
Melolonthidæ	.03	.02	.10	.03	.01	....	.03	...	...	.04
Elateridæ	.02	....	02	.03	.01	.02	†	...	...	.02
Rhynchophora	.02	.01	.02	.03	.03	.10	....	...	...	.02
Chrysomelidæ	....	.01	†	....	.02	.01	....	...	...	...
Hemiptera	.03	.02	.04	.01	.10	....	.02	...	...	.03
Predaceous	.02	.01	.01	.01	.07	....	.01	...	...	.02
Herbivorous	....	.01	.01	....	....	....	.01	...	...	...
Orthoptera	.04	.03	.04	.06	.07	.03	.01	...	...	.04
3. ARACHNIDA	.01	.02	.01	.01	.04	....	.02	...	...	.01
4. MYRIAPODA	....	.03	.03	.07	.12	.02	.01	...	...	.02
5. FRUITS	.34	.51	.24	.19	....	....	.35	...	...	.32
Strawberries	....	.01	....	....	....	....	....	...	...	...
Blackberries	.09	.24	.17	....	....	....	†	...	...	.11
Cherries	.11	.12	.03	....	....	....	.06	...	...	.08
Currants	.02	.01	....	..	....	....	....	...	...	.01
Grapes	.07	.03	†	....	....	....	.27	...	...	.05
6. FRAGMENTS OF GRAIN	....	....	.21	....	....	....	....	...	...	.04

Family SAXICOLIDÆ. (The Stonechats.)

Sialia sialis, L. The Bluebird.

This beautiful and beloved bird, endeared to the student of nautre by every particular of its plumage, song and way of life, is also one of the most popular of all birds with farmers and gardeners. Living under the eyes of men from the first yielding days of the later winter until the year grows chill and dark with the retreat of autumn, it has been praised most warmly for its tireless service of man by those who knew it best. A cursory observation of its feeding habits will strongly support the general impression of its usefulness. Most frequently it takes a short, quick flight to the ground from a fence-post or a low branch of a tree, and, after a moment's pause, returns to its perch with a caterpillar or a grasshopper or some other insect in its beak, which it devours at its leisure, repeating this operation so frequently that none can doubt its enormous destructiveness to insect life.

It is true that a little reflection will suggest that, as it evidently sees its prey before it leaves its perch, it must usually take only the most conspicuous and the most active insects, and that there is no security that these will be the most injurious—that they may not be, in fact, among the most beneficial; but this consideration does not seem to have made any impression, and the bluebird remains to this day substantially without reproach.

I have now examined carefully, with the microscope, the contents of one hundred and eight stomachs of this species, of which ten were taken in February, twenty-one in March, thirteen in April, nine in May, ten in June, nine in July, twelve in August, ten in September, two in October and twelve in December (in southern Illinois). I propose to present the data for each of these months; to summarize them for the year; to estimate the benefit and injury indicated to farm and garden, and to make a comparison of the food of this bird with that of the robin, and of the thrushes generally.

February.

The ten birds of this month were all shot at Normal, Ill., from the 24th to the 29th of the month, in the present year. These stomachs, with those obtained from Galena, in early March, represent the first food of the season.

The record opens with a bird shot on the 24th. Thirty per cent. of its food had been grass-eating cutworms, forty per cent. crickets (*Gryllus abbreviatus*), five per cent. Ichneumonidæ (*Arenetra nigrita* Cress.), and twenty-five per cent. the larvæ of the two-lined soldier-beetle (*Telephorus bilineatus*). Now, the ichneumons are doubtless parasitic, although about the habits of the genus Arenetra, I have at present but little specific information; and the soldier-beetles are reported by Prof. Riley and others to be highly useful insects, noted especially for the destruction of the apple-worm and the eggs of grasshoppers.*

Taking the month together, we find that the most important elements of the food were cutworms and ichneumons—twenty-four per cent. of the former to twenty-two per cent. of the latter. The larvæ of the soldier-beetles amount to eight per cent., locusts (chiefly the young of *Tragocephala viridifasciata*) to nine per cent., Carabid beetles and their larvæ (including Amara and Anisodactylus) to five per cent., Pentatomidæ or soldier-bugs (chiefly *Euschistus servus*) to seven per cent., spiders to four per cent. and Iulidæ (thousand-legs) to three per cent. Other items are, two per cent. caterpillars of Arctians (*Callimorpha lecontei*), four per cent. crickets, and nine per cent. dung-beetles (*Aphodius fimetarius* and *A. inquinatus*). The ichneumons, Carabid beetles, soldier-bugs and spiders thus make up forty-six per cent. of beneficial insects, while the caterpillars and Orthoptera amount to but forty-one per cent. of injurious species. Or, if we drop the Pentatomidæ from the former category, on account of the supposed trifling injuries to vegetation done by some of them (hence often called "plant-bugs"), the figures will stand, beneficial insects thirty-nine, to forty-one injurious.

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* See 4th Rep. State Ent. Mo., p. 29, and Rep. U. S. Ent. Comm., 1877, p. 302.

March.

Twenty-one specimens were examined which had been shot in this month, in 1880, ranging from the 7th to the 31st. Seven of these were shot at Normal, nine at Heyworth (fifteen miles south) and five at Galena, in extreme northwestern Illinois. These latter differed from the central Illinois specimens chiefly in the presence of the dried and sometimes mouldy fruit of the sumach (*Rhus glabra*) in their stomachs, indicating a scarcity of desirable food at that early season. One of these, unfortunately for the record of the month, had stuffed itself with larvæ of Harpalus, which made ninety-three per cent. of its food.

Ichneumonidæ (Arenetra) appear again (four per cent.), for the last time during the season.

Harpalid beetles and their larvæ were unusually abundant, making up eleven per cent. of the food of the month. Among these Platynus, Evarthrus, Pterostichus, Amara, *Chlænius tomentosus,* Agonoderus and Harpalus were recognized. The larvæ of soldier-beetles also occur, constituting four per cent. of the food, but do not appear again throughout the year. Four birds had eaten a predaceous bug (*Coriscus,* near *ferus*),* which is too minute to figure in the ratios; and four per cent. of the food was Pentatomidæ, of which only *Peribalus modestus* was recognizable. Sixteen of the twenty-one birds had eaten spiders, making five per cent. of the food. The beneficial insects thus amount to twenty-eight per cent. On the other hand, thirty-eight per cent. was caterpillars, chiefly Noctuidæ,† including *Callimorpha lecontei* and the army-worm (*Leucania unipuncta*); one per cent. was *Euryomia inda,* and twenty-one per cent. was Orthoptera (crickets and grasshoppers), the injurious species thus rising to sixty per cent. One bird had also eaten a minute curculio. Among neutral elements we enumerate Aphodii three per cent., Iulidæ three per cent., and sumach berries four per cent. Two birds had eaten ants, but in trivial quantity.

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* Kindly identified for me by Mr. Uhler.

† I have thus reported all smooth caterpillars in which the cervical and anal shields, common to most cutworms, were distinguished. A few such caterpillars are not Noctuids, but are equally injurious.

In order to determine the number of specimens which it is necessary to examine in each month, to reach reliable averages of benefit and injury, I divided my notes on twenty of the specimens for March into two groups of ten each, so selected that all the localities and all parts of the month were equally represented in each group; and then averaged each ten separately and compared the averages. In the first group beneficial insects composed twenty-nine per cent of the food, and injurious insects fifty-nine per cent.; in the second group beneficial insects composed twenty-seven per cent. of the food and injurious insects sixty-one per cent. The close correspondence of these averages shows that, on this question, ten specimens would have given as accurate information as twenty, and indicates that ten birds a month will usually afford a fair basis for an opinion.

April.

The food for April, as shown by the thirteen specimens of that month (from Normal, Evanston, Waukegan, and Elizabeth, in 1876 and 1880), was remarkable for the number of Aphodii (dung-beetles) it included; twenty-one per cent. of the food of the month was *Aphodius inquinatus*, nine per cent. *A. fimetarius*, and one per cent. undetermined Aphodii. This peculiarity is accounted for, in harmony with what has been said above respecting the feeding habits of the bluebird, by the fact that this is the month when the Aphodii fly most actively in the latitude of northern Illinois. Carabidæ now stand at eight per cent., including *Carabus palustris*, Pterostichus, Evarthrus, and other Pterostichi, Platynus, *Chlænus tomentosus*, *Anisodactylus rusticus*, *Amphasia interstitialis*, and Harpalus; four per cent. of Hemiptera includes Coriscus and *Hymenarcys nervosa*, while spiders rise to nine per cent. Caterpillars are twenty-one per cent. (seventeen per cent. Noctuids), June-beetles (Phyllophaga) two per cent., Curculionidæ one per cent., and grasshoppers (Tettigidea sp. and *Tettix ornata*) eight per cent.; a total of thirty-two per cent. of injurious insects against twenty-one per cent of predaceous species. Among the

neutral elements we find a sprinkling of ants (two per cent.), larvæ of a Tenebrionid (*Merancantha contracta**) four per cent., and thousand-legs (Iulidæ) one per cent. Long strips of grass, in pieces much too large to have been eaten by any of the insects present, were found in the stomachs of two of these birds, and also occurred during each of the three following months. I am in doubt whether these were taken as food; but, since I have found them in no other bird, and since a species which feeds so largely on cutworms and grasshoppers may have acquired the power of digesting the very considerable quantities of grass contained in the intestines of these insects, I have thought it best to include them in the percentages of food. It is probable, however, that they were swallowed accidentally with insects taken from the ground.

It will be noticed that the excess of Coleoptera in April is largely compensated by the diminished quantities of Orthoptera and caterpillars.

May.

In this month nine birds were taken, from six localities in central and northern Illinois, in 1876–80. The Lepidoptera, Coleoptera and Orthoptera return to about their normal ratios, but spiders rise to the excessive figure of twenty-one per cent. This ratio is, however, partly misleading, as, although six of the nine birds had eaten spiders, yet eleven per cent is due to a single bird, which had eaten nothing else. In such a case a larger number of specimens is required to restore the balance, so violently disturbed. Two birds of this month had eaten moths, and five had eaten cutworms. The averages stand fifty-five per cent. of moths, caterpillars, June-beetles, curculios and Orthoptera, opposed to thirty-five per cent. of Carabidæ, soldier-bugs and spiders. The Carabidæ include *Cratacanthus dubius*, *Agonoderus comma*, Anisodactylus, and Harpalus. Other details may be obtained from the table at the close of this paper.

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* For the determination of this species and most of the other larvæ which have been identified specifically, I am under obligations to Professor Riley.

June.

In June ten birds—one from Mt. Carroll, the others from Normal—had taken a somewhat unusual diet. The ratio of spiders (eighteen per cent.) falls a little short of that for May, but an examination of the notes shows that here, too, a single bird had eaten nothing else. Ants rise suddenly from two per cent. in May, to twenty per cent. in June, taken by six of the birds. Most of these, however, were of the winged forms, and their number is evidently due to the same cause which rendered the Aphodii so abundant in April. Three of the birds of June proved, to my surprise, to have eaten raspberries, and one gooseberries—these fruits amounting to eight per cent. of the food of the month. No cutworms were recognized in June, but measuring-worms (Phalænidæ) replaced them, composing six per cent. of the food. While all the cutworms found in any month whose food was at all distinguishable had eaten nothing but grass—or endogenous foliage, more accurately speaking—several of these Phalænidæ had been feeding on net-veined leaves. The Harpalinæ (six per cent.) include Evarthrus sp., *Pterostichus lucublandus* and *Anisodactylus baltimorensis*. June-beetles (Phyllophaga) had been eaten by one bird, and a Melanotus, a curculio, and a long-horn beetle (*Tetraopes tetraophthalmus*,) each by one. Pentatomidæ reach five per cent., chiefly *Hymenarcys nervosa*, and Orthoptera fall to three per cent. The excess of ants is therefore taken, like the excess of Aphodii, from the caterpillars and grasshoppers.

The averages of beneficial and injurious species stand thirty per cent. to twenty-six per cent., respectively. Regarding ants, I find such conflict of opinion among good authorities, that I am not able to give them a definite place on either side of the line. The injury to fruits is probably too insignificant to be taken into account, except as evidence that the species is not strictly insectivorous, even in midsummer.

July.

The nine birds of this month were all shot in central Illinois, during four successive years. Besides the return

of the percentages of Hymenoptera, Coleoptera, Lepidoptera and Arachnida to about their usual figure, we notice the large ratios of June-beetles (twelve per cent.) and Orthoptera (twenty-seven per cent.). The latter includes seven per cent of *Udeopsylla nigra*, a large cricket-like locust. We find also a trace of raspberries in the food of two individuals. The caterpillars eaten by these birds were unrecognizable, except those from a single stomach, which Prof. Riley has identified as *Nephelodes violans*, Guen. The record of benefit and injury is now more favorable to the species—sixty-seven per cent. of injurious insects, and only fourteen per cent. beneficial, the latter Carabidæ and spiders.

August.

Twelve specimens were obtained in August at Normal, three early in the month and the others on the 29th and 30th. The bluebirds were at this time most abundant in meadows and pastures; and the contents of their stomachs indicate that the chief business of the month was the pursuit of locusts, crickets and grasshoppers, moths and caterpillars. The Orthoptera eaten by these birds amounted to fifty-eight per cent. of their food, and the Lepidoptera to twenty-seven per cent. About half of the former were Gryllidæ (Gryllus and Nemobius), and the remaining half were equally Locustidæ and Acrididæ (*Xiphidium fasciatum* and *ensifer*, *Caloptenus femur-rubrum* and *bivittata*, and *Œdipoda sordida*). Half of the Lepidoptera were unrecognizable moths and the remainder caterpillars—five per cent. being Noctuidæ. Ants were about one per cent. of the food, Coleoptera only five per cent. (including three per cent. Harpalidæ), Pentatomidæ (*Cœnus delius*) one per cent. and spiders six per cent. A few wild cherries and elderberries were the only fruits taken. The beneficial elements thus amounted to nine or ten per cent. of the food and the injurious elements to about eighty-five per cent.

September.

All but one of the ten specimens upon which the account of the September food is based were shot at Normal, and

all but two on the 29th of the month. The chief peculiarity of the month is the almost total disappearance of Coleoptera, which were represented only by a few small Harpalids and a single minute Atænius. The Lepidoptera rise to thirty-seven per cent., chiefly through the abundance of the larvæ of *Prodenia lineatella*, Harvey. The Orthoptera make nearly half the food, the species differing from those of the preceding month mainly in the greater number of red-legged grasshoppers. Spiders were only two per cent. of the food; and some unknown wild fruits formed seven per cent. It will be seen that a striking change in the food of this species attends that increase of the Orthoptera in numbers and activity which occurs in the late summer and early autumnal months, these insects being almost entirely substituted for Coleoptera, Hemiptera and Arachnida. The Coleoptera of the six preceding months averaged twenty-seven per cent. of the food, while this order amounts to but three per cent. in August and September. The Orthoptera of the foregoing months averaged but fourteen per cent., while those of the two months in question rise to fifty-four per cent. It is evident from the foregoing that Orthoptera and smooth caterpillars are the favorite autumnal food of this bird, and as the first of these remain abundant until frost, it is not likely that the food of October is much less favorable to the bird than that of September. The two specimens taken in the former month were well filled with winged ants.

December.

To learn the food of the bluebird in midwinter, I went to extreme southern Illinois in December, 1879, and shot a number of specimens, some from the heavy forests in the bottoms of the Ohio River, and others from the wooded and cultivated highlands in Pulaski county. The weather at this time was sometimes above and sometimes below freezing, and bluebirds were abundant and very much at home. The principal food of the twelve specimens examined consisted chiefly of various wild fruits (eighty-four per cent.), of which the berries of the mistletoe (*Phoradendron flavescens*) were the most abun-

dant (fifty-eight per cent.). Grapes, the berries of sumach, scarlet thorn (Cratægus) and holly (*Ilex decidua*) were also found. Sixteen per cent. of the food was insects, of which the larger part (ten per cent.) was the larva of Harpalinæ—eaten, however, by but two of the birds. Prominent among these was the larva figured and described by Professor Riley in the Report of the United States Entomological Commission for 1877, p. 290, and there doubtfully referred to *Harpalus herbivagus*. The remaining kinds were *Geotrupes blackburnii*, *Podisus spinosus*, a single spider, and one unknown caterpillar. Even in the dead of winter, therefore, this bird does not cease its warfare on our predaceous bugs and beetles.

Summary for the Year.

To these figures, giving the averages for all the months mentioned taken together (except October), I invite special attention. Being derived from a much larger number of specimens than any of the monthly averages, they are much less likely to be affected by accident or error. They give, furthermore, the basis for an estimate of the total effect of the bird, year after year; and from this we should be able to predict the probable effect of a destruction or diminution of the species.

Taking up first the injurious insects destroyed, we find that these include twenty-six per cent. of Lepidoptera, nearly two-thirds of which were recognized as *Noctuidae*, three per cent. of leaf-chafers and twenty-one per cent. of Orthoptera—a total of fifty per cent. on this side of the account. On the other hand, the ichneumons amount to three per cent., the Carabidæ to seven per cent., soldier-beetles to one per cent., soldier-bugs to three per cent. and spiders to eight per cent.—a total of twenty-two per cent. of predaceous and parasitic forms. Other elements are ants four per cent., Diptera only a trace, Aphodii six per cent., Iulidæ one per cent. and vegetable food thirteen per cent. The edible fruits amount only to about one per cent. of the food of these one hundred and eight specimens. Comparing with the Turdidæ, we find that the bluebird is essentially a thrush in food. From the robin it differs principally in the larger number of Hymenop-

tera (seven to four) and Lepidoptera (twenty-six to seventeen), the lack of Diptera (robin seventeen per cent.), the excess of Aphodii (six to two), of Pentatomidæ (robin one per cent.), of Orthoptera (twenty-one to four) and of spiders (eight to a fraction); but especially in the matter of edible fruits (one to thirty-four). These differences are but little greater, however, than those among the thrushes themselves. Compared with the thrush family as a whole, its salient peculiarities are its neglect of Diptera and garden fruits and its preference for Lepidoptera, Orthoptera and spiders.

Economic Relations.

Mr. B. D. Walsh, the first State Entomologist of Illinois, reasoning from the comparative numbers of injurious and beneficial insects, concludes that a bird must be shown to eat at least thirty times as many injurious individuals as beneficial before it can be considered useful.*

According to this estimate, the bluebird does at least thirteen times as much harm as good; that is to say, the beneficial insects eaten would themselves have destroyed thirteen times as many injurious insects as the birds have eaten. This conclusion is so unexpected and astonishing that it certainly cannot pass without careful examination. In the first place we should bear in mind that nothing has yet been learned of the food of the young, and there is some reason for supposing that birds select the softer insects for their young. Whatever deficiency of credit may be due to this neglect of the food of the young is compensated in part, at least, by the fact that the number of caterpillars eaten is doubtless overestimated in comparison with hard insects, as their flexible skins remain in the stomachs of birds longer than the hard structures of insects. This is exactly contrary to the usual supposition, but the frequent occurrence of the empty and twisted skins of cutworms in the stomachs of these birds, still recognizable as Noctuidæ when not even a fragment of a single head remains, is sufficient evidence that the hard parts break up and disappear

* "Birds vs. Insects." Practical Entomologist, Vol. II, pp. 44-47.

before these delicate but yielding skins. Secondly, while our knowledge of the food of Arctians, cutworms and grasshoppers is sufficiently definite and full to enable us to predict with certainty exactly what would happen if those eaten by bluebirds were allowed to live and multiply, we have not the same complete and certain knowledge of the food habits of the different genera of Ichneumonidæ, the ground-beetles, the soldier-bugs and soldier-beetles.

One hundred bluebirds, at thirty insects each day, would eat in eight months about 670,000 insects. If this number of birds were destroyed, the result would be the preservation, on the area supervised by them, of about 70,000 moths and caterpillars (80,000 of them cutworms), 12,000 leaf-chafers, 10,000 curculios and 65,000 crickets, locusts and grasshoppers. How this frightful horde of marauders would busy itself if left undisturbed, no one can doubt. It would eat grass and clover and corn and cabbage, inflicting an immense injury itself, and leaving a progeny which would multiply that injury indefinitely. On the other hand, would the 160,000 predaceous beetles and bugs, spiders and ichneumons either prevent or compensate these injuries. I do not believe that we can say positively whether they would or not.

In a discussion of the natural checks upon the cutworms Professor Riley, in his First Report as State Entomologist of Missouri, mentions two species of Ichneumon that parasitize the larva, credits the spined soldier-bug and the Carabid larva, *Calosoma calidum,* with its destruction, and says that some kinds of spiders are known to prey upon it.

From the Report of the United States Entomological Commission for 1877, we learn that the grasshopper is preyed upon at one or the other stage by Agonoderus, Harpalus, Amara and other Carabids; by soldier-beetles, soldier-bugs and spiders; and that certain Ichneumonidæ parasitize the egg. It seems *probable,* therefore, that the beneficial insects eaten by bluebirds include the special enemies of the cutworms and grasshoppers it destroys; but he who knows best the small number of reliable obser-

vations upon which our general statements of the food of predaceous insects rest, will have the most hesitation in trusting them without reserve.

I would also call attention to the fact that we do not yet know that the normal rate of increase among these carnivorous and parasitic insects is not sufficient to keep their numbers full to the limit of their food supply, and to furnish also a *surplus* for destruction by birds. Just as a tree puts forth more leaves than it needs, and sets more fruit than it can possibly mature, as an offset to the constant, normal depredations of insects, so there is much reason to suppose that our insect friends have become adjusted to this steady drain on their numbers.

TABLE OF THE FOOD OF THE BLUEBIRD. (*Sialia sialis*, L.)

KINDS OF FOOD.	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL.	Ratio of each element to whole of food.
	Number of specimens, and ratio in which each element of food was found.													
Number of specimens.....	...	10	21	13	9	10	9	12	10	2	...	12	108	
		10	21	13	9	9	9	12	10			5		
I. INSECTS.....	...	.92	.88	.88	.76	.71	.89	.91	.91	...	...	.16	98	.78
		7	5	5	3	7	6	4	4					
1. *Hymenoptera*.....	...	.22	.04	.02	.02	.21	.04	.01	.04	...	...	...	41	.07
			2	5	3	6	6	4	4					
Formicidæ.....	...	...	†	.02	.02	.20	.04	.01	.04	...	...	...	30	.04
		6	2											
Ichneumonidæ.....	...	.22	.04	...	...	...	...	...	...	...	...	...	8	.03
		8	20	9	7	5	7	7	7			1		
2. *Lepidoptera*.....	...	.28	.38	.21	.39	.13	.27	.27	.37	...	...	.02	71	.26
		1	4											
Arctiinæ.....	...	.02	.04	...	...	...	...	...	...	...	...	...	5	.01
		6	11	5	3		1	2	4					
Noctuidæ.....	...	.24	.39	.17	.19	...	.10	.05	.14	...	...	...	32	.12
						2								
Phalænidæ.....	...	...	...	...	...	.06	...	...	...	...	...	...	2	.01
		1	1	1		1								
3. *Diptera*.....	...	†	.01	†	...	†	...	...	...	...	...	...	4	....
		9	16	13	8	7	10	7	4			4		
4. *Coleoptera*.....	...	.22	.19	.51	.18	.28	.26	.05	.02	...	...	.13	78	.20
		6	16	10	5	3	4	6	2			2		
Carabidæ.....	...	.05	.10	.08	.12	.06	.09	.03	.01	...	...	.10	54	.07
						1								
Dytiscidæ.....	...	...	...	...	...	.01	...	...	...	...	...	...	1	....
				1										
Staphylinidæ.....	...	...	...	†	...	...	...	...	...	...	...	...	1	....
			1	1										
Histeridæ.....	...	...	†	†	...	...	...	...	...	...	...	...	2	....
				1										
Byrrhidæ.....	...	...	...	.01	...	...	...	...	...	...	...	...	1	....
		3	4	10	2	5	3	3	1			1		
Scarabæidæ.....	...	.09	.04	.33	.05	.12	.14	.02	†	...	...	.03	32	.09
		3	2	10	1	4			1					
Aphodius.....	...	.09	.03	.31	.03	.04	...	...	†	...	...	...	21	.06
												1		
Geotrupes.....	...	...	...	...	...	...	...	...	...	...	...	.03	1	....
				1	1	1	2							
Phyllophaga.....	...	...	...	.02	.02	.08	.12	...	...	...	...	...	5	.03
			1											
Euryomia.....	...	...	.01	...	...	...	...	...	...	...	...	...	1	...
			1			1								
Elateridæ.....	...	...	†	...	...	.01	...	...	...	...	...	...	2	....
				1										
Tenebrionidæ.....	...	...	...	.04	...	...	...	...	...	...	...	...	1	....

TABLE OF THE FOOD OF THE BLUEBIRD. (*Sialia sialis*, L.)—Concluded.

	Jan.	Feb.	March	April	May	June	July	August	Sept.	Oct.	Nov.	Dec.	TOTAL	Ratio of each element to whole of food.
Number of specimens.....	...	10	21	13	9	10	9	12	10	2	...	12	108	
KINDS OF FOOD.	Number of specimens, and ratio in which each element of food was found.													
Telephorus	...	3 .08	2 .04	..	...	...	...	...	...	...	...	...	5	.01
Curculionidæ	...	1 †	1 †	3 .01	2 .01	1 .01	3 .01	...	...	...	...	...	11	....
Cerambycidæ	...	...	...	...	...	1 .01	1 .02	...	...	...	...	...	2	....
Tetraopes.....	...	...	...	...	...	1 .01	1 .02	...	...	...	...	...	2	....
5. *Hemiptera*.....	...	4 .07	10 .04	7 .04	2 .02	3 .05	2 .05	1 .01	1 †	...	...	1 .01	31	.04
Coriscus.....	...	...	4 †	1 .01	...	...	...	...	...	...	...	...	5	....
Alydus	...	...	...	...	...	...	1 .04	...	...	...	...	...	1	....
Pentatomidæ	...	3 .07	7 .04	4 .02	2 .02	3 .05	1 .01	1 .01	...	...	...	1 .01	22	.03
6. *Orthoptera*.....	...	7 .13	13 .21	5 .08	6 .13	2 .03	5 .27	12 .57	9 .48	...	...	....	59	.21
Gryllidæ	...	1 .04	2 .03	...	1 .02	...	1 .01	6 .28	2 .11	...	...	...	13	.05
Locustidæ.....	...	...	...	...	...	...	1 .07	4 .15	1 .02	...	...	...	6	.03
Acrididæ.....	...	6 .09	11 .18	5 .08	5 .11	2 .03	5 .19	4 .14	6 .33	...	...	...	44	.13
II. ARACHNIDA.....	...	6 .04	16 .05	9 .09	6 .21	5 .18	2 .05	6 .06	3 .02	...	...	1 †	54	.08
III. IULIDÆ	...	6 .04	8 .03	2 .01	1 .01	...	2 .02	...	...	...	...	...	19	.01
IV. VEGETABLE FOOD.....	...	...	3 .04	4 .02	3 .02	5 .11	6 .04	3 .03	1 .07	...	...	12 .84	37	.13

	Percentages for each month													Ratios.
Beneficial elements.....	...	46	28	21	35	*38	14	10	03	...	...	11	...	22
Injurious elements.....	...	41	60	23	55	26	67	80	85	...	...	02	...	49
Neutral elements.....	...	13	12	56	10	34	19	10	12	...	...	87	...	29

* Includes 8 per cent. fruit.

BULLETIN No. 3.

In the preparation of the paper on The Food of Birds in this Bulletin, Uhler's "List of Hemiptera West of the Mississippi River" (1876) was followed with respect to the arrangement of the species mentioned; but through an unfortunate misunderstanding of the intention of the author of that list, the Pentatomidæ were all included under the Cydnidæ. For the latter name, the former should consequently be substituted, as follows:

Page 90, line 3 from bottom; page 92, line 11 from bottom; page 94, line 5, and line 5 from bottom; page 105, line 5 from bottom; page 108, line 13 from bottom; page 117, line 9 from bottom; page 126, line 14 from bottom; page 130, line 16; page 131, line 7 from bottom; page 132, line 13; page 138, lines 16 and 24; page 139, line 10; page 141, last line; page 143, line 2; page 145, line 5; page 148, line 12 from bottom.