3-1926

The European Corn Borer

Carl J. Drake
Iowa State College

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The EUROPEAN CORN BORER

Fig. 1. The European corn borer working in cob and shank of ear of dent corn.

AGRICULTURAL EXPERIMENT STATION
IOWA STATE COLLEGE OF AGRICULTURE
AND MECHANIC ARTS
ENTOMOLOGY SECTION
AMES, IOWA
THE EUROPEAN CORN BORER*

By Carl J. Drake.

A little less than a decade ago, 1917, the European corn borer was discovered near Boston, Mass. Up to that time the corn growers of the United States and Canada had not suffered very extensive and regular losses from insect pests. True, now and then the corn earworm, white grubs, cutworms, wireworms and a few other insects did serious damage to the corn crop, but such outbreaks were sporadic, more or less local, never widespread and they did not repeat themselves year after year.

The spread of the corn borer since its appearance has been rapid. Climatic conditions, coupled with the lack of natural enemies, have been very favorable for its multiplication and dissemination in America. The annual increase and spread of the insect have been so great and certain that the corn crop of America is now threatened with tremendous losses. This danger is not very far removed from Iowa, for in the Lake Erie region during the past summer (1925) the borer advanced westward to within 35 miles of the Ohio-Indiana state line.

INTRODUCTION AND DISTRIBUTION

When or how the European corn borer reached America is not known, but evidence seems to indicate that it was probably imported on broom corn from Italy or Hungary about 1909 or 1910. It was first found in the vicinity of Boston during the summer of 1917, where it was causing heavy losses in fields of sweet corn; it was discovered near Schenectady, N. Y., in January, 1919; south of Buffalo, N. Y., and Girard, Penn., in September, 1919; in the Province of Ontario, Canada, in August 1920; and in the counties bordering on Lake Erie in Michigan, Ohio and Pennsylvania during the summer of 1921.

From the first four centers, which were probably the result of separate importations from Europe, there have arisen three distinct and somewhat widely separated infestations in North America (fig. 3); namely: (1) New England (Maine, New Hampshire, Massachusetts, Rhode Island and Connecticut; also on Long Island); (2) eastern New York, including part of Vermont; and (3) the Lake Erie region, the largest and most important infestation, including southwestern New York, northwestern Pennsylvania, northern Ohio and southeastern Michigan and the Province of Ontario, Canada.

*Pyrausta nuballis Hüb.: order Lepidoptera: family Pyralidae.
The corn borer is widely prevalent in central and southern Europe; in western, central and northern Asia, and in China and Japan. The distribution of the corn borer in Europe and Asia and its present status in America indicates the ability of the insect to invade the greater part of the corn-growing region of the continent.

Area infested in North America, December, 1925

<table>
<thead>
<tr>
<th>Area</th>
<th>Sq. Ml.</th>
</tr>
</thead>
<tbody>
<tr>
<td>New England (1924)</td>
<td>5,750</td>
</tr>
<tr>
<td>Eastern New York and including part of Vermont (1924)</td>
<td>2,875</td>
</tr>
<tr>
<td>Lake Erie region (United States, 1924)</td>
<td>32,982</td>
</tr>
<tr>
<td>New area infested in United States (1925)</td>
<td>16,834</td>
</tr>
</tbody>
</table>

Total infestation in United States (1925) 58,441

<table>
<thead>
<tr>
<th>Area</th>
<th>Sq. Ml.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Province of Ontario, Canada (1924)</td>
<td>20,379</td>
</tr>
<tr>
<td>New area infested in Ontario, Canada (1925)</td>
<td>1,789</td>
</tr>
</tbody>
</table>

Total infestation in Ontario, Canada (1925) 22,168

Total infestation in United States (1925) 58,441
Total infestation in Ontario, Canada (1925) 22,168

Total infestation in North America (1925) 80,609

Fig. 2. Field of dent corn totally ruined by European corn borer, Ontario, Canada, 1925 (Photo, Crawford).
HOST PLANTS

Corn (including sweet, dent, flint and popcorn) is by far the first choice of the food plants and also the primary breeding plant of the European corn borer. All varieties are susceptible to attack and no varieties have been found exempt or immune from the ravages of the borer. In addition to corn, many other cultivated crops and weeds are subject to attack. Over two hundred species and varieties of plants have been found infested in the United States. However, some of these hosts serve only to a limited extent as breeding plants and others only as temporary food plants or shelter plants for the winter.

According to Caffrey, U. S. Department of Agriculture (Farmers' Bulletin No. 1294), the corn borer attacks barnyard grass, cocklebur, smartweed, pigweed, ragweed, beggarticks, dock, burdock, horseweed tanzy and many other succulent herbaceous plants in New England; of these only the more important economic plants are listed below.

Group I. Economics plants frequently attacked by the European corn borer.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Plant</th>
<th>Plant</th>
<th>Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aster</td>
<td>Chrysanthemum</td>
<td>Hemp</td>
<td>Sunflower</td>
</tr>
<tr>
<td>Barley</td>
<td>Cotton</td>
<td>Hops</td>
<td>Swiss chard</td>
</tr>
<tr>
<td>Beans</td>
<td>Cowpea</td>
<td>Millet</td>
<td>Sweet sorghum</td>
</tr>
<tr>
<td>Beets</td>
<td>Dahlia</td>
<td>Peppers</td>
<td></td>
</tr>
<tr>
<td>Broom corn</td>
<td>Gladiolus</td>
<td>Potato</td>
<td></td>
</tr>
<tr>
<td>Celery</td>
<td>Grain sorghums</td>
<td>Rhubarb</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 3. European corn borer infestation in United States and Canada, December, 1925.
Group II. Economic plants occasionally attacked by the European corn borer.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Group II. Economic plants occasionally attacked by the European corn borer.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Artichoke</td>
<td>Hollyhock</td>
</tr>
<tr>
<td>Buckwheat</td>
<td>Johnson grass</td>
</tr>
<tr>
<td>Calendula</td>
<td>Marigold</td>
</tr>
<tr>
<td>Cosmos</td>
<td>Mignonette</td>
</tr>
<tr>
<td>Geranium</td>
<td>Oats</td>
</tr>
<tr>
<td>Golden glow</td>
<td>Okra</td>
</tr>
</tbody>
</table>

The favorite breeding plants of the European corn borer in Europe and Asia are chiefly hemp, hops, broom corn, millet and certain wild grasses, but after the introduction of corn or Indian maize, this became the preferred host in which to breed. In these countries the corn and hemp crops have been very seriously injured by this pest. In 1913 and again in 1914 serious outbreaks of the corn borer occurred in Russia, as many as 40 to 60 borers being found in a single corn stalk.

LIFE HISTORY AND FEEDING HABITS

The European corn borer passes thru four different stages in its life cycle: (1) the adult, a moth; (2) the eggs, which are laid by the female moth; (3) the caterpillars, the borers themselves, which hatch from the eggs and do all the damage to corn and other plants; (4) the resting stage (called pupa) into which the borers change when they are full-grown and from which the adult moth later issues. This life cycle is completed by two generations annually in the New England states, but in the Ohio-Michigan-Ontario region a different form of the borer exists which passes thru only one generation annually. The
reason for this great difference in the life cycle is not known. The adults, eggs, larvae and pupae of the two forms appear to be identical in structure and color. According to host records the two-generation form infests more different kinds of plants than the one-generation form. However, the range of food plants in the Lake Erie region may be increased as the number of the borers increases. The seasonal notes on the life history below apply to the one-generation form of the Lake Erie region and, therefore, would not agree in certain details with the two-generation form occurring in New England.

The corn borer winters only as a full-grown larva within the corn stalk or ear or other food plants. With the approach of warm weather in the spring, the borer becomes active, tunnels to the surface of the food plant and then makes a small round hole which serves as an exit for the resulting moth. After closing this opening with a silk-like substance, the borer spins a delicate cocoon within the burrow near the exit hole and then transforms to the pupal or resting stage inside of this cocoon. The pupa, during a short reconstruction period of about two weeks, changes to a moth, then emerges and soon flies to nearby corn fields.

The adult moths are about three-fourths of an inch long, have slender bodies and a wing expanse of nearly one and one-fourth inches. The females are somewhat cream colored with a more or less brownish tint and have three narrow, wavy, purplish bands across the wings. The males are slightly smaller and darker in color than the females. Their food seems to consist solely of water, chiefly in the form of drops of dew and water on the plant. They are nocturnal in habit, flying mostly in the evening and hiding during the day on the underside of the leaves of corn, in weeds, grasses and other plants. Altho the moths do not as a rule fly long distances, the power of sustained flight is fairly well developed. However, occasionally they do fly long distances of their own accord, or by the aid of favorable winds. In the infested area marked individuals have been recovered at distances from 5 to 20 miles from the place where they
were liberated. The original infestation along the shore of Lake Erie in Michigan, Ohio and Pennsylvania was the result of the migration of the moths by flight from the Province of Ontario.

Egg-laying begins about four or five days after emergence and then continues each night until the female dies. The average length of life for both sexes is from 15 to 18 days, the maximum being about 29 days. The eggs are deposited in small, irregular, shingle-like clusters of from 3 to 50 each, usually on the underside of the leaves of corn near the point where the leaf bends over. This location gives the eggs shelter and also protects them from the direct rays of the sun. Each female deposits from 250 to 1,200 eggs, the average being between 300 and 400. The incubation period varies from four to nine days.

On hatching, the young borers are very small, being about one-sixteenth of an inch long. On young corn plants the newly hatched borers frequently feed for two or three days on the tender leaves before tunneling into the unfolding leaves, tassel buds or the stem of the plant. A little later in the season, when the leaves are tough, they immediately bore into the tassel, the husks and silk of the ear, or the main stem of the plant. In heavy infestations the borers tunnel any part of the plant, even the tap-root, the ear-shanks and the ears. The broken-over tassels, the sawdust-like castings hanging from the burrows or collecting on the leaves of the plant, and often the exudation of sap from the injured parts are characteristics and almost unmistakable signs of infestation. The borers also enter the ear directly thru the shank. Here they eat out small or large areas among the kernels and frequently tunnel thru all parts of the cob and shank of the ear. This injury results in a premature breaking at the shank and a poorly developed ear. As many as 15 mature borers have been found feeding upon and within a single ear of corn.

The borers have ravenous appetites and grow very rapidly. When nearly mature, some of them leave their feeding tunnels and wander considerably from plant to plant and enter other
corn plants, weeds, or other cultivated crops growing in or near the infested fields. In writing about the habits of the larger or mature borers, Caffrey says:

The larger borers are able to live for at least a month without food, even during their active period of growth. This habit is especially important, as it renders the insects easily carried in infested material which may be transported considerable distances or kept in storage for a long period.

Caffrey also says:

Experiments have shown that many of the full grown borers are able to survive total or partial submergence in either fresh or salt water for a period of at least forty days during their inactive period in the late autumn, winter, or early spring. This fact has an important bearing on the possible drift of infested material in rivers, lakes, etc.
When mature, the adult borers are cylindrical, a little less than an inch long, smooth, dirty white or pale brownish in color, and spotted with numerous small brown dots. The head is brown and the body has a fairly distinct reddish or brownish line along the middle of the back. In the Lake Erie region, about 11 months of the annual life cycle are spent in the borer stage in the host plants.

In the devastated corn fields of Essex and Kent counties, Ontario, Canada, in the fall of 1925, it was not unusual to find 30 or 40 full-grown borers per corn stalk, and many individual stalks contained about a hundred or more full-grown borers. The borer population has been estimated at several hundred thousand per acre in many fields in these counties. In such infestations the stalks are thoroughly honey-combed and broken over; the ears, mostly small nubbins, are poorly developed and shriveled; the plants in the fields appear as in fig. 1; the corn crop is almost without feeding value and a total commercial loss. In both stalk and ear injury the tunnels form favorable avenues for moisture to enter and thus create very favorable conditions for the development of rot and mold.

**IMPORTANCE OF THE EUROPEAN CORN BORER**

Prof. Lawson Caesar, provincial entomologist, Ontario Canada, gives a vivid description of the damage in certain counties in Ontario. He says:

To illustrate the damage it is capable of doing when very abundant it will be sufficient to say that in an area in Essex and Kent about twenty miles long by twenty miles wide nearly every field of early corn this year (1925)—and most of the corn was early—has been almost totally ruined. Most of the fields have an average of over twenty borers to a plant. In these fields practically every tassel has been broken off; every leaf has been killed and either fallen or hangs close to the stalk; the ears have broken down, about one-third of them rotted, the remainder are stunted and most of them riddled by the borers; the stalks are punctured by borer holes, have numerous castings on the outside and are tunnelled on the inside in all directions. The result is that almost every plant has died long before it was mature and many of them have broken over, thus forming a tangled, filthy mass almost worthless as food for cattle and fit only for hogs to run in and feed upon whatever ears have escaped destruction. No one who has seen these fields can doubt that the borer is a terrible menace.

Regarding the future outlook, Professor Caesar says:

All that need be said is that there is every reason to believe that the insect will continue to increase rapidly in the future and there is no reason to believe nature will come to our rescue and control this imported pest as she does our native insects. All the evidence indicates that unless the farmers act together, each man doing his share, the corn industry of the province will ultimately be ruined.
Speaking further of the corn borer situation in Canada and the United States, Prof. George A. Dean, entomologist of Kansas Agricultural Experiment Station, says:

This tremendous increase in the intensity of the infestation in Essex and Kent Counties, together with the crushing loss to corn growers, has all taken place within the last two years. In the season of 1923, there was absolutely no commercial injury in the dent corn fields of these counties. The infestation was less than one-fourth of 1 percent of a stalk infestation. Since the climatic conditions favorable for maximum yields of corn are also conducive to a rapid increase of the European corn borer, and since within a period of two years losses amounting to more than $2,000,000 have been experienced by the growers in Essex and Kent Counties, is it unreasonable to assume that when the European corn borer becomes established throughout the great corn belt states, that similar losses in some years may be had in five hundred or more counties?

NATURAL ENEMIES

Several different kinds of birds, including blackbirds, robins, wrens, phoebes, kingbirds, woodpeckers, starlings and pheasants, feed to a limited extent upon the European corn borer in the United States and Canada. Blackbirds have been observed to remove the borers from broken-over tassels. The hairy and downy woodpeckers frequently dig the borers out of the old stubble and corn stalks in the fields. Present records indicate that birds cannot be expected to cause a large reduction in the number of individual borers.

Predaceous and parasitic insects are represented by several different species. Ladybird beetles occasionally feed upon the egg clusters. Now and then aphis-lions eat the young borers soon after they hatch and before they enter the corn plant. The larvae of the corn earworm frequently devours borers, which are feeding on the same ear of corn. Ground beetles and crickets have also been observed to kill wandering borers on the ground. Parasites are represented by several species of two winged (dipterous)
and four winged (hymenopterous) flies. The eggs are preyed upon by tiny hymenopterous insects in New England, but the work of this parasite is quite variable from year to year. Altho a number of parasites attack the larvae of the corn borer, less than one percent of the borers have been destroyed by these beneficial insects.

Some of the parasites which prey upon the corn borer in Europe are being introduced into America by the U. S. Bureau of Entomology. Two of these parasites, an ichneumon fly (Exeristes roborator) and a wasp-like insect (Habrobracon brevicornis), are being reared in large numbers and set free in the infested corn fields of the United States and Canada. These feed upon the larvae of the corn borer and are entirely harmless to plants. It is not certain that all of the imported parasites will thrive and colonize in this country.

PREVENTIVE AND RESTRICTIVE MEASURES

The United States government, the Canadian government and several of the states in which the borer already exists have been trying numerous methods in an attempt to stop and control the borer.

Out of the experience already gained have come the following farm practices now being recommended for the destruction and restriction of the corn borer: The destruction of crop remnants and other host plants by fire or deep plowing (before May 15 in Ohio and Michigan); manipulation of the date of planting (in the Lake Erie region the late planting of early maturing varieties of corn seems to result in less injury than there is to early planted varieties); low and early cutting of stubble (this leaves fewer borers in the stubble); keeping corn and fence rows clean
(weeds harbor the borers); utilization of silo (no borers come out of the silo alive); shredding or cutting corn stalks (this kills many of the borers); feeding edible parts of corn plant and then destroying unused stover and stalk in barn, barnyard or fields before the adults emerge preferably by burning or by plowing deep so that all remnants are completely covered; the rotation of crops to fight the corn borer.

In the infested districts the states have passed quarantine laws and compulsory rules and regulations regarding the method of handling the corn crop and disposal of stubble and corn stalks. The common practice of harvesting the corn crop from the standing stalks in Iowa and other corn belt states would make conditions most favorable for the propagation and spread of the corn borer. In order to cope with the corn borer thru low cutting or burning or otherwise disposing of the stalks, present types of farm machinery are being modified and new types developed. Experiments to date indicate that spraying or dusting with arsenicals is not only impractical but almost entirely worthless. The numerous lines of research work underway make it inadvisable to give details regarding present control methods for these may soon be superseded by better methods.

**QUARANTINES**

As soon as the European corn borer was discovered in North America, the United States Department of Agriculture, also the authorities of infested states and the Department of Agriculture of Canada, immediately established rigid quarantines and inspection service in order to prevent "commercial jumps" and a general distribution of the pest by man. An ear of seed corn (also roasting ears) sent by mail or transported by automobile or in any other way whatsoever from the infested area into Iowa might start a new infestation and thus cost the state of Iowa and adjoining states millions of dollars. Quarantines cannot stop the natural spread of the corn borer by flight, but they prevent or minimize the danger of carrying corn or other material containing the borers thru human agencies into new districts. Field after field of corn and broom corn have been inspected each year by trained scouts to determine the annual spread and the distribution of the borer from year to year.

During the summer of 1922 the United States Department of Agriculture and the Entomology Section of the Iowa Agricultural Experiment Station inspected many corn fields in Iowa. Most of the scouting was done near broom corn factories, in fields of sweet corn and along the principal highways and railroads. No specimens of the European corn borer were found in Iowa or adjoining states.

The Iowa European corn borer warning and quarantine was
issued March 21, 1922. This quarantine was revised January 16, 1926, and made a little more drastic in its nature. Ever since the European corn borer was discovered in America the Iowa Agricultural Experiment Station and the state entomologist have been aware of the danger of importing this pest into Iowa and have been constantly on the alert for any indications of infestation.

OTHER CORN BORERS

Several species of native caterpillars tunnel the stalk, feed upon the silk and kernels, or live on the surface of the corn plant. Various plants other than corn which are attacked by the European corn borer also serve as hosts for a number of different species of caterpillars. On account of their general appearance or the character of their work, a number of these caterpillars are frequently mistaken for the European corn borer.

The corn earworm (fig. 11), *Heliathis obsoleta* Fabr., attacks a number of garden and truck crops, but is best known in the north as the green corn worm. The caterpillars generally enter the ear thru the tips and then devour the kernels. In severe infestations the ears are so badly injured that they are unmarketable and unfit for human food. The caterpillars are extremely variable in color,
ranging from light green to rose, brown to black, striped, spotted or perfectly plain. The full-grown caterpillars are about one and a half inches long. The eggs are usually laid on the silk and the caterpillars feed almost entirely upon the silk and kernels of corn, and rarely if ever tunnel the cob or main stem of the plant. Winter is spent beneath the surface of the ground and not in the corn plant.

The smartweed borer (fig.12), *Pyrausta ainsliei* Heinr., is a near relative of the European corn borer and it is very difficult to separate the different stages of the two species. The caterpillars are about the same size and so closely resemble each other in color and form that it requires a microscope to separate the species with certainty. The full-grown caterpillars of the smartweed borer are slightly smaller, not so robust and besides the line along the middle of the back is not so conspicuous as in the European corn borer.

The smartweed borer greatly prefers the smartweed group of plants in which to breed. The mature larvae are frequently found in the corn stalks during the fall, winter and spring. They do not derive their livelihood from the corn plant, but simply tunnel into the stalk or into stems of other plants in the fall when seeking favorable shelters for the winter. The smartweed borer spends the winter as a larva in the tunnels of its food or shelter plants. Its tunnel in the corn stalk resembles those of the European corn borer.

The common stalk borer, *Papailpema nitela* Guen., tunnels a large number of plants and is frequently found in the growing corn plant. The young borers are readily separated from those of the European corn borer by the broad, dark brown or purplish band near the middle of the body and the several conspicuous brown or purplish longitudinal stripes. The mature caterpillars are without conspicuous band

Fig. 12. (a) smartweed borer (b) European corn borers in corn stalk.

Fig. 13. Larva of common stalk borer, *Papailpema nitela*.
or stripes, slightly more than an inch long and much more robust than the European corn borer. The common stalk borer does a great deal of damage to corn, oats, timothy, potatoes and a number of other cultivated plants in Iowa. The stalk borer spends the winter in the egg stage, thus the caterpillars are not found in the corn stalks during the late fall or winter.

Among other corn pests sometimes confused with the European corn borer are cutworms (several species), the army worm (Leucania unipuncta Haworth), the lesser stalk borer (Elasmopalpus lignosellus Zeller), webworms (Crambus spp.), the gardenwebworm (Loxestege similalis Guen.), and the larvae of a few species of bill bugs (Sphaenophorus spp.). The garden webworm was a very common insect on the corn plant during the past summer (1925) in Iowa.

THE OUTLOOK

The European corn borer is permanently established in America and is just entering the great corn belt. As a menace to the corn crop, upon which depends the livestock industry, and thus indirectly to agriculture in general, the danger has probably never been paralleled in America. The serious losses to dent corn in Ontario in 1925 indicate the tremendous potentialities of the insect and rank it as the most important corn pest that has become established in America. Unrestricted, the borer is capable of practically ruining the corn crop year after year. Under the operation of control measures, Iowa will continue to grow corn, but not under such favorable conditions as are now enjoyed in the state.

IMPORTANT!

Place all corn borers and sample of their injury in tight container and mail to the Entomologist, Iowa State College, Ames, Iowa.