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The EUROPEAN STARLING

IN THE UNITED STATES

THE EUROPEAN STARLING, now found as a breeding bird in many of the States east of the Mississippi River, apparently had its origin in this country in importations planted in Central Park, New York City, in 1890 and 1891. From this center its spread at first was slow, but since about 1910 it has been much more rapid. Not only are conditions in the upper Mississippi Valley well suited to the bird, but it seems likely that ultimately the species will be found also throughout most of the area from southern Canada to the Gulf coast and westward to the Rocky Mountains. Should the starling pass the Continental Divide there is no reason why it should not prosper on the Pacific coast also.

With such an extension of range possible, it is important that the economic influence of the starling be well understood. It is essential to know not only its misdeeds, so that proper methods of control may be evolved, but also its redeeming qualities, in order that the good services of the bird in insect control may be used to the best advantage. The harmful and the beneficial influences of the starling are weighed in this bulletin and conclusions drawn to aid both farmer and city dweller in adopting an intelligent attitude toward the species.

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THE EUROPEAN STARLING IN THE UNITED STATES

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THE STARLING AN INSECTIVOROUS BIRD

THE STARLING (*Sturnus vulgaris:* Family Sturnidae) is the second European bird to become widely established in this country. Its forerunner, the English sparrow, with its checkered career, has acquired a reputation far from praiseworthy. It is not surprising, therefore, that the ever-increasing flocks of starlings, which have been extending their range throughout the Eastern States, should be viewed with suspicion by farmers and bird lovers. The starling's aggressions against native hole-nesting species and its depredations on cherries, apples, corn, and garden truck, along with its objectionable roosting habits, have been cited as ample reasons for condemnation of the species. At first little was known by the public generally of its insect-eating habits, and it is only since the publication by the Department of Agriculture of a comprehensive technical report on the economic value of the bird that these facts have been definitely brought out.[1] The investigation on which that report was based was made in 1916 and not only refuted some of the extreme accusations against the bird but also established the fact that the starling is one of the most effective bird enemies of terrestrial insect pests in this country. More recently a similar investigation of the starling in Ontario, Canada, has resulted in conclusions essentially the same.[2]

This bulletin presents in condensed form the results of the earlier investigation, together with information on food habits subsequently

[1] KALMBACH, E. R., and I. N. GABRIELSON. ECONOMIC VALUE OF THE STARLING IN THE UNITED STATES. U. S. Dept. Agr. Bul. 868, 66 p., illus., 1921.
[2] LEWIS, HARRISON F. A DISTRIBUTIONAL AND ECONOMIC STUDY OF THE EUROPEAN STARLING IN ONTARIO. Univ. Ontario Studies, Biol. Ser. 30, 27 p., illus., 1927.

obtained from stomach examination and field observation. Recommendations based on recent experiences with objectionable roosts of starlings also are included. The changes and additions bring the subject up to date and present the case of the starling as it is to-day.

DISTRIBUTION AND ABUNDANCE

The starling in its native home occupies all but the most northern parts of Europe and corresponding latitudes in the western two-thirds of Siberia. Migration in fall takes the bulk of these birds to countries bordering on the Mediterranean, and a portion to the warm latitudes as far east as India. Several other species and closely related forms of starlings occupy adjacent sections and even parts of the same area in the southeastern portion of this range. The bird also has been introduced into other countries and has become established in Australia, Tasmania, New Zealand, and South Africa, and, since 1890, in Eastern United States, whence it has spread to southern Canada. Of the various attempts to introduce the starling into this country, the importations of 1890 and 1891 into Central Park, New York City, appear to be the ones from which the birds now scattered over the Eastern States and southern Canada originated.

The spread of the starling in this country has been by no means so rapid as that of its forerunner, the English sparrow. During the first six years after its importation it did not spread, as a breeder, beyond the limits of Greater New York. Since then, however, its progress has been more rapid. By 1900 it bred in western Connecticut and north-central New Jersey. By 1910 its breeding range included the greater part of Connecticut and Rhode Island, the southern part of Massachusetts, the lower Hudson River Valley, most of New Jersey, and a limited area in eastern Pennsylvania. In 1912 the range was farther extended up the valley of the Hudson, and since that time the bird has proceeded with greater rapidity. It crossed the Alleghenies in 1916 and by 1927 it bred regularly from southern Ontario and southeastern Michigan to Tennessee, northeastern Georgia, and South Carolina. The spread of the starling, as indicated by extensions of its breeding range by 2-year periods, is shown on the accompanying map. (Fig. 1.)

The wanderings of postbreeding flocks have carried starlings far beyond the limits of their breeding range, with the result that they may appear as winter visitors for several years before they are established as breeders. More detailed information concerning the distribution of this bird in the United States has been published in circulars of the department.[3] It would appear also from records thus far obtained from starlings banded near the border of the range of the species that these individuals have a tendency to migrate farther than those near the center of abundance and are the ones most instrumental in extending the range.

As a breeder the starling is by no means uniformly distributed throughout its range. It is decidedly partial to thickly settled agricultural sections and has also shown a preference for coastal regions and larger river valleys. Thus, in its spread over the country, it

[3] COOKE, MAY THACHER. SPREAD OF THE EUROPEAN STARLING IN NORTH AMERICA. U. S. Dept. Agr. Circ. 336, 8 p., illus., 1925; and THE SPREAD OF THE EUROPEAN STARLING IN NORTH AMERICA (TO 1928), U. S. Dept. Agr. Circ. 40, 10 p., illus., 1928.

usually becomes established in lowlands first. In much of the area where the starling has been established for 15 or 20 years it probably has reached a maximum breeding abundance. This appeared to be true in 1916 in sections of New Jersey and Connecticut adjacent to New York City, where the starling about equaled the English sparrow as a breeder. In the residential sections of some of the cities the starling then outnumbered the English sparrow, but it in turn was greatly outnumbered by the smaller species about freight yards,

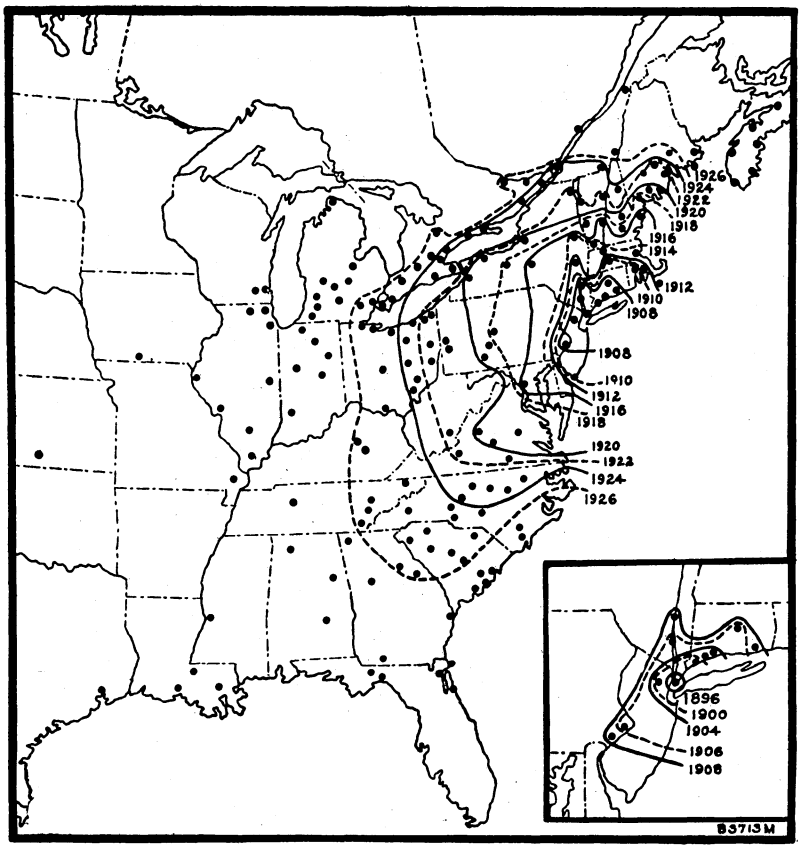

FIG. 1.—Breeding range of the starling in North America. Areas successively covered in 2-year periods are shown by alternating broken and continuous lines. Spots outside the line of the 1926 range indicate isolated records, mainly in winter

markets, business streets, and dumping grounds, and even in many of the rural sections. Beyond areas of maximum abundance, the centers of starling population where the bird as much as equaled the English sparrow as a breeder were quite restricted and often isolated by many miles from other colonies. At the border line of its range there are vast areas where for years its abundance will not be great enough to make the bird an important economic factor.

Although the severe winter of 1917–18 appeared to exert a check on the multiplication of the starling over much of its range, since that time the bird has more than recouped its former numbers. This

increase has been particularly noticeable in the vicinities of Philadelphia, Baltimore, and Washington. The large winter roosts in cities also have brought to the attention of many persons, who otherwise would not have been aware of their presence, the many thousands of starlings in areas where only a decade previously there were comparatively few.

From the preferences shown by the starling as regards habitat and food, both in Europe and in this country, and from knowledge of the bird's ability to adapt itself to new environments some conjecture concerning its ultimate distribution in the United States may be ventured. Until 1916 the Allegheny Mountains appeared to be an effective barrier against westward progress, but now that large numbers are to be found in the watershed of the Ohio River, the spread throughout the fertile farmlands of the upper Mississippi Valley should be rapid. The starling should experience little difficulty in extending its breeding range as far north as northern Michigan, Wisconsin, and Minnesota. To the south the bird will probably go nearly to, if not actually as far as, the Gulf coast as a breeder, though it may always be scarce in the southern part of this area, particularly on the coastal plain. To the west, the Great Plains, with their scarcity of suitable nesting sites, and back of them the Rocky Mountains with their high altitudes, will probably bar the starling for some time from reaching the Great Basin or California by either a northern or a southern route.

DESCRIPTION

Even in areas where the starling has been long established uncertainty exists as to its identification. Post-breeding flocks of red-winged blackbirds are sometimes called starlings, and the damage they do is often attributed to the latter. The great difference existing between the plumages of young and adult starlings, as well as the great change in the appearance of the old birds from fall to spring, also leads to confusion. The starling, however, bears several conspicuous marks of identification, and when these are borne in mind, one will have little trouble in recognizing the bird.

The adult starling is about 8½ inches long and of about the same weight as the robin, but its short, drooping tail gives it, when at rest, a chunky, hump-backed appearance. From early in spring until the middle of June the adult bird may be singled out at a distance as the only black bird having a rather long, sharp, yellow bill. In the male the base of the lower mandible is somewhat darkened with livid, while in the female this part is pale yellow. After the breeding season and coincident with the molt the entire bill darkens until it is nearly black, a color it retains through the period of sexual inactivity. In some instances, the brightening of the bill may occur as early as the middle of November, though normally it is not apparent until January or February.

The molt is usually completed by the middle of September and leaves the starling a much-changed bird. Each of the feathers of the sides of the head, breast, flanks, and underparts has a white tip, giving the bird a gray, mottled aspect when seen from a distance.

At close range, however, this is a handsome plumage; the dark parts of the feathers of the throat, breast, and flanks are resplendent with iridescent reflections of purple, green, and blue, while the back, with its green and bronze iridescence, has each of the feathers tipped with light brown; the tail and wings are dark, some of the feathers of the wings being edged with brown. During the winter most of the white tips to the feathers on the breast and underparts wear off, leaving the bird dark below with the iridescent reflections still present.

When the young leave the nest they are a uniform dark olive-brown on the back. Below they are at first somewhat streaked with lighter markings, but soon become unicolored. The throat is white or buffy. The first molt begins about the same time as that of the adults. The feathers on the sides of the breast, the flanks, and center of the back are changed first, those of the head being the last replaced. During July and August and early in September young birds in all stages of the molt may be found. When the plumage has been completely changed the young can not with certainty be distinguished from the adults, although they tend to have larger white tips to the under feathers.

In flight also starlings may be confused with a few other birds. From other gregarious species with which they often associate starlings may be distinguished by the wonderful coordination of action between the individuals of the flock, their rapid wing beats, great speed, and ability to alter direction instantly. From their habit of sailing on fixed wings for considerable distances they are often mistaken for purple martins, but a little watching will reveal the difference in the speed of the two species.

In searching for food the starling walks rather rapidly and with little change of pace, keeping up a continuous zigzag course when on grassland, seldom hesitating unless to pick up food or to probe beneath the surface.

Many bird lovers contend that the starling's lack of song is a good reason for not allowing it to supplant more accomplished native songsters. Although its notes, except for a clear whistle or two and a coarse rasping note of alarm, are subdued and lacking in melody, should one chance to be close to a male starling when he is putting forth his best efforts the result will be found fully as fascinating as the more celebrated whisper-songs of the catbird or brown thrasher. The starling is a mimic par excellence and has the notes of a number of our native birds in his repertoire. One of the birds frequently imitated is the wood pewee, whose plaintive "pee-a-wee" is reproduced with such delicate skill that it can not be distinguished from the song of the woodland flycatcher itself. The mellow tones of the bluebird's call are given with almost equal fineness. In areas where the bobwhite is common its two-noted whistle is readily taken up by the starling and executed in a way that closely resembles the original. Notes of the red-winged blackbird, grackle, field sparrow, flicker, blue jay, Carolina wren, and English sparrow, as well as others, also are given. Young starlings have a harsh hissing or rasping note that seems to have its origin as a feeding call but is given for some time after they leave the nest.

LIFE HISTORY

By the middle of April most of the starlings have paired and started breeding operations. Although a hole-nesting species, they are less particular in choice of nest sites and in nest construction than are most native birds that build in cavities. In their nesting operations starlings will appropriate either old or newly excavated woodpecker holes and natural cavities in trees, as well as boxes erected for native species. (Fig. 2.) They are partial to human association and may be found nesting also in almost any sort of cavity about buildings, behind window shutters, on fire escapes, and even in open boxes erected for domestic pigeons. When in trees, starling nests as a rule are at a height varying from 10 to 25 feet from the ground.

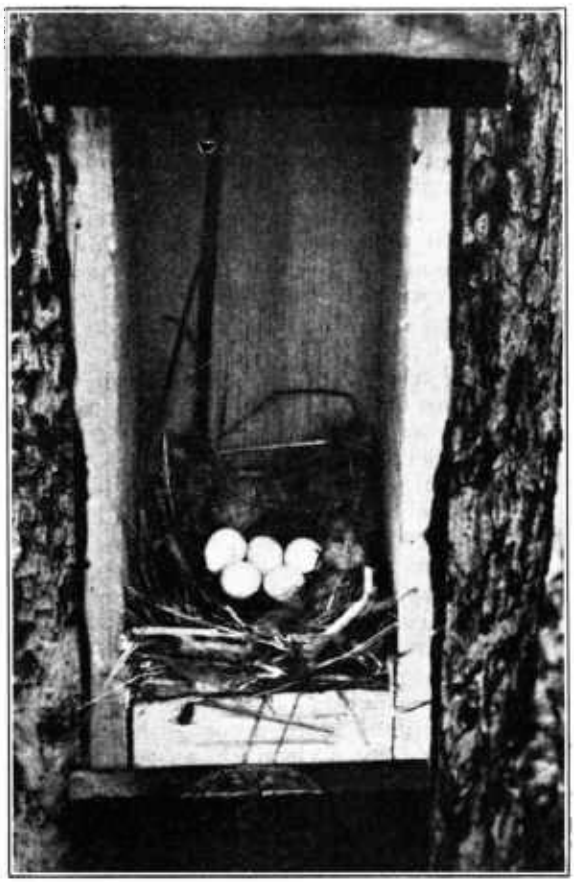

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FIG. 2.—For nesting sites starlings will appropriate either old or newly excavated woodpecker holes, natural cavities in trees, boxes erected for native species, and almost any sort of a cavity about buildings. The front of this bird box has been removed, showing a starling's nest and the eggs, which are pale blue

The nest itself usually is constructed of dry grasses, but straw, corn husks, string, and cloth are materials utilized occasionally. A little green foliage, such as may be plucked from a near-by branch, is frequently dispersed through the structure, and the interior, approximately 3 inches in diameter, is lined with a few chicken feathers. (Fig. 2.)

The eggs are pale blue and number from three to six to the set. Incubation lasts about 12 days, and the young remain in the nest for two or three weeks. Two broods are raised each year by many pairs and rarely a third is hatched. The first brood leaves the nest about June 1 and the second late in July. Soon after the first brood leaves, the young gather in flocks, which grow rapidly in size, and

late in August and early in September flocks numbering into the thousands may be seen in sections where the starling is a common breeder. There is practically no daytime association between the juvenile birds and the adults from soon after the time the former leave the nest until the molt is completed late in September. At night, however, in summer and fall both old and young birds may be found occupying the same roost. (Fig. 3.)

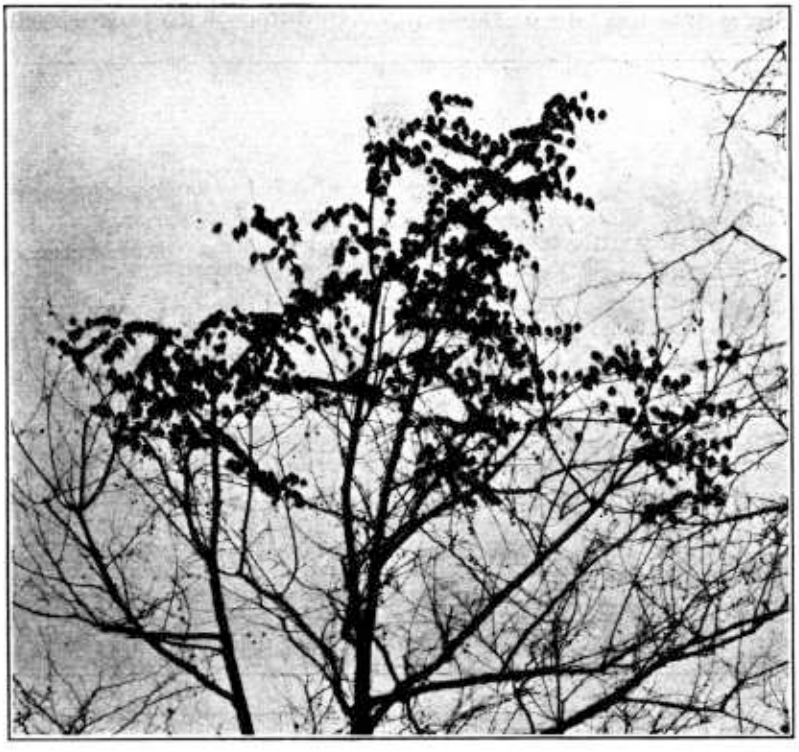

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FIG. 3.—Late in summer and during fall starlings commonly resort to tree roosts, often being joined by grackles, robins, and even purple martins. In latitudes as far south as Washington, D. C., a portion of the starlings use trees as roosting spots even in the coldest weather. Photograph taken before sunrise

To the city dweller the establishment of these roosts is the most conspicuous habit of the starling. Strange to say, the arching elms and maples of quiet residential sections of cities are places particularly attractive to these birds, and such localities are often selected, even though tracts of woodland, presenting apparently equally favorable roosting places, may be near by. Frequently the roosts are shared with other species, particularly grackles and robins. The noise produced by the gathering birds in the evening and their daybreak serenade, as well as the filth connected with thousands of birds confined to a small area, make the roosts decidedly objectionable. At the advent of cold weather in October or November, the tree roosts

of starlings become smaller as more and more of the birds seek nightly shelter in church towers, barn cupolas, pigeon lofts, ledges beneath eaves of buildings, ventilators, or other protected places.

The winter roosts of starlings in eastern cities are sometimes of enormous size. Typical of such gatherings is the one that for several years has occupied the trees and buildings on Pennsylvania Avenue and other down-town streets in the National Capital. For a distance of several blocks along Washington's historic thoroughfare starlings gather nightly during the fall and winter months in flocks totaling tens of thousands. Buildings with broad, shelter-

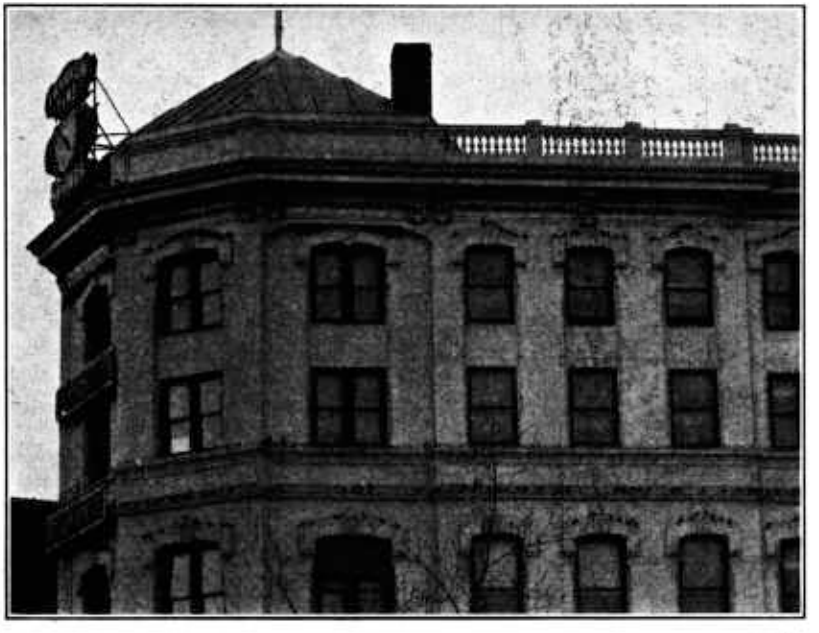

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FIG. 4.—When roosting on the sides of buildings during winter, starlings seek the ledges that are best protected from rain and snow. They also tend to frequent the sides that have been exposed to the warming rays of sunlight during the day. Photograph taken after sundown

ing eaves often have protected ledges and window sills outlined with rows of black-bodied starlings (fig. 4); and the capitals of columns at the entrances of some of the public buildings have been given similar adornment. Individual trees near the center of the roost area also furnished roosting places for more than a thousand birds, and ventilators on tall buildings harbored several thousands under conditions that assured the birds protection from rain and cold as well. Outside of the roost proper scattering flocks found nightly haven on other buildings in the business center of Washington, and at more distant points church towers afforded a readily accessible and suitable resort.

One such church tower harbored on cold nights of midwinter from 2,500 to 3,000 starlings. Though the tower was not heated, the birds

were able to keep surprisingly warm by crowding into small crevices in great numbers. As many as 80 to 100 starlings were found in cavities 2 feet wide, 3 feet deep, and a few inches high. So densely was this tower populated that there was no difficulty in capturing, banding, and releasing in two and one-half hours 1,000 birds for a study of their migratory movements.

Besides the gregarious habit, which tends to bring together late in summer and early in fall the breeding starling population of a considerable area, a migratory movement has been manifested. This, however, is not so pronounced as that practiced by the bird in the Old World. In this country starlings have shown a preference in winter for the coastal regions of Connecticut, New York, and New Jersey, and a general southward movement also has been observed at that season. At Washington, D. C., and at points even farther south, starlings had established winter roosts for several years before the first breeding birds made their appearance. The migratory instinct may become more pronounced after the birds are more generally distributed and familiar with conditions in the warmer Southern States.

FOOD HABITS IN THE UNITED STATES

Information regarding the food habits of the starling in this country has been obtained largely from analysis of a mass of material apparently greater than that used for a similar study of any other bird. A total of 2,626 stomachs of starlings, collected mainly in 1916 in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, and Delaware, served as the basis for an intensive study of the economic status of this bird.[4] Percentages of food items presented in this bulletin have been incorporated largely from the earlier study. Since that time, however, 124 additional stomachs, obtained in Atlantic Coast States, have been examined, and notes from this material also have been included. Extensive field observations, particularly those made by representatives of the Bureau of Biological Survey during a period of six and a half months of the growing season of 1916, have given first-hand information on phases of the bird's habits not satisfactorily revealed by stomach examination. Notes on the habits of the starling contributed by various correspondents also have aided in determining the bird's economic status.

ANIMAL FOOD OF ADULTS

More than half (57 per cent) of the annual food of the adult starling consists of animal matter, including insects, millipeds, spiders, mollusks, a few crustaceans, and bits of suet and carrion. In April and May such food constitutes more than nine-tenths of the bird's diet, and even in February, when the opportunities for obtaining animal food are few, it forms more than 28 per cent of the total.

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[4] A comprehensive report on this material appeared in Department Bulletin 868 (see footnote 1, p. 1); 102 of the stomachs examined were collected in 1910 and reported on by E. H. Forbush (THE STARLING. Mass. State Bd. Agr. Circ. 45, 23 p. illus., 1915).

INSECTS

Nearly three-fourths of the animal food of the starling, or more than 42 per cent of its entire diet, consists of insects. October is the month of greatest consumption of insects, when they form nearly 58 per cent of the food, but in June, August, September, and November they also provide more than half of the starling's sustenance. From the first of December to the end of March insects furnish about a fourth of the bird's food, a rather remarkable proportion when the climatic conditions under which the insects are captured are considered.

Nearly half the starling's insect food consists of beetles—weevils, ground beetles, and plant-feeding scarabaeids predominating. Conspicuous among such items is the clover-leaf weevil (*Hypera punctata*), a European pest imported into the Eastern States some years ago and now reported as doing damage as far west as California and Oregon. The starling has displayed a remarkable ability in finding these insects even under adverse conditions of climate and environment. Nearly half of the adult starlings examined had fed on them. One bird had eaten 49 larvae of this insect and another 26 adults along with 6 other weevils. The lesser clover-leaf weevil (*Phytonomus nigrirostris*) and the clover-root curculio (*Sitona hispidulus*) are other pests that the starling frequently obtains in meadow and hayfield. Among the ground beetles eaten by the starling, those forms known to have certain vegetarian food habits occur most frequently.[5] As many as 37 individuals of species having marked herbivorous habits were found in one stomach. Of the large predacious carabids (Calosoma and Carabus) known to be effective enemies of caterpillars, starlings eat few, only 23 adult birds having fed on them. Of the plant-feeding scarabaeids, May beetles (Phyllophaga), parents of the destructive white grubs, predominate in the food, as many as 12 being found in one stomach. In areas where the Japanese beetle (*Popillia japonica*) has become established the starling has been quick to detect its presence and must be classed as one of the most effective bird enemies of that pest. Fourteen of twenty-three starlings collected near Riverton, N. J., in 1920 had fed on Japanese beetles, in some instances nearly all of the birds' food being derived from this source. The smaller dung-inhabiting species (Aphodius and Ataenius) also are obtained in considerable numbers when starlings are feeding in the vicinity of cattle. Of the other beetles eaten by the starling click beetles (Elateridae), parents of wireworms, and leaf beetles (Chrysomelidae), among which was the notorious Colorado potato beetle (*Leptinotarsa decemlineata*), found in 24 stomachs of adults, are the ones most worthy of mention.

Grasshoppers, long-horned grasshoppers, and crickets furnish about an eighth of the yearly food of the adult starling. From August to November these insects form the bulk of the animal matter taken, and 577 of the 772 birds collected during this period had eaten them. In October nearly 39 per cent of the starling's diet comes from this source. When hayfields are being cut and raked in the latter part of August and early in September flocks of young starlings obtain practically all of their sustenance from these insects, supplementing

[5] Especially members of the genera Harpalus and Anisodactylus.

it with wild black cherries and elderberries. Individual stomachs frequently contained surprisingly large numbers of these insects. One juvenile bird had eaten 7 short-horned grasshoppers (Acrididae), 1 field cricket (Gryllus), and no less than 47 small striped ground crickets (Nemobius); another had taken 5 grasshoppers, 2 field crickets, and 47 ground crickets; and a third, 6 grasshoppers, 1 long-horned grasshopper (Xiphidium), 1 field cricket, and 42 ground crickets. Conspicuous among the grasshoppers eaten were the red-legged locust (*Melanoplus femur-rubrum*) and others of the same genus.

Lepidopterous remains in the food of the starling are comprised almost entirely of the larvae (caterpillars). In the stomachs of adults these insects constituted 6.04 per cent of the yearly food, the greatest numbers being consumed in May and June. Conspicuous among those birds that had fed extensively on caterpillars was a series of 31 adults collected in the middle of June near Flemington, N. J. Only one had failed to eat caterpillars, which, on the average, formed 27.8 per cent of the stomach contents. In point of numbers eaten, a starling collected at New Haven, Conn., takes the honors; in this bird's stomach were the remains of 40 caterpillars, forming 98 per cent of the food. The terrestrial feeding habits of the starling limit the variety of caterpillars eaten, but this restriction has permitted the bird to distinguish itself as a most effective enemy of that notorious pest, the cutworm. In only a few instances were hairy or spiny caterpillars found in the stomachs. The European corn borer also has not been overlooked by the starling. A single bird collected at Watertown, Mass., had fed on six of the borers.

Hymenopterous remains, including bees, wasps, and ants, formed less than 2 per cent of the adult starling's food. Although some of these insects were beneficial parasitic forms, by far the greater part consisted of ants. Connected with the capture of the winged forms of the latter insects is one of the oddest activities of the starling: Although primarily terrestrial feeders, young starlings may be seen soon after the first of August darting forth from upper branches of trees and catching insects on the wing, much after the fashion of true flycatchers. Still later in the year starlings change their tactics of obtaining flying insects, and capture them while circling high above the ground much after the fashion of martins or other swallows. At such times one not acquainted with starlings is likely to mistake them for martins, for now in addition to being very similar in form, the starling's flight evolutions imitate the martin's perfectly.

No other order of insects forms as much as 1 per cent of the adult starling's yearly food, and the economic problems involved in their consumption are trivial. Among these are both predacious and plant-feeding bugs (Hemiptera) and flies (Diptera) and their larvae. Many of the latter are obtained about garbage heaps and in the neighborhood of cattle, of which starlings are familiar associates. These birds have been seen picking flies from the legs of cattle, and in a few instances actually alighting on the backs of cows, with the apparent intent of catching the insects there also.

From the viewpoint of the farmer the insect-feeding habits of the starling leave little to be desired. In its diet are some of the worst pests of garden and field. These it takes in surprisingly large quan-

tities during the growing season, and even in winter it eats many hibernating individuals. Its partiality for the vicinity of human abodes means that a great part of its beneficial work is done in the garden, where it will result in direct benefit.

MILLIPEDS

As far as known, no other species of bird in this country eats as many millipeds as does the starling. These creatures form 11.71 per cent of the adult bird's yearly diet, and in April they supply more than half the food (54.69 per cent).

At present the economic status of millipeds in this country is not fully understood, but if the idea generally entertained a few years ago be accepted, that millipeds feed entirely on decaying vegetable matter, the starling's fondness for them would have to be construed as a neutral factor in judging the bird. In England, however, millipeds of the same and closely related genera are known to be decidedly destructive in gardens, and recent investigations in this country have revealed instances of their displaying similar habits. Nevertheless, whether the millipeds are neutral or injurious, in feeding on them the starling obtains animal food without drawing materially from the supply of other birds, few of which have shown a preference for millipeds.

SPIDERS, SNAILS, AND OTHER MISCELLANEOUS ANIMAL FOOD

Most of the spiders eaten by the starlings are the rapidly running wolf spiders (Lycosidae), which are terrestrial in habits and generally considered less distinctly beneficial than some of the others that secure many of the flying insect pests in their silken nets. Of snails the starling eats few in this country, a habit in sharp contrast with its actions in England, where it is recognized as an effective enemy of land slugs, so injurious to garden plants.

The remains of earthworms, fragments of a crab, a few beach fleas, sow bugs, and bits of fat, suet, or cartilage, obtained apparently from garbage dumps or the winter feeding stations erected by bird lovers, fill out the varied animal diet of the starling.

VEGETABLE FOOD OF ADULTS

CULTIVATED CHERRIES

The starling's raids on the cherry crop are the basis of the most frequent complaint against the bird and at present result in the greatest losses occasioned by it. Cultivated cherries form 2.66 per cent of the adult starling's annual diet, but, of course, the consumption of such food is restricted to June and July, when it forms approximately 17 and 15 per cent, respectively. About a third of the birds collected in June and about a fourth of those in July had fed on cherries.

Some idea of the extent of the starling's activities may be gained by comparison with the food habits of the robin. From the examination of 1,236 stomachs, it has been found that the robin feeds on cultivated fruit about twice as much as does the starling, and during

June and July, robins obtain about 24 and 23 per cent, respectively, of their food from cultivated cherries.

In their attacks on the cherry crop, robins and starlings employ different methods. The robin is generally distributed and feeds in loose companies, individuals of which may be found maintaining an almost uninterrupted procession to and from some favorite cherry tree for entire days. At no time will a great number of birds be found in the tree, but the slow drain on the cherry crop is constant through all hours of daylight. Starlings, on the other hand, the juveniles of which are the chief offenders, often gather in large flocks and, swooping down on a single tree, completely strip this of its fruit, leaving other trees in the neighborhood entirely unmolested. Thus, practically every cherry grower complains of the robin; while those who suffer from the more spectacular raids of the starling are much more bitter in their criticism.

Starlings, however, are easily frightened and soon learn to shun areas where they are persecuted. A shot or two discharged at a flock of cherry-stealing starlings usually serves to keep the birds away for a few hours, and occasional shooting during the few days immediately preceding the ripening of the crop will save most of it from their attacks.

APPLES

Of a total of 2,301 adult starling stomachs examined, 45 contained the pulp or skin of apples. Only 22 of the 45, however, were among those collected in September and October, the remainder having been taken in winter and early in the spring, when the fruit eaten was manifestly waste, left on the trees or fallen to the ground. In bulk, apples form less than 2 per cent of the starling's diet. The fruit in old orchards and on isolated trees, especially on those standing in the middle of hayfields where flocks of juvenile birds are accustomed to feed, is likely to be damaged. Late-maturing varieties also are more frequently attacked by starlings than are those ripening at the height of the apple season, possibly because the supply of wild fruit, as wild black cherry (*Prunus serotina*) and sour gum (*Nyssa sylvatica*), has been materially depleted by that time.

As in the starling's feeding on cherries, it is the flocks of juvenile birds that are to blame for most of the damage to apples. The fruit in the central top of the tree is most often sampled, and in many instances the birds return to feed on fruit attacked on previous occasions. An opening an inch or two in diameter is pecked in the skin, and through this break a large portion of the pulp and sometimes the seeds are removed. (Fig. 5.)

Although much time and attention both in field observation and stomach examination were given to investigating the relation of the starling to the apple crop in 1916, the positive incriminating evidence against the bird was slight. On no farm given largely to fruit raising, where the trees were thrifty and well kept, was injury to apples observed or reported. A very large number of extensive fruit raisers in areas where starlings were abundant had no complaint to make against them. The bulk of the damage was confined to old orchards or isolated trees, usually in environments to which the starling is partial, and in many cases the damaged fruit was on neglected trees or those of inferior quality.

To a great extent this situation still prevails. Since 1916, however, the starling has extended its range and become abundant in important apple-growing sections, notably those in New York State and in the Shenandoah Valley of Virginia. What the ultimate result of excessive numbers of these birds will be in areas given largely to apple raising is uncertain. Judging from past experience, the extensive grower of apples has little to fear; yet the fact can not be evaded that excessive abundance of any bird that is frugivorous, even to a limited degree, may become a source of great damage. The starling will bear close watching in extensive apple-raising sections.

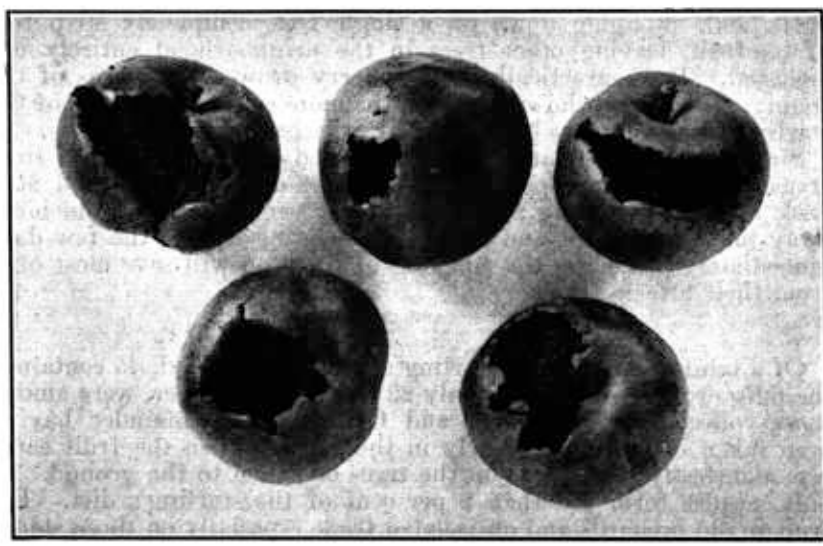

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FIG. 5.—Russet apples damaged by starlings. These apples were from the tops of trees in an old orchard near Adelphia, N. J. Some of the damaged fruit showed evidence that the birds returned to apples opened on previous visits

OTHER FRUITS

To a slight extent starlings inflict damage on peaches and pears. They also sample grapes, but at present the injury is confined principally to small arbors. In 1927 starlings inflicted severe damage to grapes on the Arlington (Va.) Experimental Farm of the Department of Agriculture. (Fig. 6.) A large flock driven from neighboring cornfields by bird minders congregated in the vicinity of the vineyard of 2¼ acres and in a few days destroyed almost the entire crop on some vines. By moving the bird minders to the vineyard the damage was stopped. In view of the reputation of the starling in the vineyards of France, also, its advent to grape-growing sections in this country should be watched. Strawberries, blackberries, and raspberries also are occasionally attacked, but the aggregate damage to fruits of this kind is negligible.

CORN

Probably the bird damage most keenly felt by the farmers living in the intensively cultivated areas in northeastern New Jersey

is that inflicted by grain-eating species on sweet corn. During July and August mixed flocks, numbering into the thousands, of grackles, red-winged blackbirds, cowbirds, and, in recent years, starlings, roam through the country, obtaining the bulk of their sustenance from cornfields. Sweet corn, just ready for market, is torn open, some of the juicy kernels eaten, and the ear either rendered unsalable or its market value considerably reduced. In the aggregate such losses are very great, and the farmers of northeastern New Jersey hold the starling to blame for a large share of the damage. As in the case of men, however, who are often judged by the company they keep, the starling has been accused of deeds perpetrated largely by the species with which it associates. Not only is it generally accredited with eating as much corn as the grackle and the red-winged blackbird, an assumption that has been disproved, but many farmers confuse it with these species, with the result that flocks of juvenile redwings are often considered to be starlings and their depredations charged against the newcomer.

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FIG. 6.—Grapes on the Arlington (Va.) Experimental Farm of the Department of Agriculture severely damaged in 1927 by starlings, aided by catbirds and robins. A bird minder had to be stationed in the vineyard to put a stop to the depredations

Of the total of 2,301 adult starling stomachs examined, 52 contained corn, which formed 0.77 of 1 per cent of the yearly food. Of the 1,059 starlings collected during the ripening and harvesting season of July, August, September, and October, only 14 had fed on corn. This constituted only 0.2 per cent of the sustenance of these birds during this period. In the planting and sprouting season of April and May, 6 out of 249 adult starlings had fed on corn, which formed 0.52 per cent of the food. By far the largest part of the corn eaten by starlings is waste grain obtained during winter and early spring.

The result of the examination of so large and thoroughly representative a series of stomachs tends to disprove the extreme charges against the starling as a corn eater. On a few occasions the writer observed starlings actually tearing down the husks of corn and feed-

ing on the kernels, but in no case were they seen in large flocks inflicting serious damage. From other observers, however, positive incriminating testimony has come, and a few cases are on record where flocks consisting only of starlings have damaged fields of sweet corn to the extent of from 10 to 25 per cent of the yield.

Injury to field corn is noted less frequently, and many of the reports are subject to the same errors of identification of the birds doing the work. In the vicinity of roosts, however, field corn in the dough stage is likely to be damaged in the morning and evening when the starlings appear in flocks often numbering thousands. To a limited extent starlings are accused of pulling sprouting corn, but the aggregate damage is trivial.

In summarizing the relation of the starling to the corn crop it may be said that while the examination of a large and representative series of stomachs has shown that the bird is not an extensive feeder on corn, field observation has revealed that under certain favorable local conditions, as in the vicinity of roosts, the bird may do damage. The fact that starlings are easily frightened by gunfire, and will shun an area after a day or two of shooting, suggests effective preventive measures.

SMALL GRAIN

The farmer has little to fear from the starling as a menace to small grains. Only 20 of the 2,301 adult starlings examined had fed on small grain. Of these 13 had eaten wheat; 6, oats; and 1, millet. In bulk this formed 0.39 per cent of the food, and fully half this was eaten at a time of year when it manifestly must have been waste. The few complaints on this score were either so trivial or, when of consequence, were so few and widely separated that the aggregate injury can not be important.

GARDEN TRUCK

The starling's depredations in the garden include injury to ripening tomatoes, lettuce, onions, peas, beans, and sprouting muskmelons; and in one truck-crop section, where seeds of radishes, parsley, and spinach were planted under manure early in the year, starlings were accused of scratching them out. In the main their work is confined to small plots, and the losses are most keenly felt by the city dweller who has painstakingly tilled a few square yards of soil to raise produce for home consumption. In extensive truck-crop sections the aggregate damage of this kind is not great.

WILD FRUIT

Wild fruit forms an important food item for the starling, supplying more than 22 per cent of its yearly sustenance, and in August, when large quantities of wild black cherries (*Prunus serotina*) and elderberries (*Sambucus canadensis*) are available, it furnishes nearly 41 per cent. In fall the fruits of sour gum (*Nyssa sylvatica*), Virginia creeper (*Parthenocissus quinquefolia*), and bayberry (*Myrica carolinensis*) become popular, and in winter even the dry outer coatings of seeds of the various sumacs (*Rhus*) and poison ivy (*Rhus radicans*) are sought. Wherever the starling has extended its range into areas in which persimmons (*Diospyros virginiana*) are common, these fruits also furnish it an attractive winter food.

The starling's consumption of various wild fruits results in a certain reduction in the food supply available for native birds. Observers have noted the effect of this depletion on the local abundance of native species, but considering the great abundance of such food available, it is doubtful whether a general shortage has occurred. When feeding on poison ivy the starling acts as a disseminator of this noxious weed, since the embryos of the seeds eaten are not affected by digestion, only the outer coating being removed. In this work the starling adds its influence to that of no less than 66 species of native birds that do the same thing.

MISCELLANEOUS VEGETABLE FOOD

In the Northern States winter compels the starling to lead the life of a scavenger to a certain extent. At this season it is a frequent visitor to the garbage heap, where it feeds on such things as fruit and vegetable parings, orange seeds, beans, and even coffee grounds. Such food items comprise more than 13 per cent of the starling's annual diet. The bird also picks up, probably accidentally, a few weed seeds.

The resourcefulness and energy of the starling in its search for food can be shown no better than by an inspection of the débris found at winter roosts. In common with many of our native birds the starling regurgitates indigestible portions of its food. This material often accumulates in great quantities in towers or other inclosures to which these birds resort. About a quart of such débris, collected at Washington, D. C., in February, 1928, revealed no less than 106 specifically different items, 49 of which were of vegetable origin, including weed seeds, wild fruits, corn, wheat, oats, buckwheat, and vegetable garbage containing considerable quantities of coffee grounds. The remaining items, of animal origin, consisted of beetles, grasshoppers, bugs, wasps, ants, flies, spiders, millipeds, crawfishes, snails, and carrion.

Figure 7 represents diagrammatically the proportions of the various food items of the adult starling, and Table 1 gives the same information in percentage terms.

TABLE 1.—*Monthly percentages of the various items in the food of adult starlings (see fig. 7)*

Kind of food	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Monthly averages
Weevils	14.10	20.16	7.97	4.35	4.31	7.39	13.36	10.91	3.93	3.13	5.33	7.00	8.50
Ground beetles	1.23	0.42	1.07	7.31	8.76	7.96	9.11	13.02	12.93	4.56	1.16	1.12	5.71
May beetles	0.14	------	0.27	4.52	11.04	3.28	4.08	0.45	0.38	2.60	0.10	0.05	2.24
Other beetles	2.27	0.49	2.39	6.55	6.23	4.56	3.70	1.76	0.75	1.15	2.27	5.54	3.14
Grasshoppers	4.42	0.55	2.61	1.59	0.84	1.24	2.77	22.30	30.75	38.95	38.76	4.76	12.41
Caterpillars	3.88	1.04	5.24	5.56	13.97	20.56	4.57	3.69	0.83	2.16	5.69	5.26	6.04
Millipeds	0.44	0.04	0.66	54.69	42.19	23.66	3.68	0.20	4.11	7.64	1.24	2.02	11.71
Miscellaneous animal matter [1]	3.91	3.07	6.23	5.26	6.98	10.80	5.71	5.56	3.56	11.83	3.01	5.05	5.93
Garbage (animal)	1.69	2.40	8.15	1.39	0.63	0.32	0.35	0.32	------	0.23	------	0.36	1.32
Garbage (vegetable)	40.56	35.97	41.25	6.76	4.58	1.04	1.49	0.34	0.54	3.61	------	26.62	13.57
Cultivated cherries	------	------	------	------	------	17.01	14.92	------	------	------	------	------	2.66
Other cultivated fruits	5.84	0.66	2.87	0.76	------	1.06	------	0.50	2.19	0.38	0.96	5.78	1.75
Wild fruits	19.98	32.90	13.69	0.34	------	1.12	35.82	40.88	39.57	23.76	41.80	36.44	23.86
Grain	1.54	2.30	7.60	0.92	0.47	------	0.44	0.07	0.46	------	0.18	------	1.16

[1] Under this heading are included ants, bees, wasps, flies, and other miscellaneous insects, spiders, and mollusks.

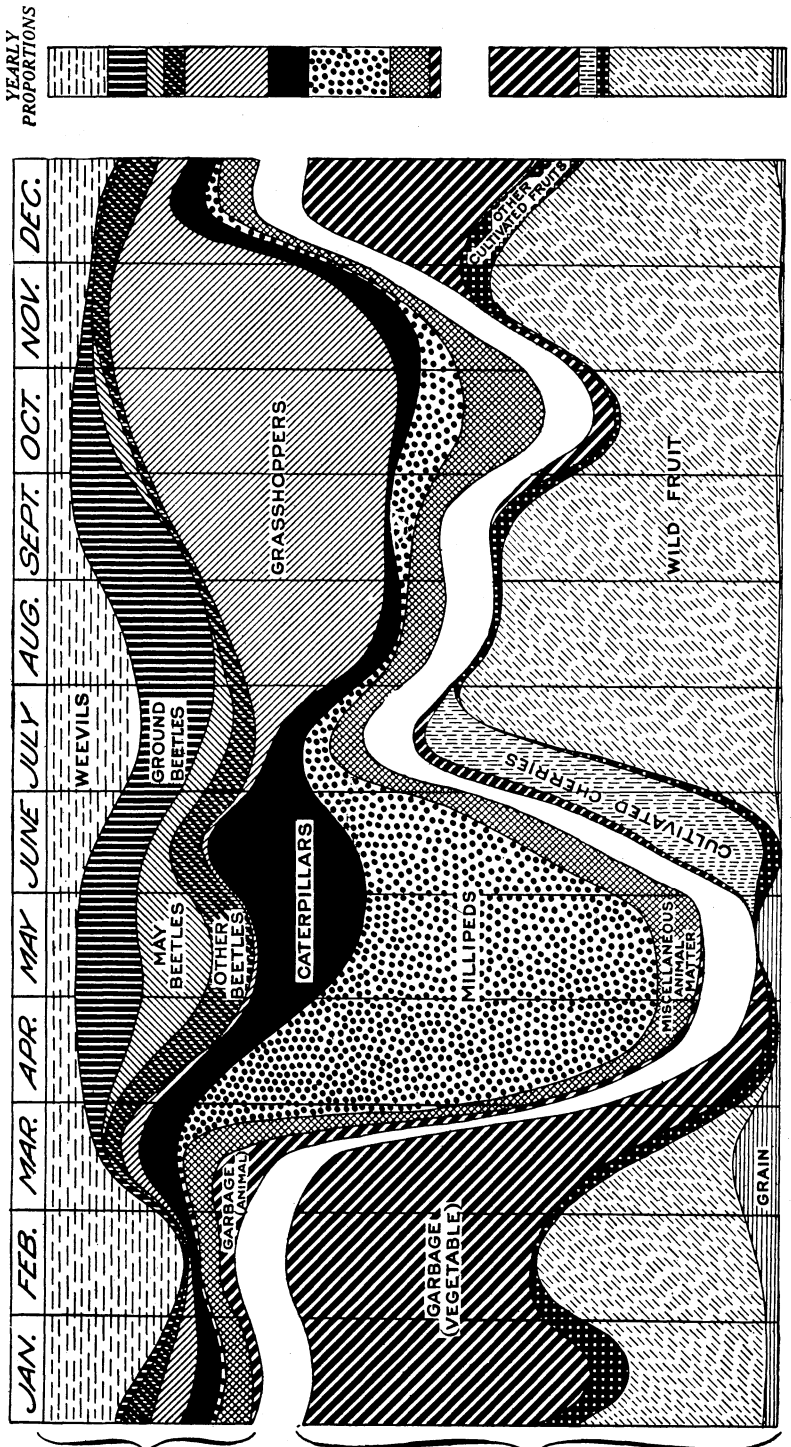

FIG. 7.—Chart of food of adult starlings, showing the varying proportions of the principal items from month to month and the relative yearly proportions of each. The information is shown in percentage terms in Table 1

FOOD OF NESTLINGS

From an economic standpoint the food habits of nestling birds are more favorable, as a rule, than those of the adults, and when one considers that during the nestling period the young birds of many species outnumber the parents two to one, the importance of knowing what they are capable of doing is manifest. It must also be remembered that the food required for the young growing bird is greatly in excess of that needed for its parent. During the first few days of their lives, nestling birds consume enormous quantities of food, estimated in the case of some species to be a mass equal daily to the birds' own weight. This demand for food, much of which consists of injurious insects, is greatest during May, June, and July, a time when growing crops are benefited most by a suppression of their insect enemies.

Few birds are more voracious than young starlings, and it requires the most strenuous efforts of the naturally active parents to supply the constant needs of their offspring when there are from four to six to be fed. Observations made on a brood of five young starlings revealed that they had been fed, on the average, once every 6.1 minutes during the nestling life. On the assumption that the young were fed 12 hours a day, which is conservative, a record of 118 feedings a day would be established. As this brood left the nest on the sixteenth day, probably several days short of the normal nestling period of the starling, for the birds were disturbed considerably during the latter period of their nestling life, a total of 1,888 feedings would have been given to this brood of five, or 377.6 feedings for each nestling. One may get some idea of the quantity of food required to develop a brood of young starlings from the fact that the parent birds would often bring in three or four cutworms, earthworms, or grasshoppers, or an equal bulk of miscellaneous insect food at a single trip.

TABLE 2.—*Monthly percentages of various kinds of food eaten by nestling starlings, showing the changing character at different ages (see fig. 8)*

Age of nestlings	Ground beetles	May beetles, etc.	Weevils	Grasshoppers and crickets	Caterpillars	Millipeds	Spiders	Miscellaneous animal matter	Cherries	Miscellaneous vegetable matter
1 to 5 days	2.43	3.91	5.59	13.96	45.26	1.48	23.44	2.98	0.18	0.77
6 to 10 days	11.59	18.33	4.49	11.23	34.88	5.34	3.57	5.93	3.36	1.28
10 or more days	7.69	18.25	1.02	8.98	37.81	6.38	3.28	7.61	4.76	4.22

A detailed study of the food of nestling starlings gives striking evidence of the great influence they exert for good. More than 95 per cent of the nestling's food is animal matter, largely insects. Cutworms are especially attractive to the young birds, caterpillars as a group forming more than 38 per cent of their diet. The character of their beetle food is economically more favorable than that of the adults, and, though the nestling period is too early in the year to permit extensive feeding on grasshoppers, crickets in large quantities supply their orthopterous food. Spiders are almost sure to be found in the stomachs of nestlings 1 or 2 days old, while

millipeds, such favorite food items of the adults, are much less frequently eaten. In the consumption of cherries, the nestling starling by no means equals its parents, or the young that have left the nest.

In summarizing it may be said that the habits of the young materially improve the starling's economic status in the early summer months. In the consumption of destructive caterpillars, scarabaeid beetles, and crickets, three favorite food items of starlings, the young birds excel. Furthermore they destroy fewer beneficial ground beetles and cultivated cherries than do their parents.

Correlated with this demonstrated superiority of the young in food habits is the fact that, bird for bird, nestlings consume more food than adults and that, in the case of the starling, they outnumber the adults 2 to 1. Such an array of favorable testimony makes it scarcely possible to overestimate the relative worth of the nestling starlings. A diagrammatic representation of their food habits at different periods in their life is presented in Figure 8. Table 2 presents this same information in percentage terms.

RELATION TO OTHER SPECIES OF BIRDS

The starling's hole-nesting habits have placed it in intimate contact and frequently in actual competition with native birds of similar habits. This has resulted not only in their usurping the nest sites but in some instances in destroying the eggs and killing the young of native birds. Bluebirds and flickers have suffered most from the starling, but martins, house wrens, robins, English sparrows, and a few other wild species, as well as domestic pigeons, are molested in their nesting operations.

Unrelenting perseverance dominates the starling's activities when engaged in controversy over a nesting site. More of its battles are won by dogged persistence in annoying its victim than by bold aggression. At times the starling carries its irritating tactics to such an extent that it seems almost as if it were actuated more by the morbid pleasure of annoying its neighbors than by any necessity arising from a scarcity of nesting sites. A pair of starlings has been seen keeping vigil for days within a few feet of a flicker's nest containing young, awaiting the first opportunity to enter the cavity should the flickers relax their guard for a moment, but when the flickers had brought forth their young the starlings also departed. A pair of bluebirds had four nests destroyed in rapid succession by a pair of starlings that had already chosen a nesting site. A purple martin, starting to build in a bird house, was promptly evicted by starlings that were nesting near by; the nest material was pulled out and the martins were finally driven away. Young robins have been killed by starlings, and even squabs have been dragged from pigeon lofts and dropped to the ground.

These instances, of course, picture the starling at its worst. If, however, the injurious habits of any other bird were depicted in unqualified form a gloomy picture would be presented. In the case of the starling, many of the nest-despoiling activities occur in the dooryard, where they are almost certain to come under human observation. The driving out of the native species that enthusiastic bird lovers have induced to take up sites in nest boxes also will be more

keenly felt than the molesting of breeding birds at a greater distance from the home and with which there has been less intimate acquaintance. A factor seldom considered by bird lovers lamenting these conflicts with native species is the relative value of the starling and some of its breeding competitors based on economic grounds. In this respect the starling is superior to the robin, the flicker, or the English sparrow, and it has food habits fully as favorable as the house wren,

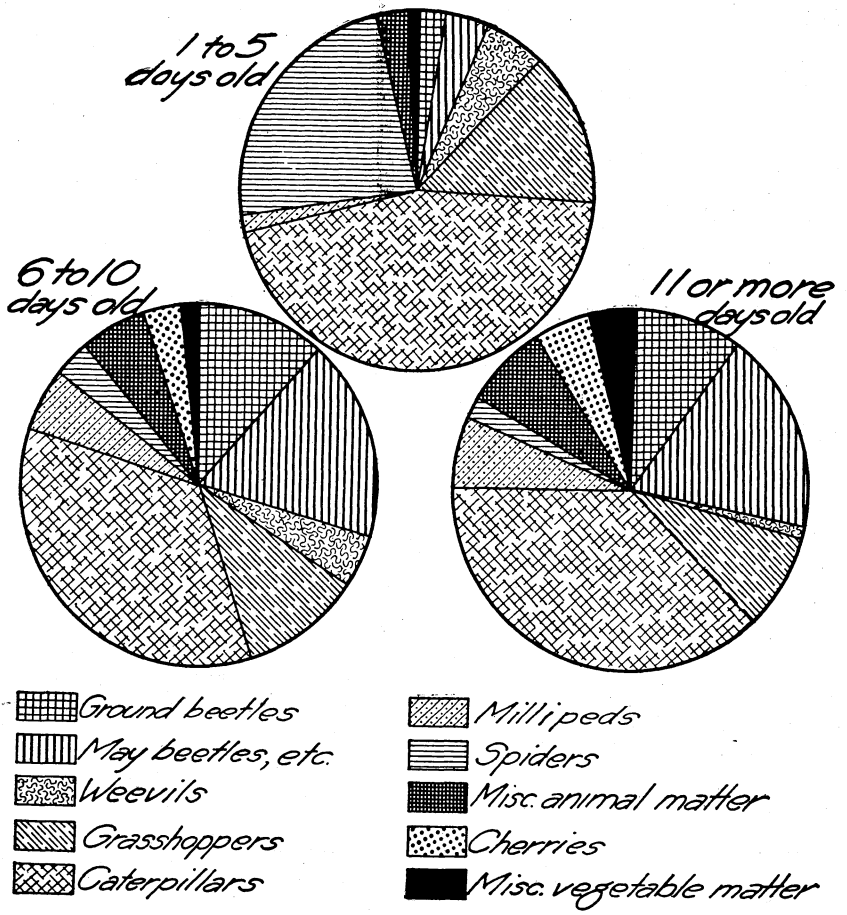

FIG. 8.—Chart of the food of nestling starlings, showing its change in character during three stages of nestling life. The information is shown in percentage terms in Table 2

which in recent years has been shown to be a nest despoiler. Thus the bluebird and the martin are the only species with which the starling is in intimate competition during the breeding season the economic worth of which may be considered greater than that of the starling.

Bluebirds are common and generally distributed in some of the sections that have been thickly settled by starlings for years, and although observers have noted their disappearance in areas confined to

the dooryard or suburban section, it is the opinion of persons qualified to judge the general abundance of birds that in Connecticut and northeastern New Jersey bluebirds have held their own since the advent of the starling and that there is little danger that the race as a whole will be placed in jeopardy by the newcomer. In fact, bluebirds continue to nest commonly in localities far from human habitation, where they have little to fear from starlings. Furthermore, in the dooryard their nests, eggs, and young may be protected by providing nest boxes having an opening no greater than 1½ inches in diameter, through which the starling can not pass.

The flicker also will be driven from the vicinity of houses, but it, too, will always find a refuge in the wilder situations to which the starling goes less frequently. In some parts of Connecticut, New York, and New Jersey, where in 1916 the starling was a common bird and had been in competition with the flicker for at least 15 years, the latter still maintained as conspicuous a place in the bird world as it had in other parts of those same States where the starling had not yet arrived. This also can be said of the robin, which in northeastern New Jersey and in the Hudson Valley, and along the Connecticut shore, is an extremely abundant bird, perhaps even too abundant for the best interest of the small-fruit grower. In 1916 martins were more abundant in western, central, and southern New Jersey than nearer the center of starling population, but such a condition of relative abundance existed before the advent of the starling and could not be construed to result from starling aggression. Neither can the apparent decrease in the English sparrow population throughout New Jersey and parts of New England since 1910 be correlated with the spread of the starling, since in many sections where a decrease of the sparrow was noted the starling had not yet arrived in numbers. As for the other species at present known to be attacked by starlings, the acts of vandalism are so occasional that the effect is negligible.

The increasing scarcity of nesting sites available to native hole-nesting species becomes apparent as the country is more thickly settled. To meet the growing need it is incumbent on bird lovers to furnish ample facilities in the shape of nest boxes. It will be well to provide for the needs of both native species and the starling. Such a procedure will tend to reduce the competition for nesting sites, and at the same time those who wish to reduce the local breeding population of starlings can do so by equipping nest boxes with the trap device mentioned in the following section, on control measures (p. 26).

Field observation sheds some light on the added competition for food imposed upon native species by the presence of the starling. During the breeding season, robins in suburban sections and meadow larks in the more open country are the species thrown most intimately in contact with the newcomer. Immediately after the breeding season the starling associates with cowbirds, red-winged blackbirds, and grackles, but, strange to say, the food preferences exhibited by the starling do not seriously conflict with those of these species.

Probably the greatest influence exerted by the starling upon the food supply of other birds is occasioned by its consumption of wild fruit late in summer and early in fall. Wild-cherry and sour-gum

trees heavily laden with fruit are soon stripped when a flock of several hundred starlings feeds continually in the vicinity, and, although the total supply of this food is enormous, instances have been observed where locally such birds as robins, catbirds, and cedar waxwings have been compelled to seek other sources of food. During winter starlings obtain a certain portion of the food formerly eaten by English sparrows, especially about the dumping grounds of cities. Where bird lovers have taken pains to attract native species they have often found the foreigner greedily consuming all they can supply, with the result that in some localities the high cost of attracting birds approaches the prohibitive point.

Here again must judgment on the relative worth of the species concerned be rendered before the seriousness of the starlings' consumption of the former food supply of other birds can be understood. After carefully weighing all the evidence available, it is safe to state that in the Northeastern States the starling is economically the superior of the robin, the catbird, the red-winged blackbird, the grackle, the cowbird, or the English sparrow. This leaves the meadow lark as the only highly desirable species materially affected by this competition for food.

CONTROL MEASURES

Despite the fact that starlings in normal numbers exert an influence for good and may well be left unmolested when not inflicting noticeable damage, there are times and circumstances under which they may become objectionable, or even decidedly injurious. This section on control measures has been included to supply information useful in overcoming the objectionable traits of these birds, or reducing their numbers where they have become unduly abundant locally.

ERADICATION OF ROOSTS

For the removal of objectionable tree roosts of starlings, a number of methods have been employed, but none at present in use assures lasting success. If vigilance is not employed, temporary eradication may be followed by reestablishment of the roost. Experience gained through attempts to remove starling-grackle-robin roosts in Connecticut and northeastern New Jersey has shown that the use of shotguns is effective, at least temporarily, and can be recommended wherever State and local laws permit. Five or six successive nights of attack are usually sufficient to cause the birds to move on. It is not necessary to kill many, benefits being derived from the frightening effect of the gun fire, coupled with misfortune visible to other members of the flock. For this reason the most effective work can be done early in the evening, when the first birds arrive. When there is still daylight the frightened birds will fly for some distance before alighting, whereas later in the evening they will move only a few yards from their perches. Shells loaded with black powder will produce a more deafening report and will frighten the birds more than those loaded with smokeless powder.

In a few places where the use of shotguns was impracticable, satisfactory results have been obtained through the use of powerful

Roman candles discharged among the roosting birds. A roost at Hartford, Conn., was removed by such means, but at some of the populous and long-established roosts in northeastern New Jersey such tactics were less successful than the use of the shotgun. The application of a stream of water from a fire hose has been resorted to with success on occasions, as well as milder forms of frightening operations, such as the use of electric lights and bells and other noise-producing apparatus, but as a rule the less drastic measures have little effect on large and long-established roosts.

In Washington, D. C., a severe trimming of the slender topmost branches of sycamores on which starlings roosted during most of the winter aided in the removal of an objectionable down-town roost.

When starlings resort to window ledges, fire escapes, and sheltered spots beneath the eaves of buildings on the business streets of cities, the problem of roost eradication becomes more difficult. Gunfire, pyrotechnics, and even the fire hose can not always be used, and the milder forms of frightening measures must be employed. In the winter of 1930–31 a small group of men, stationed on the roofs, eradicated the starlings from two Government buildings in Washington by lashing the overhanging eaves with long whips. This attack was supplemented by shooting pebbles with sling shots against the stonework of the building beyond reach of the whips. Four nights of persistent application of these measures completely eliminated the birds. However, they sought other roosting spots in the down-town section.

More permanent relief may be had in the case of roosts beneath the eaves of some buildings by the use of poultry wire. Usually only a narrow strip of netting of 1-inch mesh stretched tightly from the edge of the overhanging eaves down to the windows of the top or next to the top story, will completely exclude the birds from their roosting perches. When neatly done this wire is scarcely discernible from the street, especially after it has been dulled by exposure.

Starlings roosting in church towers, where they have sometimes become a nuisance on account of the accumulated filth, can be excluded by the use of wire screen of a mesh of 1 inch or less. This method is commonly adopted in areas thickly populated with starlings.

FUMIGATION

Suggestion frequently is made that toxic gases might be used as a means of removing objectionable roosts of starlings. Under conditions prevailing at tree roosts the danger to human beings and to the life of the trees themselves is too great to warrant the release of toxic gases in concentrations dense enough to kill birds. Experiments with a number of gases that have been used in warfare have demonstrated that concentrations approximately one-third the human lethal dose or greater are necessary to give consistent results. To carry such a concentration to the treetops over any considerable area in residential sections of cities would require the release of gases in such densities that, near their source, they would be far above the human lethal dose. Furthermore, gas clouds when once released are subject to the fickleness of air currents. For these reasons their use has not been recommended.

In inclosures where toxic gases can be confined and otherwise controlled, however, there are possibilities in their use against starlings when unduly numerous. Probably the most workable of these is hydrocyanic-acid gas. This is highly toxic and is frequently used in greenhouse as well as outdoor fumigation against insect pests. Experimental work is needed to determine the correct concentration of this gas for the most economical and effective control work against starlings and for the development of a technic that will give the most satisfactory results. In any event, such operations must be conducted only by persons thoroughly familiar with the handling of this highly toxic gas and in conformity with any local regulations regarding its use.

Crude calcium cyanide in dust form, which has found increased use as an insecticide in recent years, also has been found effective as a fumigant against English sparrows and starlings roosting in vines of ivy or Virginia creeper on the sides of buildings or on ledges and window sills under partially inclosed porticos. Calcium-cyanide dust on coming in contact with a humid atmosphere produces hydrocyanic-acid gas, and for this reason it should be used only by persons thoroughly familiar with the attendant dangers. The fact that it can be applied with portable dust guns, by which the density and size of the dust cloud can be readily controlled, makes for greater safety and convenience than do other methods of generating hydrocyanic-acid gas.

A small hand-operated dust gun, having only a few feet of hose and tubing from which the dust cloud is expelled, has been used effectively in killing English sparrows roosting as high as the top of the second story of buildings. After all near-by windows have been tightly closed a dust cloud is released near the ground. This produces a volume of hydrocyanic-acid gas that on calm nights will slowly rise, passing up the side of the building and penetrating all the spaces between overlapping leaves beneath which the birds customarily roost. By using extensions to the tubing attached to the duster higher roosting spots can be reached. A period of a minute or more may elapse between the time the dust cloud is released and the time the first birds receive lethal doses and begin to drop. Although starlings are more responsive to nightly disturbances than are English sparrows and are more likely to fly from the gassed area, with ordinary precautions they may be reached.

OTHER METHODS OF CONTROL

No extensive poisoning experiments against starlings have yet been carried out. The preference of these birds for an animal diet largely of insects during the spring, summer, and early fall precludes successful poisoning operations against them at those seasons. During winter, however, when they feed extensively on scattered grain and a variety of other items from garbage heaps and municipal dumping grounds, the chances for success should be better. At the localities mentioned there would be little danger to any species other than starlings and English sparrows.

Bird banders have been successful in trapping starlings in the sieve type of trap, tilted up on one edge by a short stick that is jerked out when the birds are feeding beneath. Even the funnel type of

trap will catch starlings when the ground is covered with snow and the birds are hard pressed for food. The nest-box trap used against English sparrows can also be employed against starlings and should find favor with those bird lovers who deplore the aggressions of starlings against native species at nesting time. Descriptions and illustrations of these and other traps that, with slight modification in size, should prove satisfactory for starlings are presented in Farmers' Bulletin 493, The English Sparrow as a Pest.

UTILIZATION AS FOOD

The ease with which starlings may be captured in church towers and other winter-roosting inclosures at night by aid of electric flashlights has given rise to the suggestion that an undue increase of these birds might be prevented by recommending their use as food. There is some merit to this suggestion, although the rather strong, gamy flavor of the starling's flesh will probably limit its popularity from a culinary standpoint. When the breasts of these birds have been soaked in a soda-salt solution for 12 hours and then parboiled in water, which is afterwards discarded, they may be used in a meat pie that compares fairly well with one made of blackbirds or English sparrows.

CONCLUSIONS

Most of the starling's habits are either beneficial to man or of an economically neutral character. Field observation has established the fact that the time spent by starlings in destroying crops or in molesting other species of birds is extremely short compared with the endless hours they spend searching for insects or feeding on wild fruits. There is no question that the influence of the European starling, in moderate numbers, in the United States is beneficial. As a destroyer of such pests as the clover-leaf weevil, the Japanese beetle, May beetles, cutworms, and grasshoppers it is even more energetic than some of our protected native birds.

Nevertheless the starling has certain tendencies for harm. These have been intensified by the bird's flocking habits, as well as by a general increase in abundance in recent years, and have led to insistent demands for a curtailment in numbers. It can not be denied that the bird inflicts damage to cherries, other small fruits, certain garden truck, and even late fruit and corn, and that it is the direct cause of the disappearance of certain native birds from the dooryard.

No doubt there are local areas in which the starling is detrimental to agriculture and horticulture at the present time, but the factor of overabundance rather than pronounced tendencies for harm on the part of the individual bird has brought this about. The same factor, too, has been important in making its roosting habits objectionable in residential and business sections of cities. To remedy such conditions it would appear that local control is the logical procedure. The suggestions for measures to combat the starling have been included in this bulletin with that object in view.

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