BIRD ENEMIES OF THE CODLING MOTH.

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RELATION OF BIRDS AND INSECTS.

Most birds are to some extent insectivorous, and many species live almost exclusively upon insects. There is no doubt that their combined attack has an important influence on the numbers of the insect army. In spite of birds and other enemies, however, it not rarely happens that certain insects suddenly increase in numbers and threaten great damage locally to crops. Instances of the suppression by birds of such strictly local outbreaks of insects are numerous. Rarely, however, do they exercise a noticeable degree of control over an insect so widely distributed and so important economically as the codling moth. Nevertheless, since 1746 nearly all entomologists who have published accounts of the codling moth have paid high tribute to its avian enemies, and they are almost unanimous in declaring birds to be the most efficient natural enemies of the pest.

LOSSES DUE TO THE CODLING MOTH.

The experts of the Bureau of Entomology state that the codling moth causes greater loss to apples and pears than all the other insect enemies of these fruits combined. They estimate the damage the insect does to the apple crop of the United States at approximately $12,000,000 annually.1 If account be taken of expenses incurred in attempts to control the insect, as for labor, arsenicals, and spraying apparatus, an additional sum of probably not less than $3,000,000 or $4,000,000, or a total of at least $15,000,000, must be charged to the presence of this insect in the apple orchards of the United States.

LIFE HISTORY OF THE CODLING MOTH.

The life history of so important a pest has, of course, been carefully studied. It has been found by entomologists that as a rule the eggs are laid upon the leaves or the fruit. There are usually two broods of the insects and consequently two periods of oviposition, namely, in early spring and in midsummer. The eggs hatch in

from 9 to 18 days, and the minute larvae immediately hunt for the fruit. Those finding it bore in at once and spend from 10 to 30 days feeding upon the seeds and flesh around the core. At maturity the larvae emerge, chiefly at night, and seek sheltered places, such as holes or cracks in the trees or ground, crevices under bark scales on the trunk, or refuges under boards or other litter on the ground in which to spin their cocoons. (Pl. X, figs. 2 and 3.) Here they either pupate at once in preparation for the second brood of the season, or, if winter is near, pupation is postponed till the following spring. The adults fly mostly by night.

DESTRUCTION OF LARVAE BY BIRDS.

Thus the nocturnal habits of the species in its active stages and the fact that it is hidden at other times leave few opportunities for birds to attack it. In spite of this, however, birds destroy great numbers. Some larvae are no doubt captured during the interval between emergence from the fruit and spinning the cocoon, but as this period is brief and usually occurs at night, a great majority of them probably reach a hiding place in safety. But woodpeckers drill through the bark flakes under which larvae or pupae lie in their cocoons, or enlarge cracks that shelter large numbers of these insects in immature stages, and the titmice, chickadees, nuthatches, and creepers find them in shallow crevices or by prying off loose scales of bark. Probably most of the other birds, also, which feed upon the larvae and pupae get them chiefly by these latter methods.

WOODPECKERS.

The most effective enemies of codling moths are those that can best attack them in their pupal chambers. It is not surprising, therefore, that woodpeckers, accustomed as they are to obtaining their food from crevices and under bark flakes, should take high rank among the foes of this pest. (Pl. XI.)

Roesel, the first man who published an accurate account of the codling moth, noted the beneficial work of woodpeckers. He says of the larvae seeking places to pupate: "They conceal themselves so thoroughly as scarcely to be found by men; but the woodpeckers and similar birds know how to discover quickly their retreats."¹

Trimble, an American investigator, was the first to ascertain how the downy woodpecker "finds where to peck through the scales of bark, so as to be sure to hit the apple worm that is so snugly concealed beneath." After stating that the sense of smell will not account for it, he says:

¹ Roesel von Rosenhof, A. J. Insecten-Belustigen: 1ster Theil, Der Nachtvögel, 4te Classe, No. 13, p. 36, 1746.
This little bird finds the concealed larvae under the bark, not from any noise the insect makes; it is not a grub of a beetle having a boring habit and liable to make a sound that might betray its retreat, in seasons of the year when not torpid. A caterpillar makes scarcely an appreciable noise, even when spinning its cocoon, and when that is finished it rests as quietly within as an Egyptian mummy in its sarcophagus. There is no evidence that the downy woodpecker ever makes a mistake; it has some way of judging. The squirrel does not waste time in cracking an empty nut. There is no reason to believe that this bird ever makes holes through these scales merely for pastime or for any other purpose except for food. He knows before he begins that if he works through, just in that spot, he will find a dainty morsel at the bottom of it, as delicious to him as the meat of the nut is to the squirrel. But how does he know? By sounding—tap, tap, tap, just as the physician learns the condition of the lungs of his patient by what he calls percussion. . . . Watch him. See how ever and anon he will stop in his quick motions up and down, and give a few taps upon the suspected scale, and then test another and another, until the right sound is communicated to that wonderful ear.

Dr. Trimble examined the stomachs of three downy woodpeckers and found codling-moth larvae in two of them. This was in the sixties; the observation has been confirmed many times since, and the downy has been praised on all sides. Well does he deserve appreciation. In most apple orchards in the United States in fall and winter the sound of the tapping of the downy woodpecker may be heard almost every day, and many a codling-moth larva or pupa do the birds devour. The insects have been found in stomachs of this species from New York, New Jersey, Texas, and California, and no fewer than 20 larvae have been taken from a single stomach. The downy woodpecker not only gets codling worms from the trunks of apple trees, but takes them from the fruit itself.

F. M. Webster notes that Mrs. S. H. Hine, of Sedan, Ind., a most careful observer of birds, stated that she had seen this species feeding on these larvae, extracting them from apples which were hanging to the tree. She had watched a downy woodpecker on a tree in her yard until it worked upon an apple within her reach, and, keeping her eye on this apple, she had approached the tree and picked it. She found that the young larva had made some progress into the fruit, starting from the calyx, but that it had been deftly extracted by the woodpecker and without injury to the fruit. Mr. Webster says further:

In a conversation with Judge McBride, of Elkhart, Ind., also a careful observer of birds, he stated that he had also observed downy woodpeckers extracting the worms from young apples, and he had never observed that in so doing the birds in any way injured the fruit. It seems, then, that the labors of this bird act not only as a preventive, but also afford actual and immediate relief to the infested fruit.

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2 Insect Life, III, p. 348, Apr., 1891.
Two western species of woodpeckers also are known to extract larvae in the same way. Mr. W. Otto Emerson, of Haywards, Cal., in a letter to the Biological Survey, dated March 14, 1909, says:

Several cases have come under my observation when in the fall months the California and Lewis woodpeckers made their appearance in canyon apple orchards and went through them, picking open the apples for the codling-moth worms they contained.

Other woodpeckers known to feed on the codling-moth larvae are the hairy woodpecker (*Dryobates villosus*), Texan woodpecker (*Dryobates scalaris bairdi*), red-headed woodpecker (*Melanerpes erythrocephalus*), red-shafted flicker (*Colaptes cafer collaris*), and pileated woodpecker (*Phleotomus pileatus*). Plate XI illustrates work of woodpeckers, probably mostly that of the pileated, in search of codling-moth larvae. The red-shafted flicker is given great credit by Mr. A. P. Martin, of Petaluma, Cal., who—

writing to the Pacific Rural Press of June 27, 1890, states that in looking over his orchard last spring and examining all crevices and bark of the trees for the codling-moth larvae, he failed to find any, where there were thousands last fall. He discovered plenty of cocoons, but in every case the former occupant was absent. It was too early for transformation to have taken place, and he found small holes in the bark scales which had been made by some bird. His belief is that the good work was done by a bird whose scientific name he does not know, but which is variously called the “yellow hammer,” “flicker,” or “high hole,” and which Dr. Merriam informs us is, in California, *Colaptes cafer*. During the early spring months Mr. Martin states that they were to be seen by hundreds in his orchard, industriously examining the trunks and larger limbs of the fruit trees, and he also found great numbers of them around sheds where he stored his winter apples and pears. As the result of several hours' search Mr. Martin found only one worm, and this one escaped only by an accident, for several had been within a quarter of an inch of it.¹

So eager are woodpeckers in search of codling worms that they have often been known to riddle the shingle traps and paper bands which are placed to attract the larvae about to spin cocoons. In fact, the beneficial work of woodpeckers in relation to this pest has everywhere been so conspicuous as to call forth laudations of the birds and recommendations for protecting them and attracting more of them to the orchards.

**FLYCATCHERS.**

One would not expect birds so expert in catching insects on the wing to resort much to tree trunks for food, but at least two species, the kingbird (*Tyrannus tyrannus*) and the western yellow-bellied flycatcher (*Empidonax difficillus*), are known to prey upon the codling moth. No fewer than 15 larvae were found in the stomach of a bird of the latter species collected at Haywards, Cal., in September.

¹ *Insect Life, III, pp. 79–80, Sept., 1890.*
FIG. 1.—LARVA. (3 TIMES NATURAL SIZE.)

FIGS. 2 AND 3.—PUPÆ UNDER BARK SCALES.

LARVA AND PUPÆ OF CODLING MoTH.
Holes and Cracks in Trees Enlarged by Woodpeckers Searching for Codling Moth Larvae and Pupae.
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THE CROW FAMILY.

The blue jay (Cyanocitta cristata), the California jay (Aphelocoma californica), and the magpie (Pica pica hudsonia) give the crow family representation among codling-moth enemies. It is reported that in the State of Washington magpies frequently tear loosely fastened bands off the trees while searching for the hibernating larvae. Pupae of the codling moth have been found in several stomachs of the California jay, collected at Haywards, Cal., in May.

BLACKBIRDS AND ORIOLES.

Three species of this family are on the list of foes of the apple worm, namely, the crow blackbird (Quiscalus quiscula), Brewer blackbird (Euphagus cyanocephalus), and Bullock oriole (Icterus bullocki). Pupae were found in the stomachs of many Brewer blackbirds collected at Haywards and Watsonville, Cal., in May and June. Twenty-six Bullock orioles taken in the same localities from April to August had eaten enough pupae and larvae of the codling moth to make about 20 per cent of their food. One of these birds had taken 14 larvae and pupae.

THE SPARROW FAMILY.

Members of this family that prey upon the codling moth are: English sparrow (Passer domesticus), chipping sparrow (Spizella passerina), California towhee (Pipilo crissalis), cardinal (Cardinalis cardinalis), black-headed grosbeak (Zamelodia melanoecephala), and lazuli bunting (Passerina cyanea). The adult California towhees, besides eating the pupae of the codling moth themselves, feed them to their nestlings. Black-headed grosbeaks have the same habit and to such an extent that they rank among the most important enemies of the insect. No fewer than 12 larvae were found in one stomach and 29 pupae in another. Twenty-one black-headed grosbeaks collected at Haywards and Watsonville, Cal., in May, had made over 20 per cent of their diet of codling larvae and pupae.

SWALLOWS AND VIREOS.

On the Pacific coast the barn swallow (Hirundo erythrogastera) is said to catch adult codling moths, but probably its services in this direction have been overstated.

The stomachs of several western warbling vireos (Vireosylva gilva swainsoni), taken in California in April, May, and June, contained pupae of the codling moth.

WARBLERS.

Only two warblers, the summer or yellow warbler (*Dendroica aestiva*) and the lutescent warbler (*Vermivora celata lutescens*), are now known to prey upon codling moths, but it is certain that further study of the food of this much neglected family will add a considerable number of species to the list. The lutescent warbler shows a strong liking for the pupae, two taken in California in May having eaten 10 and 18 pupae, respectively.

CREEPERS AND NUTHATCHES.

Each of these families has a single species on the list of enemies of the apple worm, namely, the brown creeper (*Certhia familiaris americana*) and the white-breasted nuthatch (*Sitta carolinensis*). It is reasonable to suppose that all the subspecies of creepers and nuthatches will in time be found to eat codling larvae and pupae.

TITMICE AND CHICKADEES.

Next to woodpeckers, titmice are probably the most important enemies of the codling moth. Their habits of searching every nook and cranny, however small or difficult of access, and the thorough way they go over trees and stumps, enable them to find the favorite hibernating quarters of the larvae. A description of their methods of hunting is given by Trimble, who remarks (p. 120), after detailing that he had taken 5 larvae from the stomach of a black-capped chickadee (*Penthestes atricapillus*):

The day had been dry and windy, following a warm wet day and night; and it is in just such weather that the bark of the buttonwood, shellbark hickory, and other shaggy trees will be found curling out and falling off.

I have never seen anything that would lead me to believe that this minute bird makes the holes in the scales of bark that lead directly to the cocoons of these caterpillars; they are made by the downy woodpecker and probably by it alone. The chickadee most likely finds these worms only or chiefly on such days as this, when the warping of these scales exposes them to the prying eyes of these busy little friends.

Besides the black-capped chickadee, the following four species of this family are known to eat codling moth larvae or pupae: Plain titmouse (*Baeolophus inornatus*), Carolina chickadee (*Penthestes carolinensis*), mountain chickadee (*Penthestes gambeli*), and California bush tit (*Psaltriparus minimus californicus*).

Ten stomachs of the last-named species, examined by Prof. F. E. L. Beal, contained, on the average, 25 per cent of pupae of the codling moth. Eight of these stomachs were of nestlings, containing pupae as follows: Two stomachs contained 2 each, two contained 3 each, one contained 4, one 7, one 9, and one 11, making 41 in all, or an average of over 5 to each.
The economic value of these nestlings is commented upon by Prof. Beal as follows:

The oak tree in which these birds were found was in a belt of timber along a creek, and just across the stream was a considerable area of neglected orchard. It is evident that the parent birds used this orchard as a foraging ground and did their best toward remedying the neglect of the owner. As with nesting birds feeding and digestion are almost continuous during the hours of daylight, it follows that the above record would be several times repeated during a day's feeding. There were probably not less than a dozen nests of the bush tit (several were seen) along the border of this orchard, and if, as is possible, the occupants all did as good work as the ones recorded, it is evident that the birds must exert a powerful restrictive influence upon the increase of the codling moth, as well as other insects.

**KINGLETS AND THRUSHES.**

One species of kinglet, the ruby-crowned (*Regulus calendula*), eats codling larvae, as do also two species of the thrush family—the robin (*P. migratorius*) and the bluebird (*Sialia sialis*). The robin eats this insect in both the East and the West, and a stomach from Pullman, Wash., contained 11 larvae.

**EFFICIENCY OF BIRD ENEMIES.**

We find that in the United States there are 36 species of birds, belonging to 18 families, that feed on the codling moth. The three important families seem to be woodpeckers, titmice, and sparrows. Probably, however, future investigation may place some other family, possibly warblers, among the first three.

We have shown that certain species, as the downy woodpecker, Bullock oriole, black-headed grosbeak, and bush tit, consume large numbers of codling-moth larvae and pupae. It is probably only because of insufficient investigation that the same cannot be said of other birds. Although we can not accurately rank the species in importance, we can confidently declare their utility collectively.

Almost every entomologist who has written on the subject substantially agrees with Slingerland that “by far the most efficient aids to man in controlling the codling moth are the birds.” The two facts that have chiefly led to this conclusion are the great scarcity of intact hibernating cocoons and the abundance of empty ones which have evidently been rifled by birds. Long ago Walsh and Riley said:

From the careful inspection of several large orchards in the early spring months, we are convinced that almost all of the cocoons of the apple-worm moth that have been constructed in the autumn on the trunks and limbs of apple trees are gutted of their living tenants by hungry birds long before the spring opens.

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In Virginia "counts of over 400 cocoons observed on apple trees revealed the fact that * * * birds had destroyed fully 85 per cent of the worms."  

From New Hampshire comes this report:  

Only from 5 to 20 per cent of the larvae survived the winter. An examination of 7 trees, which averaged over 38 cocoons per tree in the fall, showed but 5 per cent alive in the spring, 87 per cent having been killed by birds, 4 per cent by disease, and 3 per cent by cold. In another orchard 1,096 cocoons were examined in May, 1907, with 19 per cent alive, 66 per cent having been killed by birds, 6 per cent by disease, and 9 per cent by cold. It is quite evident that the birds, particularly the downy woodpeckers and the nuthatches, are the most important enemies of the codling moth in New England and that they should be given every protection and attracted to the orchard in every way possible. * * * They annually save us barrels of apples by destroying the apple worms under the bark in winter. They should therefore be encouraged and allured to the orchard whenever possible. Bits of suet and meat suspended from the trees will often attract them and sometimes help them through a hard winter.

Other measures recommended to aid birds in the warfare on this destructive moth are cementing up cavities suitable for the hibernation of the moth, thus forcing the larvae to spin cocoons where birds can get them, and scraping off loose flakes of bark, especially those below the snow line, as under these the largest numbers of larvae survive.

FOREIGN BIRD ENEMIES OF THE CODLING MOOTH.

The suggestion has been made that foreign birds with an established reputation as codling-moth destroyers be imported into this country. The bird most frequently mentioned is the great titmouse or Kohlmeise (Parus major) of Europe. However, European records fail to show that this bird pays any particular attention to the codling moth. Moreover its food habits, while apparently beneficial on the whole, include some bad traits, such as eating bees, budding trees, attacking pears, and killing smaller birds. Thus the species is distinctly not a promising one for trial in the exceptionally hazardous field of international importation. Among foreign birds that have been definitely recorded as enemies of the codling moth are the European nuthatch (Sitta casia), European wren (Nannus parvulus), tree creeper (Certhia familiaris), blue titmouse (Cyanistes caeruleus), kinglets (Regulus cristatus and Regulus

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ignicapillus),¹ one of the babblers (Pomatorhinus superciliosus),² the white-eye (Zosterops ceruleascens),³ and the white-throated treecreeper (Climacteris leucophaea),⁴ of Australia. Woodpeckers and sparrows are said to share in the work in Europe.

With three exceptions these birds belong to the same families as native species which we know devour the codling moth. These families are the creepers (Certhiidae), nuthatches (Sittidae), titmice (Paridae), and kinglets (Sylviidae). The United States already has a sufficient number of species of these families, besides numerous members of other families, which, if properly protected and encouraged, will probably destroy more codling moths than foreign species. To favor the increase and efficiency of our own useful species is not only far more profitable than to introduce foreign ones, but avoids the danger, acknowledged by all authorities as great, of opening our doors to a bird that in its new home may become obnoxious. It is a well-known fact that a very large number of our crop pests, both plant and animal, are imported. Furthermore, it is clear that the fundamental idea underlying proposals for introducing bird enemies of the codling moth is false. This idea is that each pest has some specific enemy or set of enemies which, if introduced, will control it to such a degree that the usual combative measures like spraying can be abandoned. This is a most alluring theory, but it is not borne out by practical experience. Birds exert a constant repressive influence on the number of insects, but those who expect either native or introduced birds to control a widespread insect pest to the degree necessary for the commercial success of the crop attacked will be disappointed.

SUMMARY.

Birds are recognized as the most effective natural enemies of the codling moth. In some localities they destroy from 66 to 85 per cent of the hibernating larvae, and their work in large measure accounts for the small spring broods of the insect. This annual reduction in numbers of the pest is a very valuable factor in its control.

Thirty-six species of birds are known to prey upon the codling moth in the United States. These species belong to 13 families, of which the most important, so far as number of species on the list is concerned, are the woodpeckers, titmice, and sparrows. Especially valuable species are the downy woodpecker, Bullock oriole, black-headed grosbeak, and bush tit.

³ Emu, VII, pt. 1, p. 36, July, 1908.
At least 10 species of foreign birds have been recorded as enemies of the codling moth, and there has been considerable agitation for the introduction of one or more of them. The importation of foreign species is, however, notoriously dangerous, and if successful would result in crowding out native species probably of greater value.

Exaggerated claims have been made for all sorts of natural enemies of insects, including birds, but all that can be truthfully claimed for them is that their influence is to lower the number of insect pests and hence is for the good. The amount of good done varies in different cases, and admittedly the bird enemies of the codling moth deserve the best protection and encouragement in recognition of their rank as the chief natural enemies of the pest.