

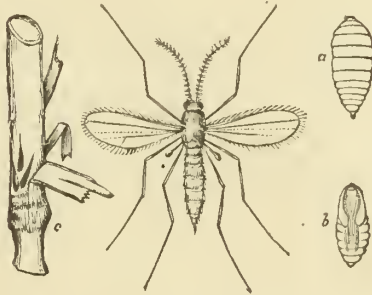
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BULLETIN No. 4.

THE HESSIAN FLY,

ITS RAVAGES, HABITS, ENEMIES, AND MEANS OF
PREVENTING ITS INCREASE.



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THE HESSIAN FLY:

ITS RAVAGES, HABITS, AND MEANS OF PREVENTING ITS INCREASE.

INTRODUCTION.

Next to the Rocky Mountain Locust, the Cotton Worm, and Chinch Bug, the Hessian Fly is at present the most destructive of our noxious insects. It attacks wheat, our most important agricultural product, and at times has been so abundant as to cause farmers to abandon the culture of this grain over large sections of the Union. While the fly has been well known and destructive for about a century, the vast extension within a decade of years of the wheat-growing area of the West, and the corresponding prevalence of the fly in the Northwestern States, together with its wide-spread destructiveness, has given fresh interest and importance to this pest. Moreover, the cultivation of wheat in the New England States, where about twenty years ago it was abandoned on account of the ravages of this fly and the wheat midge, has been resumed in part, so that the dissemination over the wheat area of the United States of the known facts in regard to its habits and modes of doing injury seems necessary. This area, as seen in part by the map* appended to this Bulletin, which has been compiled from Walker's Statistical Atlas, embraces all of the United States north of the 35th parallel of latitude and east of the 93d meridian, with the addition of tracts in Dakota, Montana, Colorado, New Mexico, and Utah, as well as in California, Oregon, and Washington Territory. These last-named wheat areas were not mapped by General Walker, and have been omitted on the present map, since the Hessian Fly is not known to exist west of Eastern Kansas.

Though the habits of the Hessian Fly are tolerably well known, much additional knowledge is desirable regarding its distribution, its breeding habits, and its parasites, while in order to properly apply the best preventive remedies, to stamp out the pest as it appears in new wheat sections, we need the results of a larger number of experiments as to the effects of early and late sowing, what varieties of wheat to sow, and as to the value of manures and artificial fertilizers in promoting the rapid and healthy growth of the young wheat, by which it may outgrow the weakening effects of the worm and ripen its grain.

The object of this Bulletin is not so much to convey new information to wheat-growers as to briefly state what thus far is known as to the appearance, ravages, habits, and remedies against its attacks. By widely disseminating this knowledge, seeking fresh facts from practical farmers all over the country, who are hereby asked to send to the author all new facts and results of valuable experiments, it is hoped and believed that

* Taken from a report on the Rocky Mountain Locust and other insects now injuring, or likely to injure, field and garden crops in the Western States and Territories. By A. S. Packard, Jr. From the Report for 1875 of Hayden's United States Geological Survey of the Territories.

the Commission will be able in a future report, after another season's work in the field, to throw further light on the subject.

Although this pamphlet has been prepared by but one member of the Commission, the writer is indebted to Prof. C. V. Riley for drawings, specimens, and data; to Professor Thomas for facts and suggestions; and would also acknowledge aid received from Prof. A. J. Cook, of the State Agricultural College, Lansing, Mich., whose address on the Hessian Fly has been of much service and liberally quoted in this Bulletin, and also from the correspondents and agricultural papers mentioned here and there in the following pages.

LOSSES OCCASIONED BY THE HESSIAN FLY.

This fly first became a serious pest in the country in the year 1779, although, as will be seen further on in the section on the distribution of the insect, it probably began its work of destruction on Staten Island and Long Island in 1776. According to Fitch, 1779 was probably the date when its ravages actually began. "The crops of wheat were severely injured or wholly destroyed by it in King and Richmond Counties during several of the following years, and each succeeding generation regularly enlarged the sphere of its devastations in every direction."

In 1781 the fly almost totally destroyed the wheat crop in Eastern Long Island, and in 1786 the crops were either totally or partially destroyed in New Jersey in and about Prospect, an area situated forty miles southwest of Staten Island. In 1786 and 1787 the ravages of this pest attracted much attention in New York and Pennsylvania; the wheat crop on Eastern Long Island having been "cut off almost universally." About Trenton, N. J., in 1788, the wheat crop was in many cases a total failure. As wheat in large quantities was at this period exported to Great Britain, "accounts of the appalling havoc that this insect was making excited the attention of the government there and aroused their fears lest so dreadful a scourge should be introduced into that country by means of the American grain." (Fitch.) As a result, the exportation of grain from America was prohibited until the English Government was assured that the fly with eggs could not be introduced in the grain. As long since as 1800, Dr. S. L. Mitchell, of New York, affirmed that "the insect is more formidable to us than would be an army of twenty thousand Hessians." (Herrick.)

Between 1789 and 1803 severe losses ensued from its attacks in Saratoga and Washington Counties, New York; "on two or three occasions many of the fields in Saratoga were entirely destroyed."

In 1804 President Dwight, of Yale College, remarked that "this insect is feeble and helpless in the extreme, defenseless against the least enemy, and crushed by the most delicate touch; yet for many years it has taxed this country annually more, perhaps, than a million of dollars." (Herrick.)

In 1803 and 1804, in the neighborhood of Richmond, Va., "they swept whole fields." In 1817 it "renewed its ravages in various sections of

the country; was unusually abundant," and "in parts of Maryland and Virginia it was perhaps more destructive than it had ever been before."

At what year the Hessian Fly first occurred in the New England States is uncertain; so far as we can ascertain it was first noticed at New Haven, Conn., in 1833, by Mr. Herrick, a careful entomologist, but without doubt it was introduced from New York early in the century.

In Lower Canada it was, according to Hind,* between 1805 and 1816, "prevalent and destructive in some parts," but in 1830-'36 it disappeared in Lower Canada.

The fly first appeared in 1837 at Paw Paw, Mich., in the second crop sown in Van Buren County; none had been raised at a point nearer than twelve miles. (D. Woodman.)

The Hessian Fly has been known in Person County, North Carolina, for fifty years; and another correspondent writes us from Goldsborough, N. C., that—

Previous to the period, say 1840, our farmers had been accustomed to sow wheat as early as September, but a fly, called by them the "Hessian Fly," so depredated that they deferred sowing to the latter part of November, and now, generally, to "between the Christmases" (new and old Christmas); their crop is now unmolested by the Hessian or any other fly.

The losses in Pennsylvania in 1842 were heavy, the wheat crop of the State being estimated at 20 per cent. less than in the preceding year, the fly being the principal cause of the loss. At this year Ohio was visited by it, when "it appeared to be increasing so much that serious apprehensions were beginning to be felt respecting its future ravages." (Fitch.)

Great havoc in many fields in Maryland and Virginia was committed by it in 1843. In the following year it did much injury in Northern Indiana and Illinois and the contiguous parts of Michigan and Wisconsin, in many places occasioning "almost a total failure of the crops." In Michigan the wheat crop was almost an entire failure. On Long Island, at Rochester, N. Y., and throughout Pennsylvania the losses this year were severe; the following year it did more or less injury all over the State of Illinois, while in the central parts of Maryland the crops, in many instances, were rendered totally worthless. "In Georgia, moreover, its ravages in the counties around Milledgeville are said to have been dreadful; whole fields were totally destroyed, and others yielded not more than a fourth of an ordinary crop."

In 1846, in the upper counties of Georgia, it was said "the fly has committed such ravages upon the wheat as scarcely to leave enough seed for another year." Throughout the State of New York it was destructive this year; in the western section the loss from this insect was estimated at not less than 500,000 bushels. In Maryland this same year (1846), as recorded by Fitch, "so great ravages have not been committed by the Hessian Fly since 1817. On some of the best land wheat has

* Essay on Insects and Diseases injurious to the Wheat Crops, by H. Y. Hind, Toronto, Canada, 1857, 8^o, p. 139.

been plowed up, and other portions are so much injured that they will not be worth harvesting. At least one-half of the crop of Talbot County has been destroyed." And in the upper counties of Georgia it is said "the fly has committed such ravages upon the wheat as scarcely to leave enough seed for another year."

In 1847 the losses were generally widespread but light, while in 1849 it was destructive in some of the counties in New York, and especially in Ohio. From this date until 1853 it was not destructive, but this year it "committed great ravages in some parts of Pennsylvania." In 1854 it was destructive in Aroostook County, Maine, as well as in Michigan.

From 1855 to 1860 the Hessian Fly attracted little attention from the agricultural community. In 1860 the fly "had reached as far west as Iowa and Minnesota, and in 1863 the wheat-fields along the Detroit and Milwaukee Railroad promised nothing because of the ravages of this pest." (Professor Cook).^{*} In 1866 it is reported to have occurred in Maryland, Delaware, and Ohio, and in 1868, according to a writer in the *American Entomologist*, about Fond du Lac, Wis., "much of the wheat crop was damaged by it."

In 1871 it was generally prevalent throughout the Middle States from South and North Carolina and Virginia to Missouri northward; also occurring in Kansas, Georgia, and Minnesota, and in 1872 and 1873 was destructive and widespread in Maryland, Ohio, Indiana, Illinois, and Eastern as well as Western Virginia, as well as in Michigan, "as also in the States south and west" of the last-named commonwealth.

In 1874 it was widespread, but much less destructive; in 1875 and 1876 it was especially destructive in Missouri, Pennsylvania, and Virginia. In 1876 "it appeared in force in many of the southern counties of Michigan, reaching as far north as Mason, in Ingham County, causing much destruction." (Professor Cook.)

In 1877 the losses again became heavy over a large part of the wheat area. At Lawrence, Kans., the early-sown wheat "suffered a good deal from the ravages of the Hessian Fly." At Gardner, Kans., all early-sown wheat "was full" of the "flaxseed" of the Hessian Fly. At Saint Genevieve, Mo., the fly was "much worse than for years past." At Independence, Mo., the crop in some fields was nearly a failure. In Henderson County, Kentucky, while prevalent, only one wheat-field was "badly damaged"; while in Vanderburgh County, Indiana, "many fields were infected." In Central Illinois a correspondent of the *Cultivator and Country Gentleman* states that "the Hessian Fly has been present in the lower portion of the winter-wheat region for several years," and in 1877 "it appears that the Hessian Fly is generally present in greater or less numbers over the whole winter-wheat region; that in almost every case it has attacked and done more or less damage to early-sown wheat-fields."

^{*} In his seventh report, written apparently in 1862, Dr. Fitch remarks: "We hear of it at the present time as very destructive in Illinois and some of the contiguous States, the crop in many wheat-fields being totally ruined by it."

In Michigan the fly, while troublesome in 1876 was also very generally so in the succeeding year, as stated by Professor Cook, as follows:

This year, 1877, we hear of it as more broadly distributed in our State, while complaints come to our ears from Ohio, Indiana, Illinois, New York, and Pennsylvania. Since writing the above, I have passed through our State and also the State of Ohio, on two of the different trunk lines of railroads, and I find that all through Southern Michigan and all of Ohio, at least north of the latitude of Columbus and Dayton, this insect abounds in force.*

The following extracts from Michigan papers show the situation in that State this year:

Farmers are complaining of the ravages of the "fly" in their wheat-fields. Much damage is reported.—*Jonesville Independent*.

Mr. James Taylor showed some wheat-stalks from his farm to-day which had over forty insects in one stalk.—*Kalamazoo Gazette*.

Wheat heading out ten days to two weeks earlier than usual this year, and doubtless much of it will be ready to cut in June.—*Portland Observer*.

The "fly" or "insect," as called by the farmers, is playing sad havoc with the wheat crop in this county. Not over half a crop will be realized.—*Kalamazoo Gazette*.

The fly is very seriously injuring the wheat in Porter. One of the largest farmers in that township yesterday told us that a few weeks ago he would not have taken 3,000 bushels for his crop, but now he would gladly take 1,000.—*Paw Paw Courier*.

Much complaint is now heard from all sides in regard to the work of the insects in early-sown wheat. The dry weather has so far retarded the growth as to give the pests the power to destroy. There is little question that early-sown wheat is suffering greatly.—*Marshall Exponent*.

Farmers from all over the county come to town looking doleful enough. The wheat crop promises to be almost a total failure. Two weeks ago everybody was happy over the prospects of an abundant harvest, but now flies, worms, and drought seem to have ruined the crop and blighted every home.—*Marshall Statesman*.

Farmers from all the adjoining towns complain that their growing wheat crops are badly injured by the insects. Wheat-fields which promised a heavy yield two weeks ago, it is thought, will not produce over a half a crop, and many fields are reported as already nearly destroyed. Naturally some allowance should be made for the apprehensions of those whose fields are thus ravaged; but there is no doubt that the crop through this section is materially damaged by these destructive pests.—*Battle Creek Journal*.

Mr. T. F. Miller, of Richland, brought into our office Monday morning a handful of wheat (taken from a farm on the prairie) that is literally alive with the insect. He says that in his opinion nearly every field in Richland is so badly affected that there cannot be half or even a third of a crop. The dry weather has stopped the growth, and the wheat is more affected on that account. We hear the same report from other parts of the county. Grain is also suffering for want of rain.—*Kalamazoo Gazette*.

The following extract from the New York *Cultivator and Country Gentleman* will give the condition of affairs in West Virginia:

Since reading your article making known Mr. A. S. Packard's request, in the issue of November 15, I have had occasion to make a business trip through Hardy, Hampshire, Mineral, and Grant Counties, and find upon examination that there is not a single field which is not more or less damaged by the fly. The early-sown wheat, having luxuriant growth, does not seem to be entirely destroyed, but has the appearance of mixed yellow and green. I find, upon close examination, it is filled with the fly. Other fields, sown after corn-cutting, show a greater amount of damage; one in particular, a limestone upland, was scarcely tinted with green, the fly having already

* The Hessian Fly. A lecture by Prof. A. J. Cook, of the Michigan State Agricultural College, delivered at Farmer's Institute held at Paw Paw and Climax, Mich., 1878, 8vo., p. 14.

consumed nearly the whole of it. My course from this point was north and west. I find that the farther north I travel the more damaged is the wheat. In this (Hardy) county the damage, so far, appears not to be material. Some crops of early-sown wheat were considerably shortened last year, the first year in many that we have felt the effects of the fly. One farmer, whose wheat seemed already a failure, asked me what he should do. I advised when the land was dry, or hard frozen, to put all the sheep he could get upon it, and keep them there until they had eaten it off as close as a sheep could nip, as the only remedy. I thought that the sheep could do no worse than what must be eventually done by the fly, and it might save the crop. He asked me if I thought the insect would be "wholesome for the sheep." This I could not answer, and refer the query to you.—R. M. W., Moorefield, W. Va.

A correspondent of the same paper thus records the injury done by this insect about Syracuse, N. Y.:

Wheat sown early, from the 1st to the 20th of September, has made an extraordinary growth. The fine weather was favorable; besides more care has been paid to good culture than before. The seed also has been selected, cleaned, and graded with greater care, showing much progress. From appearances now, it will result in a loss. Whole fields, and parts of others, are turning yellow, showing the ravages of the fly to a larger extent than I ever before witnessed. It began to turn yellow on knolls, or where the plaster rock came near the surface, and was thought only the effect of dry weather, but now it has extended all over early-sown fields. Should the warm weather continue, great injury will result to the entire crop, as it has been sown much earlier than usual and has looked remarkably fair. Later sowing, with a greater breadth of spring wheat, is the only remedy now offered. Will other parties in different sections make an examination and send notes?—C., Syracuse, N. Y.

While, so far as we have been able to learn, no serious damage, if any, has been done to wheat in New England by this pest since 1854, in Western Canada it again became abundant in 1874, but most injurious in 1876 and 1877. In 1876 it appeared in great force in the townships of Amabel, North Bruce, Grey, and Kippel.

In 1878, the losses were still heavy in Southern and Central Michigan, but in 1879 the insect seemed to be moving northward, the greatest amount of injury being sustained in the northern part of the State, the fly being scarce in the middle of the State.

As regards its abundance in southeastern Michigan in 1878 and 1879, Mr. F. S. Sleeper, of Galesburg, near Kalamazoo, writes me as follows:

In February, 1878, I noticed what was to me something new. The month was very warm and spring-like. For nearly three weeks the temperature did not reach the freezing point. About the middle of the month I noticed many flies flying over the wheat and depositing their eggs, but, so far as I could see, none reached the "flax-seed" state. I have several times noticed the fly depositing her eggs as late in the autumn as October 26.

Since the summer of 1877 no very serious damage was done until last spring (1879). Then the fly put in an appearance. On the 26th of May, above one field of wheat the air was almost black with them. I never saw such a sight before. I had fears that the fall-sown wheat would be badly damaged, but it is not so, as none but early-sown wheat is damaged in the least. I presume it is owing to the fact that September was cold, so that probably the sudden atmospheric changes destroyed all that had not reached the pupa state.

In 1878 it did great damage in Dickson County, Tennessee. In Maryland, the winter wheat in the neighborhood of Baltimore, Md., was, in 1879 and the spring of 1880, seriously affected. In Central New York,

in Seneca and Tompkins counties, considerable damage was done in 1878 and 1879. About Watertown, N. Y., some injury was done in 1879, one field of wheat being ruined.

In 1879 apprehensions that injury would be caused by the fly were felt in Lowell, N. C.

These facts indicate that the losses from the Hessian Fly are greatest in the grain-raising areas of the middle and northwestern States, and adjoining regions of Canada, and that the New England States have been comparatively free from their attacks, though this is perhaps mainly due to the fact that so little wheat is cultivated there. No statistics as to the losses have ever been collected, either by the State or national governments, but they have been sufficient to occasion much consternation and alarm at certain years. By reference to the chapter on the supposed periodicity in its attacks or years of maximum abundance, the reader may learn approximately by the history of the past how often its more serious attacks may be probably renewed.

DESCRIPTION OF THE HESSIAN FLY.

This insect belongs to the Diptera or two-winged insects, of which the common house fly is the best-known type. It belongs to the family *Cecidomyiidae*, a large group of minute flies, resembling the crane flies or daddy-long-legs (*Tipulidae*), but of diminutive form. They are nearly all gall-flies, the females laying their eggs by means of the soft extensible end of the body which slides back and forth like the joints of a telescope. The irritation caused by the egg results in the swelling of the stems of plants, or the formation of tumors or galls on the leaves and buds. The Hessian Fly, as we shall see farther on, does not produce true galls in this way, but the presence of the insect in the flaxseed state, between the leaf and the stalk, causes the stem to swell, and the leaves to wither and die. The scientific name is *Cecidomyia destructor* of Say.

The female (Plate I, *f*; II, *A*.)—The body is rather slender, uniformly dark brown, the head is round, but somewhat flattened, the eyes are black, the wings uniformly dull smoky brown, while the legs are paler brown than the rest of the upper side of the body. The body, wings, and legs are provided with fine hair-like scales (Plate II, *A*, *c*), those on the wings being in many cases quite broad and ribbed, somewhat like the scales on the wings of a butterfly or moth. The pale brown antennae are about half as long as the body, the joints are very distinct, like a string of beads, each one being oval-cylindrical. There are seventeen joints, the two basal ones being large, nearly globular, flattened lengthwise, and nearly half as long as thick, and each of nearly equal size; joints 3-5 are longer than the remaining ones, and are slightly contracted in the middle; the remaining 6-17 gradually decrease in length, each joint being provided with about ten hairs, arranged in a rude whorl; the terminal joint (Plate II, *A*, *a'*) is long and conical. The legs are of the same color as the under side of the body, being a little paler than the back. The abdomen is rather full, with nine well-marked rings or segments, the

paler small ovipositor forming the tenth. The latter is one-half as thick as the ninth segment, and about two-thirds or quite as long; is slightly sinuous, and a little smaller at the end than at the base. The wings are dusky, with a fine fringe around the edge, and there are three veins. The subcostal vein ends near the outer third of the wing; the median vein arises from near the base of the submedian vein and runs nearly parallel to the subcostal vein, while a branch (its base disconnected with the main vein) extends along the middle of the wing; the submedian vein is well developed, at the base throwing off the median vein at a little distance from the base of the wing, and losing itself before turning down to the edge of the wing. The length of the fly is $2\frac{1}{2}$ millimeters, or about one line, *i. e.*, $\frac{1}{10}$ of an inch.

The male.—The male is rather smaller than the female, being distinguished by the long slender abdomen, and the longer and more hairy antennae. The joints of the latter (Fig. A, *a''*, *a'''*) are twenty in number, oval, the terminal one conical, and all provided with a few hairs, much longer than in the female, and arranged in a decidedly verticillate manner. “The abdomen in the living specimen is black or brownish black, with bands at the sutures both above and beneath, of a brick red, tawny yellow, or grayish color, varying in their width as this part of the body is more or less distended.” (Fitch.) The claspers at the end of the body are stout, much more so than in *Cecidomyia leguminicola* of the clover.

The egg (Plate I, *a*, enlarged) is very minute, about a fiftieth of an inch long, cylindrical, pointed at each end, the shell shining and transparent, the egg being of a pale red color.

The larva.—After remaining about four days in the egg state, the larva or maggot of the Hessian Fly hatches, and is of the form represented by Plate I, Fig. *b*, and Plate II, Fig. B, *Ba*, *Bb*, *Bc*.

The body is soft, smooth, shining, oval cylindrical, beneath a little flattened, and consists of twelve segments besides the head, the latter soft, fleshy, and but slightly separated from the body, with very rudimentary mouth-parts (jaws, &c.). The rings or segments are moderately convex and tolerably distinct from one another; the sutures between the segments in the living larva being indicated by faint transverse lines of a greenish brown hue, according to Fitch, who also states that the mature worm, freshly taken from the roots of the wheat, measures about 0.15 of an inch in length by 0.06 inch in width. Mr. Riley informs us that there are nine pairs of minute spiracles, which appear as yellowish rounded tubercles.

The puparium or flaxseed state (Plate I, Fig. *c*, Plate II, Fig. D).—When fully grown the larva is ready to transform into the third or pupa stage of its transformations. The body turns brown, and finally of a bright chestnut color, while the skin loses all appearance of sutures, and assumes a rude spindle-shaped form, somewhat larger than the larva. This brown case protects the growing pupa within the skin of the latter, finally separating from the cast larva skin, called the pupa-case or

puparium, and which serves as a sort of cocoon to protect the pale, soft-bodied pupa within. While many two-winged gall-flies are protected by the galls within which they live, others, like the larval wheat and clover seed midge and the pitch-pine midge, spin true cocoons of silk; and the Hessian Fly is the only species of the genus or family, so far as we know, which assumes this puparium state, being peculiar to the house fly and other species of Muscidae and allied families, in which the pupa is said to be *coarctate*, i. e., protected by the cast dried brown skin of the maggot or larva.

From the decided resemblance to a flaxseed the insect, when at this stage of its transformations, is said to be in the "flaxseed" state. It is, however, rather flatter than a flaxseed, being pinched, as it were, at the head end of the body. I have taken the semi-pupa or incompletely-formed pupa from the flaxseed December 1. In this flaxseed state the partly-formed pupa resides during the five winter months of the year.

In early spring, during warm weather in April, the semi-pupa rapidly transforms into the complete pupal or chrysalis state.

The pupa (Plate II, C).—As we have not personally observed the mode in which the fly issues from the pupa and its case, we extract the following account from Fitch. By the time the insect reaches the pupa state the flaxseed case has become quite brittle, breaking asunder transversely if rudely handled, one of its ends slipping off from the insect within, like a thimble from the end of the finger.

The time for its last transformation having arrived, the pupa, by writhing and bending its body, breaks open its puparium or flaxseed case, crawls from it, and works its way upward within the sheath of the leaf until it comes to some cleft in the now dead, brittle, and elastic straw. Through this cleft it crowds its body until all except the tip of the abdomen is protruded into the air, the elasticity of the straw causing it to close together upon the tip of the abdomen sufficiently to hold the pupa in this situation secure from falling to the ground; and, as if to preserve the body in a horizontal position, the feet are slightly separated from the abdomen and directed obliquely downwards, with their tips pressed against the side of the straw, thus curiously serving, like the brace to a beam or to the arm of a signpost, to support the body from inclining downwards. Thus securely fixed and now freely exposed to the drying influence of the atmosphere, the outer membrane of the pupa exhales its moisture, and, as it becomes dried, cracks apart upon the back or upper side of the thorax. Out of this opening the inclosed fly protrudes its head and thorax, more and more, as it gradually withdraws its several members—the antennae, wings and legs—from the sheaths in which they are respectively enveloped—a process analogous to that of withdrawing the hand and its several fingers from a tight glove—until at length, entirely freed from its pupa-skin, the fly, now perfect in all its parts, usually walks a few steps further up the straw, where it pauses for its body and members to acquire more firmness and strength by the further evaporation of their moisture, after which it is ready to spread its wings and mount into the air.

The Hessian Fly is easily distinguishable in all its stages from the wheat midge, which belongs to a different genus, *Diplosis* (*D. tritici* of Kirby). The wheat midge is orange-colored, has a stouter body, with clear, transparent, and much broader wings, and pale-yellow legs, while the larvae are orange-colored, and live crowded around the wheat-grains

at the top of the plant: they spin a silk round genuine cocoon, smaller than a mustard seed, which remains in the ground just beneath the surface. So it will be seen that the forms and habits of the two insects are very dissimilar, and that they need not be confounded.

HABITS OF THE HESSIAN FLY.

Having become acquainted with the appearance of this two-winged gall-fly in its different stages, we are now prepared to study its habits; for an intimate knowledge of how it comports itself as an egg, larva, "flaxseed," and perfect winged fly is absolutely essential to the farmer who would endeavor intelligently to combat this pest.

Number of broods.—The Hessian Fly is doublè brooded; the "flaxseeds" or puparia being found on the winter wheat from late in the autumn, through the winter, until the early part or middle of April. The "flaxseeds" of this brood, from one to about twenty in number, are situated between the stalk and sheathing base of the leaf, at the roots of the young grain, slightly beneath the surface of the ground.

The "flaxseeds" of the second generation affect the wheat in the late spring and summer; but are situated higher up, an inch or two above the surface of the ground, at the lower joints of the straw.

In the ordinary course of nature, therefore [says Fitch], our crops of winter wheat are liable to two attacks of the Hessian Fly, one generation reared at its roots producing another, which occupies the lower joints of the stocks. Thus the larvæ and pupæ are present in it almost continually from the time the tender young blades appear above the ground in autumn till the grain ripens and is harvested the next summer. Our spring wheat, on the other hand, can rear but one brood of these insects; they consequently resort to it but little, if at all. Nor can the Hessian Fly sustain itself except in districts where winter wheat is cultivated in which for it to nestle during the autumn and winter.

As a general rule, then, there are two broods of the fly, the first laying their eggs late in April and in May, and the second brood of flies ovipositing* in August, during September, and perhaps a few early in October. Sometimes the flies appear earlier, as Professor Cook, who observed the insect in Michigan, says that "in July and August the flies again issue forth, and the cycle of changes for the year is complete. Thus we see that the flies are ready for work in the fall, much before the wheat is ready for them, and may attack a volunteer crop long before the usual crop is above ground or even sown."

A third brood may sometimes appear, as shown by Mr. B. Hulick, of Michigan. According to Professor Cook, Mr. Hulick found the empty "flaxseeds" on volunteer wheat in September. On Professor Cook's expressing some doubt whether the fly had issued, suggesting that it might be the parasite that had eaten the fly and come forth, as the time appeared to

* Mr. F. S. Sleeper writes us that he has on one occasion seen the Hessian flies laying their eggs as late as October 26. In February, 1878, during very mild weather, he observed them laying their eggs in February. See his statements farther on.

him too short, Mr. Hulick at once planted some of the volunteer wheat, still containing the "flaxseed," in close jars, and—

Saw many of the flies issue; and, more, had eggs laid by these flies on the same wheat in October. Mr. Hulick showed these flies and their eggs to several of his neighbors. In this case the eggs were deposited in July, the flaxseed state assumed in September, from which came a third brood of flies in October. This is certainly a very important matter, as it shows that three broods are possible under favorable conditions. That while the fall flies may, generally must, wait till September to deposit eggs, they only want opportunity to breed their mischief much earlier, even in July or August, and thus propagate a late brood of flies which will be in readiness for even the latest sown wheat. No doubt, too, as in the case of all insects, varying degrees of heat or cold will accelerate or retard the various transformations. (Lecture, &c., p. 9.)

Mode of egg laying (see Plate I, *e*, the fly of its natural size engaged in laying its eggs on the leaf of wheat). The mode of oviposition has thus been described by Mr. Herrick:

The eggs are laid in the long creases or furrows of the upper surface of the leaves (*i. e.*, the blade or strap-shaped part) of the young wheat plant. While depositing her eggs the insect stands with her head towards the point or extremity of the leaf, and at various distances between the point and where the leaf joins and surrounds the stalk. The number found on a single leaf varies from a single egg up to thirty, or even more.

Professor Cook says that—

The fly very rarely lays more than three eggs at one time without change of position. She more frequently lays two, and generally but one. In case she lays but one it takes less than a quarter of a minute, and less than a half a minute to lay three, when they are all laid without a change of position on the part of the fly. After laying she seems to draw in her ovipositor soon to extend it again, at the same time crowding into it the one, two, or three eggs that are next to be laid. She then flies to another leaf, alighting usually, not always, with head towards the end of the leaf. She then appears to wipe the eggs off the jointed ovipositor. She really crowds the egg till the end touches the leaf, when by friction of the leaf and adhesion of the egg the latter is held fast while the egg-tube is withdrawn. If the second and third are to be laid she repeats the operation, after which she retracts her ovipositor, restocks it, and in a trice is depositing the fatal germs on another leaf. I say usually on the upper surface, for occasionally eggs are laid on the stalk, and sometimes on the under side of a leaf. I have observed that the fly often makes many unsuccessful efforts to cause the egg to adhere on the outer face of the leaf before she succeeds. I have seen a fly work thus for two minutes before success crowned her efforts. The fly may thus learn by experience that it is easier to deposit on the inner or upper face of the blade, and so generally choose that surface. We shall see, too, in the sequel that it is better for the prospective maggot that the egg be placed on the upper surface. In four to ten days, more or less, as the weather is cool or warm, the eggs hatch. (Lecture, p. 7.)

Mr. C. V. Riley describes as follows the process in the New York *Tribune*:

I have very carefully studied the oviposition of the Hessian Fly, closely observing the female in the act on several occasions; and as accurate observations on this point are not easily made, I herewith transcribe my notes of several years ago:

Eggs deposited in irregular rows in the longitudinal cavities and depressions of wheat stalks between the stalk and sheath when this is loose, or on the leaves between

the natural ridge or carinae of the upper surface, this last being the more common habit. Ordinarily there are from five to ten in a row, but sometimes more. Each egg .02 inch long, cylindrical, rounded at each end, soft, translucent, and pale orange red in color. Before hatching, the pale sides of the inclosed larva show through the shell. Larva hatched in four days; crawls down leaf to base of sheath, which on young grain is at crown of root. The orange-red color is soon lost, and the larva becomes pale, translucent, and plump, sinking more or less into the stalk by the depleting process kept up.

In an article in a Saint Louis paper I described, last June, the process of oviposition on the leaves, and my own observations in Missouri accord entirely with those of E. Tilghman recorded in 1820, and of E. C. Herrick in 1844, and quoted by Fitch in his essay on the Hessian Fly (Albany, 1846), with the exception that they do not mention the exceptional habit of pushing the eggs between the sheath and the stalk, owing doubtless to the fact that their observations were made solely on the autumn brood of flies ovipositing on the young plants, the habit being more common in the early summer brood when the plants are larger.

Mr. William Strong, of Kalamazoo County, Michigan, thus describes the process, adding some particulars of interest:

I have seen the wheat plant with many of the maggots at work before there was any stalk for the fly to lay its eggs on, by introducing its extensile abdominal tip under the leaf sheath. Even this fall I have seen this very thing when there was as yet but one shoot from the kernel having but three leaves, the wheat having been sowed not more than three weeks. I have seen these maggots when too small to be seen without the aid of a glass, so low down toward the kernel, which was sowed with a drill, that if the fly had deposited the eggs under the leaf on the stalk, if there had been one there, she would have been obliged to use a spade to dig to get a chance. I am not the only one who believes that the egg is laid on the leaf and hatches there, when the small maggot works its way down inside of the leaf as low as possible. If there should be fifteen or twenty on one leaf (not a large number to find the past year under one leaf), of course as they took their places they would be somewhat in rows, but they, of course, are not the "eggs placed in the longitudinal grooves of the stalk."

In Solon Robinson's "Facts for Farmers," page 214, we read: "The female deposits her eggs soon after the wheat begins to grow, * * * in the cavities between the little ridges of the blades. In from four to fifteen days the eggs hatch and the diminutive maggots work down into the leaf sheath and there spend the winter." In the Kalamazoo Telegraph for November 7, this year, are a few lines upon the Hessian Fly by M. B. Batcham, of Ohio. He is too well known to need an introduction at this time. He says: "In the spring, with the first warm weather, the fly will come forth and deposit its eggs upon the leaf, which will then soon hatch, when the worms, crawling down the leaf, feed upon the stalk, injuring its growth, often causing it to die." A reason given by some why the fly does not injure red wheat as much as white is because the leaf of the red grows so long and slants down from the shoot so that when the egg hatches the maggot works down the wrong way, falls to the ground, and so many fail to harm the wheat.

A writer in the Country Gentleman, Mr. Caleb S. Fuller, of Jackson County, Michigan, says:

The fly commences as soon as the wheat is up an inch high. I placed in a glass fruit jar some stools of wheat which was sown on the 31st of August, and about the 15th of October the fly hatched out of the brown eggs [puparia] which were in the wheat in large numbers, and was a lively little black fellow about one-eighth of an inch long. Now, if the eggs were deposited about the 8th of September, as that is as soon as the wheat would be large enough for them, it would give them about 37 days to mature so as to fly again, though they might hatch a little sooner or later in the open field. I cannot say as to that; have no certain means of knowing.

The flies of the second brood are, in Southern Michigan, ready to deposit their eggs late in April or early in May "on spring wheat or barley which is sufficiently advanced, in lieu of which they deposit on the wheat again, not on the basal or radical leaves, but on the leaves which will be above the first or second, rarely the third, joints." (Cook.)

Habits of the larva.—As soon as the footless larva or maggot hatches, it makes its way down the leaf to the base of the sheath, which, in the young winter wheat, is at the crown of the root.

Here [says Herrick] it fastens, lengthwise, and head downwards, to the tender stalk, and lives upon the sap. It does not gnaw the stalk, nor does it enter the central cavity thereof; but, as the larva increases in size, it gradually becomes imbedded in the substance of the stalk. After taking its station, the larva moves no more, gradually loses its reddish color and wrinkled appearance, becomes plump and torpid, is at first semi-transparent, and then more and more clouded with intestinal white spots; and when near maturity, the middle of the intestinal parts is of a greenish color. In five or six weeks (varying with the season) the larva begins to turn brown, and soon becomes of a bright chestnut color, bearing some resemblance to a flaxseed.

EFFECT OF THE WORM OR LARVA ON THE WHEAT.

As has been stated, the worm in autumn lies at the sheathing base of the leaves just above the roots, at or near the surface of the soil. It is easy to detect the flaxseed from its large size and chestnut-brown color, by separating the leaf from the stalk of the young wheat in October and November, when the worm has stopped feeding and is incased in its brown sack. Scattered shoots will be found, withered and changed to a light yellow color, and, as Fitch observes, strongly contrasting with the rich green of the vigorous uninjured plants. (See Plate I, representing a healthy stalk on the right and a dwarfed plant on the left, containing three flaxseeds, with the leaves partly withered.) The worms, before assuming the flaxseed state, rest between the leaves and the stalk; their soft fleshy undeveloped mouth-parts do not enable them to gnaw the surface of the plant, but the sap is supposed to be absorbed directly through the walls of the body, and thus they are said to feed by imbibition; this weakens the plant and causes it to become unhealthy and turn yellow and die; moreover, although this point is disputed by Dr. Fitch, the presence of the worms causes the formation of a gall-like swelling or enlargement of the stalk, an abnormal growth of the plant being caused by the slight interruption to the flow of the sap. Of course when six or a dozen of these comparatively large flaxseeds are lodged under the base of the leaves the plant turns yellow and dies, as if the roots had been affected.

How a field of winter wheat may be attacked and affected by the Hessian Fly may be seen by reading the following account in the *Cultivator and Country Gentleman*:

Last fall the appearance of the wheat plant on different fields and locations was very different. On strong and level lands, little injury was shown. Hilly fields, or where there was a ridge or worn point, or where the rock cropped nearer the surface,

the wheat appeared injured or dead, as also when sown after spring grain, particularly oats. That the fly either enters the ground or remains in the dry stubble till the size of the wheat affords a lodgment, appears true. As an instance, I note the following facts: An acre of potato ground of 1876 was sown to oats in 1877. It was in fair condition, and a heavy crop was secured. Surrounding this piece of oats on three sides was a meadow, the highway bordering the other side. A good crop of hay was taken in June, and the field was all plowed in July. The after cultivation was the same, putting the field in an excellent condition for the crop. Seeding was through early in September, and in a few days the whole field was nearly covered with the growing wheat, and was very much admired, both for its beautiful green and its superior culture. All at once the wheat on the oat stubble was turning very yellow, in strong contrast to the deep green on the surrounding meadow. In the hollows, on the accumulated wash of ages, the wheat was very large and kept green and growing; while on the sharp points of knolls and hard clay ridges, it was nearly gone. On a piece of new land near by, where never a kernel of grain was grown before, no fly or injury could be seen.

The appearance of the fly was general, as soon as one or two leaves gave them a lodgment. Owing to the superior warmth and moisture of the entire fall months, wheat sowed on strong land tillered largely. The insects took the first tiller and stuck to it, while two and even four others came out and covered the ground. On poorer parts of the field the plant could not tiller so much, and here the injury showed most. Up to this date the crop has wintered well, a deep layer of snow now keeps insects and wheat alike. About the 1st of May this entire brood will be ready to deposit their eggs, and they will number millions.

That a field of wheat may recuperate after a favorable winter, and how such a field looks early in the following June, is well brought out by the following extract from the *Prairie Farmer*:

The early sown wheat that was badly eaten by the Hessian Fly last fall, but which has been apparently entirely recuperated by the remarkably favorable winter and spring just passed, is more seriously damaged by the insect than many farmers are probably aware of. I visited to-day a thirty-acre field, sowed on the 5th, 6th, and 7th days of September. Early in October it looked very badly—was yellow and showed bare ground in many places, and the plants for a long time seemed to be dwindling and growing smaller. The fine spring, however, brought it out apparently all right. It now stands five feet four to six inches high, very well headed, and seemingly good for from thirty to thirty-five bushels to the acre. I examined the field carefully in ten places, taking twenty wheat stalks as they stood in the drill row at each place, with this result: Number of stalks examined, 200; number of stalks containing the fly, 134, or two-thirds of the whole. Many of the stalks, however, had only one larva, and these will probably not be much affected. The insects are all of full size, of a chestnut color, and plainly visible in the lowest joint and the one next above—about twice as many were found in the lower joint as in the upper one. This, I suppose, indicates a loss to the crop of from 30 to 50 per cent.

We had heavy rains on the 8th, 9th, and 10th of September, I think, which suspended the operation of seeding till the 12th or after. This seems to be the dividing line, separating the fields badly damaged from those that escaped with little injury. In a part of the same field (potato ground) sowed, near the last of September, with the same kind of wheat, the number of plants examined was 100; affected with fly, 12. In other fields the rate was four to six to the hundred.

Many fields of Mediterranean are lodging. The Clawson stands well, and by reason of its stiff straw and vigorous growth promises to withstand the ravages of the fly better than the more feebly-growing and weaker-strawed sorts.

ARVINE C. WALES.

Another extract from the *Cultivator and Country Gentleman* bears directly on this important point.

There is a dispute among good farmers whether wheat injured by the Hessian Fly is irreparably damaged. Mr. F. C. Root thinks it is, as he says when the central stalk is eaten out the plant is either dead, or able to make only a feeble growth. If it makes a head, it will perfect only one or two seeds to a plant. Mr. Jesse Dewey qualifies this statement thus: *If the land is rich enough*, though the central stalk be injured, the wheat plant will stool, and from its side roots send up stalks and perfect a fair crop. I have no doubt that both of these excellent farmers are right. On the great majority of fields, the injury to the wheat plant in the fall means the destruction of the crop. When the central plant has been injured, the side shoots have not enough vitality to perfect much seed. Yet there may be land rich enough to make a crop from the second growth, provided the Hessian Fly next spring is not numerous enough to do serious damage. Very much now depends on the character of the coming winter. A season which, under ordinary circumstances, would be favorable, may also save myriads of Hessian Flies. There was much more "crinkled" wheat last summer than usual, and I have little doubt that the cause is to be found in the heavy mantle of snow, which preserved a greater number than usual of the Hessian Flies through the winter. The wheat crop this fall would have suffered more than usual in any event, but the evil has been greatly aggravated by the warm and generally dry weather after wheat-sowing. We had no killing frost until near November, nor frost of any kind until the middle of October. With frosts in their usual season, and not sowing too late, there need be little danger from the Hessian Fly. But it is the poorness of the soil which leads farmers, year by year, to sow their wheat earlier in order to get a larger growth. Making the soil richer removes the difficulty by removing its original and principal cause.—W. J. F., Monroe County, N. Y.

INFLUENCE OF THE WEATHER AND FAVORABLE AND UNFAVORABLE SEASONS.

To properly discuss this very important subject would require an intimate knowledge of the meteorological conditions and the relative abundance or rarity of the Hessian Fly during each year since its first appearance in this country in 1776. All that we can say with our present exceedingly imperfect knowledge bears but slightly on this point and must be considered as simply provisional. We may here quote from the *Cultivator and Country Gentleman* what has been stated by Mr. Riley in speaking of the condition of the Hessian Fly in 1877:

The Hessian Fly is rather an insect of moist climates and mild latitudes: and therefore, unlike the chinch bug, its multiplication has been favored by the cool and wet summers and autumns of the last three years. While the rainy period which as a general statement may be said to have commenced in May, 1875, and continued to the present date, and during which time there have neither been severe droughts, nor continued summer heats, the chinch-bug has so nearly disappeared that its depredations have been scarcely noticed, the Hessian Fly has developed and thrived, and to the extent that if the weather favors—that is, if from now to harvest it should continue cool and moist or warm and wet—the damage likely to be done to the incoming and the following crop can scarcely be estimated. But if dry weather prevails from this time to harvest, the damage done can hardly be considerable—and if it should turn very dry and hot, all danger from serious depredations from him may be cast out of the account, in measuring the outcome of the crop—since a certain amount of moisture is absolutely necessary for the successful development of the several stages in the growth and progress of this insect scourge. But then Professor Riley warned

me against drawing final conclusions on insufficient data, it being quite possible that other forces and causes appearing might bring about a quite different and unexpected result. Nevertheless, there are many reasons for expecting a dry spring, a warm harvest, and a hot summer, and comparatively trifling damage to be done by the fly on the wheat harvest of 1878.—W. J. F.

That this fly flourishes best in a rather warm and moist season, is shown by its habits. The flies hover in the spring and autumn over the wheat-fields in countless numbers, especially at morning and evening, avoiding the direct heat of the sun.

PARASITES OF THE HESSIAN FLY.

How useful, nay indispensable, parasitic insects may prove in keeping the noxious ones within due limits is well illustrated by the case of this fly, for whenever it suddenly disappears from a given locality, this is usually due to the attacks of its parasites, and especially one Chalcid fly, the *Semiotellus destructor*, first described by Say.

This is a hymenopterous insect, having four wings and belonging to the same order of insects as the saw-flies, four-winged gall-flies (*Cynips*), the larger ichneumons, and the wasps and bees. It is a member of the family *Chalcidæ*. As stated in our *Guide to the Study of Insects*, this is a group of great extent, the species being of small size; they are often of shiny colors, as the name of the principal genus implies, being either bronze or metallic. They also have elbowed antennæ with from six to fourteen joints, and the wings are often deficient in veins. The abdomen is usually smaller, and composed of seven rings in the male, and of six in the female, the latter often having a short but visible ovipositor, a horny tube consisting of three pairs of stout bristles closely united and forming a quite solid tube. Some species are wingless. There are 1,200 species of the family known in Europe, and there are, in all probability, at least 1,000 in the United States. Few of them are over a line in length.

Semiotellus destructor, male. (Plate I. Fig. *i* much enlarged.) The head is transversely oblong, or rather cubical, being rather wider than long, and slightly broader than the thorax when seen from above, being full, somewhat rounded in front, and hollowed out behind next to the thorax. The eyes are dull red, reaching, when seen above, behind the middle of the head. The antennæ are elbowed, and when bent back reach to about the middle of the thorax; they are yellow on the basal half, black beyond. For a further account of the antennæ we quote as follows from Fitch, our specimens being defective in this respect:

In the male they are of uniform thickness through their entire length. Viewed with a common magnifier they appear ten-jointed, though the last joints are usually so compacted that in the dried specimen the full number cannot be distinctly discerned. When highly magnified two small additional transverse joints may usually be discerned, more or less distinctly, between the second and the third joints, of which the first is rather smaller than the second. The joints are slightly longer than thick, and rather narrower towards their bases. The second joint is longer than the others, its length being about double its thickness. The last joint is more than twice as long as

thick, its apex appearing to be cut off transversely, with a minute teat-like process protruded therefrom.

The thorax is about twice as long as broad, and widest at the insertion of the fore-wings; like the head, the crust is coarsely punctured. The fore-wings are broad, triangular, well rounded externally; the subcostal vein is very thick, being strongly marked, and after joining the costal or front edge of the wing for a short distance, just beyond the middle of the wing, is bent in towards the middle of the wing, ending in a knob-like expansion with a slight point extending towards the costal edge of the wing. Fitch represents a slightly marked vein extending to the outer edge of the wing, but this is absent in some specimens. There is an incomplete median and submedian vein, only perceptible under strong magnifying powers, the base of the median being quite disconnected from the submedian. In one of my specimens there was no vein extending from the subcostal knob to the end of the wing.

The legs are pale straw-yellow, the fore shank-joints (tibiæ) and toe-joints (tarsi) brownish; the third hip-joints (femora) are dusky on the basal half, while the hind terminal tarsal joints are brown. The abdomen is small, black, while the head and thorax are bright metallic green, sometimes blue. The abdomen is also smooth and polished, much flattened, oval, not so wide as the thorax, broad at the end and suddenly pointed (mucronate) at the tip. It has a large yellowish patch on the upper and under side of the second segment. Length of the body $2-2\frac{2}{3}$ millimeters (.08-.11 inch).

The female differs in her greater size and rather slenderer body, and the more club-shaped antenna, the terminal joint being twice as long as thick. The abdomen is as long and as wide as the thorax, ending in a long sharp point, the short but distinct ovipositor extending slightly beyond the tip of the body. There is a slightly marked pale spot above on the second segment. Length $2\frac{2}{3}-3$ millimeters (.10-.12 inch).

This parasite was first described by Say, his specimens occurring at or near Philadelphia; it was observed by Herrick in 1833, in Connecticut, and in 1877 we bred it from puparia of the Hessian Fly received from Ohio; and, as stated by Professor Cook, it is sufficiently abundant in Michigan to destroy the Hessian Fly in great numbers, and is probably distributed throughout the Hessian Fly area.

So destructive is this and other parasites to the Hessian Fly that as early as 1841 Herrick claimed that in Connecticut "a very large proportion, probably *more than nine-tenths*, of every generation of the Hessian Fly is destroyed by parasites." This work is mainly, we doubt not, done by the chalcid parasite under consideration. It is to this insect more than to any other means in nature that we owe the general immunity in certain years from the attacks of the Hessian Fly in most wheat regions, and to this cause that during certain years the fly is kept wholly within bounds. Few people, even naturalists, have any adequate idea of the good done by these minute parasites. What was the fact in Connecticut,

in 1841, and the few years preceding, has been the case in Michigan, according to Mr. F. S. Sleeper, of Galesburg, Mich., who writes us that the Hessian Fly was nearly exterminated in Kalamazoo County by *Semiotellus destructor*, nearly all the "flaxseeds" in the crop of 1877 having been destroyed by this friendly parasite. He writes us that in the autumn of 1877 he found these parasites in the wheat-fields in countless numbers, and that the perfect Hessian Fly was difficult to find.

No one since Herrick recorded his observations has made very careful observations on the habits of these parasites. He states that:

It pierces the sheath of the stalk (making a hole too small to be detected by a powerful microscope), and deposits an egg in the pupa within. This is done chiefly in June. The perfect insect is evolved in the summer and autumn succeeding, eating its way through the puparium and the sheath of the leaf.

Herrick also states that a second parasite, very similar to the *Semiotellus destructor*, "but with mere rudiments of wings, is sometimes evolved from the pupæ of the Hessian Fly. I am in doubt whether it should be considered a distinct species or only a variety."

A third parasite was reared by Herrick in Connecticut. It is an insect of the tribe *Chalcidie*, whose genus he did not determine. Its habits were like those of *Semiotellus*, and wingless females of this species were also found.

A fourth parasite, noticed by Herrick, belongs to Latreille's tribe *Oxyuri*, but the genus was not determined. In habits it agreed with the foregoing parasites, but it was evolved later in the year. Herrick adds that all the parasites mentioned "are likewise evolved in the spring from the Hessian Fly pupæ of the summer previous."

The fifth parasite has quite different habits. It lays its eggs in those of the Hessian Fly. Herrick, its first discoverer, thus speaks of it:

The insect is abundant in the autumn. I first saw it September 23, 1833, in the act of depositing its eggs in the eggs of the Hessian Fly. From subsequent observations it appears that four or five eggs are laid in a single egg of the Hessian Fly. The latter egg hatches, and the animal advances to the pupa state as usual, but from the puparium no Hessian Fly ever comes forth. This parasite forms within the puparium a silky cocoon of a brownish color.

It is probable that it is the species first discovered by Herrick in Connecticut which Professor Cook has detected ovipositing in the eggs of the Hessian Fly.

It is black and looks not unlike a tiny gnat. The female feels for the egg with her antennæ, and when found intrudes the fatal egg, which, I find, takes three-fourths of a minute; full three times as long as it takes the Hessian Fly. The little parasite is much longer, too, in finding the eggs than is the fly in laying them. I find that each egg receives one, two, or three of the parasite's eggs. The eggs of these latter are tardy in hatching, so that the larva of the parasite may feed on the maggot of the Hessian Fly, not her eggs. These pupate in the puparium of the fly."

Platygaster error Fitch?—Having received one of these egg-parasites from Professor Cook, I find it to be so much like the *Platygaster error* of Fitch (Fig. 1) that I refer it to that species, though with a doubt. This is probably also the parasite referred to by Mr. Herrick.

It is shining black; the head is finely punctured, rounded, and slightly broader than long, being about as wide as the thorax. The antennae are about as long as the head and thorax; they are slender, but apparently a little stouter than in *P. error*, the penultimate joints being a little broader and squarer than he represents (and they are very different from *Platygaster tipulae*), these joints not being "twice as long as thick," but only $\frac{1}{4}$ to $\frac{1}{3}$ longer, much as represented by Fitch in his figure;* the terminal joint is long, oval, not so wide as those just behind it, and it tapers to a



FIG. 1.—Egg-parasite of the Hessian Fly.

rounded point. The thorax is rounded ovate, but little longer than broad, black, with the scutellum high, rounded and pitted. The abdomen is flattened, oval, twice as long as wide, being a little longer than the thorax, but not quite so wide. The legs are pitchy black on the femora; the tibiae dull reddish brown, darker towards the end; the tarsi are 5-jointed, dark brown, hairy, with the basal joint reddish at the base. (Fitch says the legs of *P. error* are pitchy black; but in the specimen before me they have a decided reddish tinge.) The wings are veinless, clear transparent, irised. Length $1\frac{1}{3}$ millimeters, being a little larger than Fitch's *P. error*, which was .05 inch long. I am disposed to refer this specimen to Fitch's species, but should it be found to be quite distinct, it may receive the name *Platygaster herrickii*. It seems to be a genuine *Platygaster*.

Fitch states that *Platygaster error* is seen in company with the wheat midge (*Diplosis tritici*) on the wheat ears in New York, and is very numerous some years, but he thinks it doubtful whether it preys upon the midge.

REMEDIES, PREVENTIVE AND GENERAL.

Having become familiar with the habits of this insect, which can be readily observed by farmers, it is not difficult to apply such remedies as the experience of wheat raisers of the past century in different parts of the wheat region of the United States has nearly universally found serviceable. Remembering that the first brood of flies appear in August and continue to hover over the fields until late in September, as if waiting for the fall-sown wheat to appear, it is evident that by delaying the date of sowing until after a frost cold enough to kill the flies, they may be circumvented; for if the wheat is sown later than the 20th of September in nearly all the Middle and Northern States, the early frosts will destroy these delicate insects. Late sowing, then, is the most general, important, and easily applied preventive remedy.

Late sowing of most of the wheat-seed.—All writers, both entomological and agricultural, concur in recommending this easily-applied remedy;

* Sixth report on the noxious and other insects of the State of New York, by Asa Fitch, M. D. Pl. 1, fig. 4, a, b. The figure is from Packard's Guide to the Study of Insects.

that at least a part of the wheat should not be sown until after the 20th of September in the Northern States. The writings of Fitch, Harris, and of Cook concur in recommending this course in a district ridden by these pests, even though the wheat is in danger of being injured by the cold autumnal or the winter weather. As the year 1877 was a bad fly year, we quote the following explicit testimony from Professor Cook's pamphlet:

In all the century's experience in our country with this insect, this has been the most certain and satisfactory method to prevent its ravages. Even more than thirty years ago this measure is spoken of as unanimously sanctioned and the most efficient of remedies. During the past season [1877] I have reliable reports from the following counties: Ottawa, Van Buren, Cass, Kalamazoo, Hillsdale, Saint Joseph, and Lapeer, and with few exceptions it is stated that early-sown wheat was injured badly, while all sown after September 20 nearly escaped. In traveling through Ohio and Southern Michigan, I found I could often tell the early from the late-sown wheat for long distances, the former looking like oat-plants after a hard frost, the latter appearing green and healthy. Often in the same field the line of demarcation was very distinct

The following newspaper extracts bear upon this subject:

Perhaps the most effectual remedy, or rather preventive, is late sowing. No wheat should be sown in localities where they have already appeared, or in districts adjoining, until September 15, and if it is deferred until the 20th it would be all the better. Repeated rolling is said to destroy some of the larvæ, and burning the stubble, where practicable, would certainly destroy many and thus prevent so great devastation of the succeeding crop. The great objection to either rolling or burning is that it destroys both friend and foe alike.

Great care should always be used in destroying all noxious insects lest we also destroy the beneficial ones; the chief of which are the Ichneumon and Chalcid flies. In the counties of Yates, Seneca, Tompkins, and Cayuga, where the Hessian Flies have already made their appearance, it would appear wiser to fit the ground perfectly, apply extra fertilizers, and sow late, rather than run any risk or trust to any methods of destruction. If all infested and contiguous districts would sow late enough so that the wheat would not appear above ground before September 25, I believe the fly could be effectually starved out.—[I. P. Roberts, professor of agriculture, Cornell University, in the *Rural New Yorker*, September 8, 1877.

By the attacks of this (the second or spring) brood of worms, the lower joints of the wheat are weakened, and as soon as the head is formed, and the growth is heavy, the weakened joints give way and the wheat falls over, or, as it is commonly expressed, it "crinkles." If but few larvæ are at work, there will be some kernels of grain in the heads thus affected, but they will be more or less shrunk. If the insects are plenty, the head seldom "fills," and the field looks as if cattle or something else had passed through it, tangling up and throwing down the straw in every direction.

There are thus two generations of the Hessian Fly each year, one of which subsists and may be always found at the crown of the roots, and the other at some joint above, and never at the root. If the wheat could be fed off by sheep in the fall, between the time that the eggs are laid and the time of their hatching, this remedy would be perfect. Unfortunately, the wheat is then young, and farmers do not like to risk thus feeding it off. The only remedy left, therefore, is to sow so late that the wheat will not appear above ground before October 1. In this case there is the added risk of winter-killing, because the plants have not time enough to get well rooted before winter. On well-drained, rich land, this danger is greatly prevented, and therefore late sowing and thorough farming seem to be the only available means yet discovered to avoid great losses from the ravages of the Hessian Fly. Fortunately the parasitic enemies of the fly increase rapidly, and after a year or two of great losses from this insect its numbers are reduced so much as scarcely to be noticed for some years.—[*Chicago Tribune*.

I find in several counties of Northern Ohio, where I have traveled of late, a good deal of injury is done to the young wheat by the fly—more than has occurred before for quite a number of years. This is no doubt owing to the general practice of sowing wheat early, and the fact that it made a remarkably fine growth during September, when the warm weather was also very favorable for the propagation of the flies. The worms have now gone into the pupa or “flaxseed” state, and if the winter is not too wet or cold for them, it is likely the new brood next spring will prove quite mischievous.—[B., *Cultivator and Country Gentleman*.

Pennsylvania German farmers have a claim to be considered good zoologists by their knowledge of animals, from the noble horse down to the insect tribe, that so beset them with labor and loss. The German farmers have been apt and successful in contesting the insect enemies of all crops. The wheat midge, which came in upon us twenty years ago in vast numbers the last of June and the first of July, made his home in the wheat-heads, and nurtured his progeny in the cell prepared for the expectant berry, and appropriated the element nature designed for the perfection of the seed to his own use. This insect for a time literally destroyed the wheat product. Whether it was a scientific discovery that taught the farmers of Lancaster County how to get rid of this destructive insect or not, I have never learned. But I do know that I purchased and carried to my farm Lancaster red wheat which I was instructed to sow in August, and in doing so freed my farm of this pest. Continued early sowing proved successful up to the present season, when this practice brought the Hessian Fly, who begins at the root of the wheat plant. If the mother fly can get an opportunity to deposit its eggs in the fall season, the larva will stand the winter imbedded in a stalk of wheat (which is a well-tillered plant), and brings forth enough Hessian Fly to destroy the wheat before harvest time. The habit of this Hessian Fly is to bury in the ground with the first frost of the fall season. A Lancaster farmer said to me not long since, we must sow our wheat late this fall if we would avoid the fly. Early-sown wheat was a failure in Pennsylvania to an extent, in my estimation, that reduces this cereal 30 per cent. below our general average. The corn crop over the entire State is not an average one. The oat crop is above the average. The buckwheat crop, generally relied upon in the northern and western portions of our State as one of the paying bread grains, has been very extensively injured by the grasshopper, and cannot be expected to yield more than one-half the usual amount.—[V. E. Piollet's address before the Berks County Agricultural Society, at Reading.

The letter below from W. B. Billings to the Elmira (N. Y.) Farmer's Club, elicited the appended discussion, as reported in the *Husbandman* :

I have perused your club reports with much interest, especially those relating to the Hessian Fly. In an experience of fifteen years of wheat raising I have had about four acres of wheat destroyed by this pest. Eight years ago I sowed a field of ten acres to wheat, four acres of which were gravel, the remaining six acres being of sandy loam, in places so wet that I had to under-drain it. Wheat put in in good condition; land new—had been in cultivation only the two previous years. Now for the results: During the fall the wheat on the gravelly part started quicker, and when winter set in looked better, the fly doing no appreciable damage to any part of the field; but in the spring when the wheat had apparently reached about six inches in height, that on the gravel commenced turning yellow about the roots, and from that time forward grew thinner and most beautifully less until harvest, when I cut it with a mower and raked it with a wheel-rake, getting about as much straw as farmers generally get from raking a like amount of ordinary wheat stubble. On the remaining part of the field the wheat was good, no noticeable damage being done by the fly. A few years previous to this I knew of a field of spring wheat that was almost entirely destroyed by the Hessian Fly, less wheat being harvested than was sown. It is generally conceded that there are two crops, or hatchings, of the fly during the growth of the wheat; the first in the fall and working until frost comes; the second in the spring, and continuing its depredations until harvest. Late sowing is generally recommended as a preventive. Why should it be so? How do you account for the fly working in wheat

growing on warm gravelly land, while that on the moist soil escaped harm? If, as above assumed, there are two crops of insects hatched per year, how does late sowing prevent their depredations? And how can you account for the loss of the spring wheat crop mentioned? Where was the first or small crop hatched, and where did the flies remain until spring? Fresh lime is recommended as preventing the ravages of this pest; can you tell me at what particular time, spring or fall, the lime should be sown to cause the greatest destruction of the fly? Any information from the club on the subject will be thankfully received.

J. S. VAN DUZER. It must not be assumed that the flies which damaged the spring wheat were hatched in that field. The parent flies may have come from a distant field.

President HOFFMAN. To my mind the case is easily explained, so far as the spring wheat is concerned. The fly is migratory. We are told by those who have studied its habits that it flies over districts as much as twenty miles in breadth in the course of the year.

The writer furnishes the explanation of the greater damage done by the fly on his gravelly land. There the wheat came earlier, and was therefore in condition to receive the deposit of eggs, while the more backward wheat was not. It accords with the theory that late sowing is a measure of prevention against the ravages of the fly. I had last fall an illustration of the protection afforded by late sowing. On a small piece I wanted to sow wheat after wheat. Before plowing the stubble the volunteer crop had made a growth of perhaps six inches. In examining one of the plants I found twenty-five of the larvæ. In many others there were a dozen or more. I destroyed this growth by thorough cultivation, and, after proper fitting, sowed the seed. In the plants that came from that late sowing there were very few larvæ. They came too late to receive the eggs. It is well known that the fly deposits the eggs on the leaves of the wheat, and that its work ceases after some frosts come. The late sowing brings the growth too late for the fly. The fly which does the mischief in the spring is not hatched in the fall—or at least is not fully developed. It comes out in the spring, lays a new crop of eggs on the leaves of the growing plants, and the insects which hatch from these eggs are those which do the real injury to the wheat. If the time can be ascertained when the eggs are deposited on the leaves, then is the time to sow lime. I do not know that it will prevent the eggs from hatching. My observation of the work done by the fly has taught me one lesson. It is that no wheat should be sown except on rich land, where the plants will be strong and therefore able to resist the ravages of the insects.—[*Western Farmer's Journal*, March 20, 1878.]

It should, however, be borne in mind that late sowing exposes the wheat to the attacks of the wheat-midge (*Diplosis tritici*) and also to the rust, while also by late sowing the plants are less advanced and less fitted to withstand the rigors of the winter.

Early sowing as a remedy.—Still there are some who adhere to early sowing, as on the whole the best thing to do. We insert the following testimony in favor of this procedure:

In your paper of December 6, 1877, there are three or four articles respecting the Hessian Fly, and they are so different from my observation of the wheat insect, as we call it here, that I send you a few lines respecting the damage done to wheat here. The last harvest was very much injured in some localities in this State; in the west part of Calhoun County on sandy land some pieces were not harvested, and others yielded from five to ten bushels per acre. In this part of Jackson County wheat did not suffer so much; some fields on bur-oak soil yielded as high as 35 bushels per acre of the Clawson variety.

The fly commences as soon as the wheat is up an inch high. I placed in a glass fruit jar some stools of wheat which were sown on the 31st of August, and about the 15th of October the fly hatched out of the brown eggs which were in the wheat in large

numbers, and was a lively little black fellow about one-eighth of an inch long. Now, if the eggs were deposited about the eighth of September, as that is as soon as the wheat would be large enough for them, it would give them about 37 days to mature so as to fly again, though they might hatch a little sooner or later in the open field. I cannot say as to that, having no certain means of knowing. Now if we wait till the first of October to seed we will be just in time for the first brood that comes out in the fall to deposit their eggs in the late sowing, which was the case hereabouts. Fields sown on the 25th of September, 1876, suffered more than that sowed on the 25th of August the same year, not three miles apart; the latter giving a good crop, and the former a very light one.

Now, my observation as well as practice is, that the earliest seeding is the best every time. There are a few farmers in the country who invariably sow early—say as early as the 25th of August—and they hardly ever fail of a good crop. There may be a difference in varieties in resisting the ravages of the fly, and I presume there is. The Tappahannock suffered very much more than the Clawson in adjoining fields, on the same farms, and sowed about the same time. I venture the suggestion that we all sow our wheat earlier—say on the 20th of August, or soon after—as farmers used to do 50 years ago, so that our wheat will get a strong root and a large top to go into the winter with. I hope this suggestion will stir up some scientific man, like Professor Riley of Missouri, to investigate the habits of the fly as thoroughly as he has the locust or the Colorado potato beetle, for I think the country has suffered quite as much from the Hessian Fly as from all other pests put together. If this brings out the desired information, I shall be well paid for this my first contribution to your valuable paper, which I have read with great pleasure for the last ten years.

CALEB T. FULLER.

JACKSON COUNTY, MICHIGAN.

In reply to your request for information in regard to the Hessian Fly, I will state that only a few of the earliest sown pieces are affected in this and the adjoining county of Trimble. Wheat in general looks remarkably well, has tillered finely, and there is at least 15 per cent. more than an average acreage sown.

S. E. HAMPTON.

CARROLL COUNTY, KENTUCKY.

[*Cultivator and Country Gentleman.*]

We may, then, conclude that, on the whole, late sowing is the best general remedy, but still a part of the wheat should be sown early as a decoy to draw off the flies and induce them to lay their eggs in the early-sown grain, that the later sown portion may escape their attacks, and then farmers should plough under and resow the fields of early grain. Hence we indorse the following excellent advice, which was first suggested by Dr. Fitch, and reiterated by Professor Cook, as follows:

Let all, without exception, sow a narrow strip about each field, to be sown early in September, or even in August. From the fact that the flies are already in waiting, that the outer edge of a field is almost always the most injured, except that the field grew wheat that nourished flies the preceding year, and that such fields suffer most, one may expect this early-sown narrow rim to receive nearly all the eggs. Leave the balance of the field till we feel it is dangerous to wait longer, at least till after the middle of September, then sow it, after which plow deeply under the early-sown strip, that is if it is stocked with insects, which may be easily determined by examination, and resow it. We should thus kill two birds with one stone—save our crops, and destroy the pest.

Advantage of high culture.—Many farmers advocate high culture, sowing a less breadth of wheat, and cultivating the ground, using fertilizers. This is all-important, as the stronger and more luxuriant the growth of

the young wheat, the better able will it be to withstand the weakening effects of the maggots; while high culture will carry a partly infested field of wheat through, when the same grain grown on a poorer soil would succumb. The value, then, of good farming, conducted on scientific principles, the forcing of the plant by fertilizers, and the rotation of crops, is so self-evident that we need devote no more space to this subject, except to add the following remarks by practical farmers:

It is claimed by some that certain varieties of wheat are less liable to the attacks of the Hessian Fly, and entire exemption has been claimed for some. I am satisfied from experience that these claims are partially fallacious. There is no wheat which the fly will not injure under favorable conditions for its working. The supposed exemption is due to the fact, that when a weak-growing and strong-growing variety are sown side by side, the fly leaves the latter for the former. Whatever makes the wheat plant vigorous, helps to repel the attacks of all insect enemies. If the red sorts are less liable to injury, it is because their thicker and ranker leaves keep the plant too moist for the eggs and larvæ. I have seen the same result from the use of superphosphate, gypsum, salt, and in fact any manure which causes vigorous growth, with dampness. Coarse manure sometimes seems to favor the insect, but only, I imagine, when the weather is so dry that its coarse strawy substance is really more dry than the ground. Wherever the soil is moist, and wheat makes a rapid growth, the fly will do least damage. I shall take advantage of this fact, this fall, in fertilizing my wheat more liberally than ever before, using two hundred, or perhaps more pounds, of phosphate per acre, besides gypsum and salt to dilute it. If I can get a vigorous growth of wheat from the start, there will be less to fear from the fly. This liberal manuring will also enable me to defer sowing till later than would otherwise be safe.

Rolling and compacting the ground is very important as a means of keeping it moist. I shall not roll immediately after sowing, but wait until the wheat is up, when, if there is a dry time with no frosts to keep back the fly, I shall roll the ground with the hope that the roller will destroy at least some of the eggs which the fly may have laid.

W. J. F.

MONROE COUNTY, NEW YORK.

[*Cultivator and Country Gentleman.*]

In the rapidly increasing practice of extra manuring and cultivation of wheat, as by drilling and hoeing, it is found in very many cases that the Hessian Fly and other insects are far less troublesome than on the wheat fields where only ordinary cultivation is practiced. It frequently occurs, too, that superior cultivation permits of earlier sowing in the fall; the extra growth more than offsetting the damage done by the insects, to avoid which most farmers now are obliged to resort to late planting. Several examples are cited where drilled and cultivated fields, grown beside ordinary broadcast-sown and lightly-manured fields, with results wholly in favor of the former, the Hessian Fly greatly damaging if not totally destroying the latter, while the cultivated fields escaped almost unharmed.—[*Cultivator and Country Gentleman.*]

Pasturing with sheep.—Many farmers practice pasturing wheat fields with sheep or cattle; for it is claimed that if the wheat is strong enough by the middle or end of November to bear it, enough of the larvæ or flaxseeds may thus be destroyed to save the wheat and prevent the necessity of plowing it in. This is a rather rude, uncertain remedy, but can be carried on with more or less success in the Middle States. We give the opinions of those who have found pasturing successful.

From Mr. E. A. Hickman, of Independence, Mo., we obtain the following information:

In reply to your inquiry on the subject of the Hessian Fly, I will state that I have made some inquiry of our best wheat-raisers, and they report as follows: First, the wheat-

midge is not found in our State, hence is not further alluded to. A. L. H. Crenshaw, now an old wheat-raiser and quite successful, says he breaks up his ground in July and lets it lie till September, then harrows it into good planting condition and lets it remain until after a *killing frost*, which is usually from the 25th September to the 5th of October, then he puts in the seed by drilling. He has never lost a crop or had one injured by the fly.

G. W. Compton is a successful raiser; he breaks up in July, and by the 1st of September sows his wheat immediately, and as soon as the wheat is up and of sufficient height he turns sheep and other stock on it to keep it eaten down so that the fly can not shelter under its leaves. This has protected his crop until the fall of 1877, when the rains favored the breaking up of the ground and the planting and growing of the wheat to such an extent that the stock could not graze it down. Its rankness protected the fly and its abundance nearly destroyed his crops. He attributes his failure to the fact that his crop was not grazed sufficiently close.

Mr. James Lobb sowed early in September, 1878, a fine growing season; brought up a luxuriant and vigorous stand; no pasturing was applied either in fall or spring, and the crop only yielded about four bushels per acre, the balance being destroyed by the fly. This was adjoining a field that produced a fine crop, but cultivated to thwart the fly.

Two other successful men say they have followed the advice of an old settler, who told them to have everything ready, but never sow until after a *killing frost*: and they never suffer from that enemy.

Mr. Robert McNeilly, of Charlotte, Dickson County, Tennessee, writes us that "the best preventive found here is to pasture the wheat close in the winter with sheep."

We also reprint the following newspaper articles:

Another error is that pasturing will do no good. If sheep enough are turned in to eat the wheat down close before the eggs hatch, after being laid, very much good will result. This is an old remedy, and has proved very effectual in many instances. It is now too late to employ it, as the eggs are mostly hatched. During the fine weather of this fall, so far, very few days only were required to hatch the eggs, after which nothing could be done. Very few eggs are placed too close to the ground to escape the teeth of sheep, and if enough of these animals could be turned on to eat the wheat off within three days after the flies appeared, very little damage would result. Frost now will not do much good except with fields that have been sown late, where the blades have not grown large enough to attract the fly. The destruction of the entire crop does not follow the appearance of the fly always. Unless very badly infested, if the soil is rich and the season favorable, a fair crop may result in spite of the fly. Of course, the crop is always injured to some extent. The best remedy, after the larvæ have hatched and found security in the crown of the plant, is to stimulate the ground as much as possible by the application of fertilizers.

We mentioned in last week's issue that the Hessian Fly appeared in Pennsylvania as well as in Canada and other sections last year. It appears that the practice of early sowing has lately increased so much in Pennsylvania as to furnish everywhere the young winter wheat at exactly the time when the Hessian Fly is laying its eggs. This probably has a good deal to do with the trouble in Canada also. And yet the evils of late sowing are so great that most farmers would prefer to risk the Hessians. A correspondent of the Germantown Telegraph, speaking from experience—for he says that he has never known his system to fail both to destroy the fly and to greatly benefit the crop—gives a useful hint. He says that if the land is strong, the eggs of the fly may all be destroyed and the crop greatly benefited in this manner: After frosts cease in the spring, and the grain is beginning to grow rapidly, and the ground has become so dry that tramping will not injure the crop, pasture off the grain down to the crown of the plants with sheep. This will remove all the eggs, and it will

cause the plants to tiller profusely, often five to seven to one, and all starting together will each enjoy equal facilities for growth and maturity, and the crop will be greatly improved and increased. If the soil lacks fertility, it is well to apply a proper amount of a proper fertilizer when the sheep are removed. If no salt has been applied to the land, no application will be more likely to pay so well as this, at the rate of twelve to twenty bushels per acre. This is well worth trying.—[*Canada Farmer*.

Sowing of hardy varieties of wheat.—When the stalks and leaves of certain varieties of wheat are tough and hard, the stems coarse and silicious, and the plants “tiller” or throw out secondary shoots in a vigorous way, such varieties are naturally the most fly-proof and should be selected for sowing as winter wheat, while the less hardy and vigorous kinds should be sown when the attacks of the Hessian Fly are not to be expected.

Of the different varieties of “fly-proof” wheat, the Underhill variety has for nearly a century been highly recommended. As Fitch remarks, its fly-proof qualities were supposed by many to be due to the hardness or solidity of its straw. The fly laid its eggs freely upon the leaves, but it was seldom if ever materially injured by it. It is a bearded white chaff, with a plump yellow berry, requiring to be thoroughly dried before grinding, and then producing flour in quantity and quality equal to the best of the other varieties.

The Mediterranean wheat is, in the Middle States, in high repute for its fly-proof and hardy nature, recovering better than other varieties from the attacks of the fly. A correspondent in Charlotte, Tenn., writes us that “the Mediterranean, Red Chaff, and Red May are less liable to be damaged by the fly than any we have tried.” Fitch says the Mediterranean wheat is a slight red chaff, having a long, stiff beard, a long, red, and very flinty berry, and ripens about ten days earlier than other varieties. In Central New York the Lancaster, a red variety, is strongly urged.

In Michigan the Clawson is apparently the favorite wheat, on account of its “fly-proof” qualities. As stated by Professor Cook—

The fact that last summer (1876), as well as this, when Diehl and Clawson were sown side by side, Clawson was comparatively free from insects, and, as stated by Mr. Rowe, did not break down in summer, seems to show that it is more exempt from attack. It would seem that the insects have a preference, but will accept plain fare rather than starve or fail to produce. It also seems clear that Clawson, Lancaster, and the red varieties will stand attacks with far less damage, owing to their vigor and greater tendency to sprout.

He then gives the following advice :

If wheat must be sown early, so long as the Hessian Fly remains a pest, by all means sow Fultz or other varieties of red wheat, or, better still, Clawson. But if we act more wisely still, and set the trap of an early-sown strip, let this be sown to Diehl, the better to attract the flies, and then, when we sow the balance of our field, two or three weeks later, sow Clawson or other rapid, vigorous growing varieties, which not only resist attacks better, but survive better when attacked. Lastly, if the early-sown area is harboring the pests, convert it into an insect cemetery, using the insects to fertilize a still further crop of Clawson.

Mr. W. L. Devereux, of Clyde, N. Y., gives us his experience with the fly and the best varieties to sow :

Now, concerning the fly: It is the least to be feared of all the injurious insects of the United States. I am situated in or just north of the starting point of the *Cecidomyia destructor* in this last crusade on wheat, which is Seneca and Tompkins Counties, New York, between Cayuga and Seneca Lakes. This section is also where the *Clawson* wheat originated, and I hold that the *Clawson* has been the propagator of the fly in this last spread. Perhaps the *Soules* helped the spread prior to this.

To my knowledge, there isn't a single instance of a field of *Lancaster* being injured by the larvæ of the fly. Indeed, I never could find a single larva or pupa in a field of *Lancaster*. It is the kind which farmers have sown almost entirely throughout this section this year. It does well, and, although a red wheat, it now commands as high if not higher price than *Clawson*.

I would particularly impress upon you the fact that we think the fly cannot be found on *Lancaster* wheat. It is a variety which is extremely tough and hardy, having that green color which farmers call "black," while the *Clawson* and similar wheats have a green color which is very often yellow. The *Lancaster*—to strongly indicate its toughness—is said to grow readily under water or on a rock. I have no personal motives in writing thus of the *Lancaster* wheat; I only want to indicate that it is too tough fiber for the *Hessian Fly* to live on. It is nearly like or is the *Blue-stem wheat*.

Professor Cook ranks the *Clawson* as being less injured by the fly than the *Lancaster*, but I think the latter is absolutely free from the fly, while the *Clawson* is literally eaten up alive by the fly.

Mr. Devereaux afterwards wrote as follows, under date of October 29, 1879:

The *Hessian Fly* has not destroyed wheat to any great extent this year. However, all white wheat suffered from the attacks of the fly, but still not to the extent it did last year. Red wheat has never been attacked (*vide* my article in *Rural New Yorker*, June 15, 1878). The principal bearded red wheat sown in this locality is called the *Lancaster*. An amber wheat called *Fultz* (a bald wheat) seems to be proof against the fly. *Mold's* red wheat (bald) is also not attacked. But the *Clawson* (white), so extensively sown here and elsewhere, was most severely attacked in 1877, very badly in 1878, and this year it was thought to be free from the fly, but when harvest came it was noticeably short, many heads unfilled, many stunted in their height. At this date of writing every piece of *Clawson* sown this fall is being ravaged (however, there are only a few pieces of *Clawson* for miles around here), the *Lancaster*, as heretofore, remaining uninjured.

I notice after harvest long stubbles and straws of wheat in field and barn-yard which have many little pin-holes from which the imago *Cecidomyia* escaped. Barley was damaged to an enormous extent last year, whole fields having nearly every straw so badly damaged that they would break off readily by passing through with the horse-rake, throwing it into winrows. This year barley was not hurt much.

Now, wasn't the great spread of the *Hessian Fly*, which occurred many years ago, brought about at that time by that extensively sown wheat, the *Soules*, which was a very similar wheat to the *Clawson*, which brought the fly this time? Or rather, each kind of these wheats, by their tender foliage and loose culms, allowed the rapid propagation of the fly, being their favorite variety of wheat; we may also add the fact that these wheats were popular among the farmers everywhere; thus whole wheat districts were sown entirely to this wheat, bringing forth countless numbers of the *Hessian Fly* to every acre. In the former spread of the fly, farmers entirely desisted from raising wheat, or resorted to red or Mediterranean wheat, and so the pests can be driven back now to their less prosperous plants by the sowing of *Lancaster* and similar wheats.

In conclusion, we may urge that whatever kind of wheat is used, much more depends on a rich soil, a vigorous growth, and careful cultivation, all of which tend to make the stalk stouter, the growth a few days earlier, than the choice of particular varieties.

SPECIAL REMEDIES.

Under this head belong the use of lime, dusted on the young wheat, rolling, deep plowing, burning the stubble after harvest, &c. Such special remedies as these are of little use as compared with careful preparation of the ground and late sowing, and some of them actually do more harm than good, as we shall see further on.

Application of lime to kill the maggot or larvæ.—It has been frequently recommended to spread fine lime, soot, or salt upon the young wheat so as to kill the young larvæ. As a sample of such treatment, which at least can do no harm, we extract the following statement from the *Kansas Farmer*:

The farmer who recommends the remedy is a Virginian, and he writes to a local paper as follows:

"I hear there is much 'fly' in the wheat that was sown early this fall. To correct this evil I offer the following remedy, which I and others have successfully tested for a good many seasons: Sow of air-slacked or water-slacked lime one or two bushels per acre broadcast over the wheat in the early morning on the dew, or over night on a clear evening, when there is reason to expect dew or frost. As it dissolves it will form a lye which will follow the leaf towards the root and destroy the chrysalis of the fly near that point.

"The sower must always sow with the wind, else the lime will be blown back in his face and eyes and on his clothes. And he must grease his hands, face, and nostrils with lard, which renders contact with the lime innocuous. If two or more sow they should sow *en echelon*, at such a distance that the rear shall cast no lime on the front. A very good but not indispensable plan is to use tea scoops—diminutive sugar scoops—that will hold a double handful. It enables one better to take up and measure the quantity to be applied. This is an application so simple and cheap as to discredit it with the many who are often looking to be told 'some great thing.' I can only say that I know it to be effectual as a remedy, and that in no case can it do harm."

It is evident that such remedies as these should be applied before the insect transforms into the flaxseed state, as the hard, dense pupa case is impervious to ordinary appliances such as would kill the maggots.

Rolling the ground to kill the larvæ and flaxseeds.—Practical men advise rolling the ground both to keep it moist and in order to destroy the eggs, larvæ, and some of the flaxseeds. This may be in some cases worth trying, but we should think that full as much injury would be done to the wheat plants as to the minute larvæ and eggs upon them.

Cutting the grain close to the ground.—This has been sometimes practiced. A writer in the *Ohio Farmer* makes the following statement in favor of this plan:

E. C. Green, Medina County, Ohio, writes: "The Hessian Fly appeared in this vicinity, but has done but little damage. The wheat commenced to fall over before it was cut, and the eggs or larvæ were found above the first or second joint. The damage on five acres of wheat was probably five or six bushels. By reaping low and raking the stubble was all saved."

A serious objection to reaping low is that many insects of the summer brood in the flaxseed state are, as Mr. S. S. Rathvon claims, carried to the barn or stack, beyond the reach of remedy. From the straw thus har-

vested the fly would emerge before it was threshed, "and might even pass through a machine without injury". In this manner the fly has possibly been distributed through different sections of the country.

Burning the stubble.—Although this remedy has been advocated, it will be seen to be worse than useless when we reflect that after all the artificial means taken to reduce the number of the Hessian Fly, nature's method of checking its undue increase is far more important and thorough-going; we refer to the diffusion and multiplication of the insect-parasites. As previously stated, most probably nine-tenths of the young Hessian Flies are destroyed in the larva or pupa state by the parasites already described. For the most part these parasites live in the flaxseeds contained in the straw, and appear in spring. Now, to burn the stubble in the autumn or early spring is simply to destroy these useful parasites, the best friends of the farmer. We do not hesitate to urge that the straw be untouched. On the contrary, the parasites should be gathered and bred in numbers; and we believe that practical entomologists should bend all their energies towards clearing up the subject of rearing and multiplying these insect hosts. Much knowledge and practical skill is needed in this direction, as occasionally by disseminating the parasites their noxious hosts may increase and be distributed; but knowing, as we do, how many more of the parasites are in many cases bred than the insects on which they prey, it seems safe and reasonable to advise not only not burning the stubble, but letting it stand, so that the parasites may finish their transformations, become fledged, and ready, when the eggs and larvæ of the Hessian Fly are upon or in the young wheat, to destroy them.

It is a matter of fact that in years when the Hessian Fly is specially abundant and destructive, similar seasons are highly favorable to the corresponding increase in the number of their insect or ichneumon parasites; they do their work so effectively that the few following years the numbers of Hessian Flies are greatly reduced. It is, then, to these parasites that we are indebted for the years of immunity from the attacks of the Hessian Fly, as much as to favorable or unfavorable weather, and this leads us to consider the apparent *periodicity* in the years of abundance and scarcity of the Hessian Fly.

PERIODICITY IN THE ABUNDANCE AND SCARCITY OF THE HESSIAN FLY.

The following tabular view, though constructed from very scanty and often misleading data, may throw some light on this subject. All insects, especially the more noxious ones, those which fall under common observation, such as the locust, cotton-worm, army worm, chinch-bug, and the like, have their years of undue numerical increase and of unusual scarcity. This periodicity is, without doubt, partly owing to the influence of the weather, of favorable and unfavorable seasons, and partly, in most cases,

to the absence or abundance of the insect parasites, although the latter cause is largely influenced by climatic agencies.

The table has been drawn up from the reports of Fitch, Hind, Cook, and of the Agricultural Department at Washington, and from different newspapers, as well as from private correspondence. The record, as therein presented, is very imperfect, but still is sufficient to show the periodicity in the return of periods when the Hessian Fly has been sufficiently abundant to ravage wheat-fields and excite apprehension and alarm. Without much doubt, in the different States mentioned, especially in the Middle States, the insect is tolerably abundant nearly every year, but few seasons occurring when after a careful search by experts the fly would not be found.

As the recorded facts indicate, within about ninety years there have been, in the Atlantic and Middle States, six periods of unusual abundance, namely, centering about the years 1790, 1817, 1844-'45, 1871-'72, and 1876-'78. These dates, which generally are inserted in larger type in the table, mark the time of culmination in the degree of abundance and extent of ravages committed, and were preceded by from one to several years of less or greater abundance. After the culmination, or year of greatest abundance, the fly often suddenly disappears. This sudden disappearance is, without doubt, due to the great increase in the number of parasites, while the original increase is probably due to a succession of warm, damp seasons, favorable to the multiplication of the flies. These seasons, when we look at the later Hessian Fly years, such as 1844-'45, 1871-'72, and 1876-'78, when the insect had become widespread over the western portion of the wheat area, were evidently areas of similar climatic features common to the Atlantic and Mississippi Valley States. Whether these seasons were warm and moist or not, we have not the means at hand to enable us to form an opinion. We simply at this time draw attention to the great desirability of putting on record the amount of correspondence between the meteorological conditions of the seasons of undue increase or unusual scarcity of insect pests, in order that we may be able in the future to make some calculations as to their probable increase or decrease, that farmers and gardeners may govern themselves accordingly.

As stated to us by Mr. Thomas, in 1817, the rainfall from Maine to Maryland was slightly above the average, 1.01 per cent. of the mean.

The winter of 1843-'44 was the most severe in the West that had been experienced for twenty years; the spring was cold and late; 1844 was very wet over the West, in fact the wettest season known since its settlement, or at least since 1811. This was the year of the great flood in the Mississippi. It was also wet in parts of Virginia and Maryland. But along the sea-coast from Maine to Florida the amount of rainfall was only about .90 per cent. of the mean. In 1845 it was not very wet in any section where wheat was cultivated, the amount along the sea-

coast being placed at .95, and this was about the same in the Middle and Northwestern States, varying from .83 to .91 per cent. of the mean.

We thus see that the Hessian-Fly years, 1817 and 1844, were wet years, periods of more than the average rainfall. Of 1871 we have no records at hand; the spring and summer of 1877 were damp and wet, and, also, appear to have been warmer than the previous year. There thus appears to be a correlation between the seasons of greatest abundance of Hessian Flies and a greater degree of moisture, if not of heat.

New York.	New Jersey.	Pennsylvania.	Delaware,	Maryland,	Virginia,	West Virginia,	Connecticut.	North Carolina,	South Carolina,	Ohio.	Indiana.	Illinois,
1778												
1779												
1780												
1781												
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1784												
1785												
1786	1786	1786										
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1791			1791									
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1797		1797								*1797		
1798												
1799												
1800												
1801					1801							
1802					1802							
1803					1803							
1804					1804							
1810												
1817		1817		1817	1817							
1831		1820		1820								
1835	1835	1835		1835	1835		1833					
1836	1836	1836		1836	1836							
1840		1840		1840	1840		1837			1850		
1841		1841		1841	1841		1840	1840		1841		
1842		1842		1842	1842					1842		
1843		1843		1843	1843					1843		
1844		1844		1844						1844	1844	1844
1845		1845		1845						1845		1845
1846		1846		1846	1846					1846		1846
1847											1847	1847
1849										1849		
		1850			1850					1850	1850	
		1851			1851					1851	1851	
					1852							
1854		1853										
		1854										
											1861	1861
			1865	1866						1866		
1871	1871	1871		1871	1871	1871		1871	1871	1871	1871	1871
	1872	1872		1872	1872	1872		1872		1872	1872	1872
	1873		1873	1873	1873	1873					1873	1873
		1874		1874								
										1874		
										1875		1875
		1876		1876	1876			1876		1876	1876	
1877		1877						1877		1877	1877	1877
1878								1877		1877		
1879			1879					1878		1878		1878
								1879		1879		1879

*Appeared west of

DISTRIBUTION OF THE HESSIAN FLY.

There is little doubt but that this insect was, as stated first by Col. George Morgan, of Prospect, N. J., and afterwards by Mr. Herrick and Dr. Fitch, introduced from Europe. That it was originally a European insect is shown by Mr. Herrick,* who quotes a writer as authority for the statement that the insect was injurious to wheat near Geneva, in May, 1732, and again in May, 1755. It was also detected by Prof. J. D. Dana, in the spring of 1834, who found the larvæ, pupæ, and reared the flies from wheat growing on the island of Minorca. He sent several pupæ and flies from Mahon to Mr. Herrick, who identified them as the Hessian Fly. As he writes, "the Mahonese asserted that the insect had been there from time immemorial, and often did great damage both there and in Spain." Dana also collected the same insect at Naples, and also at Toulon, France. It seems, also, that this insect, or one very closely allied to it, injured the wheat in Hungary at or about the same date as Mr. Dana's visit to Europe, *i. e.*, 1834.

Like some other insects introduced from Europe, which there are only slightly injurious, the *Cecidomyia destructor* here became *prepotent*, *i. e.*, multiplied to an unusual degree, and became alarmingly prevalent, while in Europe it had not been even described by entomologists, its local ravages having been mostly confined to areas not visited, apparently, by entomological students.

With Herrick, Fitch, and others, we are disposed to credit the belief of Colonel Morgan, that this fly was introduced into America in the straw used for packing, brought by the Hessian troops during the Revolutionary war. These troops were landed on Staten and the west end of Long Island, August, 1776. This, then, was the starting-point from which the fly originated, and it will be interesting to learn how it spread to its present limits, how rapidly, and whether it is at all migratory. Our knowledge on these points will be mainly derived from Fitch's report and subsequent publications.

By reference to the foregoing chronological table of the years when the Hessian Fly was prevalent and injurious, one can comprehend easily the rapidity of distribution and the States successively invaded by it. The States are arranged as nearly as possible in the order in which they were first visited.

In his interesting history of the introduction of the fly into this coun-

*In the Elements d'Agriculture, par Duhamel du Monceau, Paris, 1771, 2 tomes, 12 mo., is a statement from M. de Châteauevieux, of which the following is a translation: "Our wheat [in the neighborhood of Geneva] has sustained, the present month of May, 1755, an injury from which the grain cultivated by the new husbandry has not been exempt. We found upon it a number of small white worms, which eventually turned to a chestnut color; they fix themselves within the leaves and gnaw the stalks; they are commonly found between the first joint and the root; the stalks on which they fasten grow no more; they become yellow and dry up. We suffered the same injury in 1732, when these insects appeared in the middle of May, and did such damage that the crops were almost annihilated," i, 299. The Hessian Fly and its parasites, by E. C. Herrick, Amer. Jour. Sc., p. 153, 1841). The chestnut-colored worms mentioned by this writer are evidently the "flaxseed" of the Hessian Fly, as no other wheat insect has such a pupa case.

try, Dr. Fitch shows that in August, 1776, Lord Howe's army, partly on Staten Island and partly at Flatbush, on Long Island, was strongly reinforced by Hessians and Waldeckers, most of whom were from Hesse Cassel, "a district but about a hundred miles distant from Saxe-Coburg and Saxe-Altenburg, where, as we have already seen, the same insect did much damage to the wheat crops in 1833."*

At Long Island, then, as shown by Dr. Fitch, the Hessian Fly originated, and from this point gradually spread over the wheat area of the colonies, and afterwards of the United States, enlarging its limits of distribution with the corresponding increase in the extent of the wheat area of our country.

It spread more rapidly at first towards the eastward, nearly to the end of Long Island and to Shelter Island. As Havens remarks, "It was first perceived a little before harvest, and appeared to have come from the west end of Long Island in a gradual progress of between twenty and thirty miles a year."

In ten years after its importation into America it reached Prospect, N. J., about forty miles southwest of Staten Island, and in 1788 it was noticed at Trenton, N. J., and in Pennsylvania. Undoubtedly, had there been railroads at that time, with the rapid transit of grain-cars and bales of hay and straw, it would have spread at least with three times the rapidity of its recorded rate of diffusion.

In 1789 the fly first reached Saratoga, a point situated 200 miles north of its original point of departure. "The insect reached here by a regular progress from the south, coming nearer and nearer each successive year."

It appeared west of the Alleghanies in 1797, though in what state we are unable to learn, while Virginia was invaded in 1801, and North Carolina about the year 1840. Westward its progress brought it to Ohio in 1840, and three years later it was detected in Michigan. In 1844 it was destructive in Ohio, Indiana, Illinois, Michigan, Wisconsin, and the eastern border of Iowa, while it was common in the Middle Atlantic States, and became destructive in Northern Georgia in 1845. Meanwhile it had reached Western Canada in 1805. North of Connecticut it seems to have existed only sporadically, and to have maintained only a temporary foothold in Vermont and Maine in 1850-52, and has never been noticed in New Hampshire or in Massachusetts. Minnesota was visited in 1860, and probably earlier.

It must have reached Missouri, Arkansas, and Texas long previous to the date given in our table, but probably the year it entered Eastern

* Sir Joseph Banks drew up a report on this insect for the Privy Council, dated March 12, 1789. He states that "since its first appearance in Long Island it has advanced at the rate of fifteen or twenty miles a year, and neither waters nor mountains have impeded its progress. It was seen crossing the Delaware like a cloud from the Falls Township to Wakefield; had reached Saratoga, 200 miles from its first appearance, infesting the counties of Middlesex, Somerset, Huntington, Morris, Sussex, the neighborhood of Philadelphia, all the wheat counties of Connecticut, &c., committing the most dreadful ravages, attacking wheat, rye, barley, and timothy grass. The Americans who have suffered by this insect speak of it in terms of the greatest horror."—Dobson's Encyclopedia, viii, art. Hessian Fly.

Kansas (1871-'72) is not much posterior to its arrival there, and this is at present its most westernmost limit. No traces of it, so far as we can learn, have been seen in Nebraska. (Compare the map at the end.)

Does the Hessian Fly migrate?—As regards the so-called migrations of this insect, we would express our disbelief in any such movement from place to place as is involved in the idea of the word migration. The history of the insect simply shows that it has steadily spread from its original point of introduction to new sections of the country as rapidly as they were settled and wheat became a staple article of production. It is periodically abundant, much as most other obnoxious insects are, more abundant some years than others; becoming abundant at some localities and scarce at others. It cannot, therefore, truly be said to "migrate" from one part of a State to another, or from one natural region to another.

Probable limits of the Hessian Fly.—The question naturally arises whether this pest will ever infest the wheat regions of Western Dakota, Montana, Utah, Colorado, and the Pacific States and Territories. We believe not, though aware that such a statement may be hazardous. It was originally an inhabitant of Central and Southern Europe; it has become acclimated in the Eastern Atlantic and Middle States, in the valley of the Upper Saint Lawrence, and in the valley of the Mississippi River; that it can thrive in the elevated, dry Rocky Mountain plateau region, and withstand the cool nights and dry, hot atmosphere of the Far West, seems very doubtful. At least, so slowly has it spread westward, so slight an amount of wheat or straw is transported westward, all produce of this kind going eastward, that we doubt whether, during this century at least, it will extend west of Kansas and Minnesota, where it has already had a foothold for several years.

SUMMARY OF THE HABITS OF AND REMEDIES AGAINST THE HESSIAN FLY.

1. There are two broods of the fly, the first laying their eggs on the leaves of the young wheat from early April till the end of May, the time varying with the latitude and weather; the second brood appearing during August and the early part of September, and laying about thirty eggs on the leaves of the young winter wheat.

2. The eggs hatch in about four days after they are laid. Several of the maggots or larvæ make their way down to the sheathing base of the leaf, and remain between the base of the leaves and the stem near the roots, causing the stalk to swell and the plant to turn yellow and die. By the end of November, or from thirty to forty days after the wheat is sown, they assume the "flaxseed" state, and may, on removing the lower leaves, be found as little brown, oval, cylindrical, smooth bodies, a little smaller than grains of rice. They remain in the wheat until during warm weather; in April the larva rapidly transforms into the pupa within its flaxseed skin, the fly emerging from the flaxseed case about

the end of April. The eggs laid by this first or spring brood of flies soon hatch; the second brood of maggots live but a few weeks, the flaxseed state is soon undergone, and the autumn or second brood of flies appear in August. (In some cases there may be two autumn broods, the earliest August brood giving rise to a third set of flies in September.)

3. There are several destructive ichneumon parasites of the Hessian Fly, whose combined attacks are supposed at times to destroy about nine-tenths of all the flies hatched. Of these, the most important is the Chalcid four-winged fly (*Semiotellus destructor*, Plate 1, fig. i. much enlarged), which infests the flaxseed; and the egg-parasite (*Platygaster*, fig. 1).

4. By sowing a part of the wheat early, and if affected by the fly, plowing and sowing the rest after September 20, the wheat crop may in most cases be saved. It should be remembered that the *first* brood should be thus circumvented or destroyed in order that a second, or spring, brood may not appear.

5. If the wheat be only partially affected, it may be saved by fertilizers and careful cultivation; or a badly damaged field of winter wheat may thus be reaperated in the spring.

6. Pasturing with sheep, and consequent close cropping of the winter wheat in November and early December, may cause many of the eggs, larvæ, and flaxseeds to be destroyed; also, rolling the ground may have nearly the same effect.

7. Sowing hardy varieties. The Underhill Mediterranean wheat, and especially the Lancaster variety, which tillers vigorously, should be sown in preference to the slighter, less vigorous kinds in a region much infested by the fly. The early (August) sown wheat might be Diehl; the late sown, Lancaster or Clawson.

8. Of special remedies, the use of lime, soot, or salt may be recommended, also raking off the stubble; but too close cutting of the wheat and burning the stubble are of doubtful use, as this destroys the useful parasites as well as the flies.

FURTHER INFORMATION DESIRED.

What has been stated in the foregoing pages has been mostly compiled from the observations of others, though all the members of the commission have paid more or less attention to this pest in former years.

In order that a more detailed, valuable report may be made as to the habits, distribution, remedies, and statistics of losses, all necessary for a full and satisfactory treatment of the subject, answers to the following topics from wheat-growers in the United States, especially in the South and West, are earnestly desired. The publications of the commission will be sent free to all persons who will kindly send replies and specimens to the following questions; and postage and all necessary expenses will be paid to those sending specimens of this or any other insects in-

festing wheat, barley, oats, and rye. The writer may be addressed at Providence, R. I.

1. At what date is the "flaxseed" state of the Hessian Fly assumed?
2. At what date does the fly appear in spring and autumn?
3. During what year did the Hessian Fly first appear to do damage in your neighborhood, and how was it introduced?
4. How many "broods" or generations are observed annually—more than two? and when does the plant suffer most, in spring or autumn?
5. State what you know of the relative immunity or susceptibility of different varieties of wheat, and upon what other cereals or grasses the insect is known to develop.
6. What kind of weather favors its injuries, and what meteorological conditions prevent them? Was the season of greatest abundance a wet or dry one?
7. Look for minute parasites in the eggs and maggots and flaxseed. They may be bred by placing the eggs and maggots with the wheat in bottles covered with paper, or even loosely corked, and the parasitic flies preserved in vials of alcohol.
8. Give statistics as to abundance and losses in your town or county.
9. State the best preventive remedies, as high culture, the rotation of crops, pasturing to sheep or cattle, rolling, &c.

Specimens of the wheat affected by these insects, and of the eggs, maggots, and flies, together with their parasites, in alcohol, are requested. When mailed, the alcohol can be poured out, and cotton soaked in alcohol will keep the specimens wet until received. Packed in a tin box they can be sent through the mail.

APPENDIX.

LIST OF WORKS AND ARTICLES RELATING TO THE HESSIAN FLY.

The following list embraces the most important writings relating to the Hessian Fly. The title of many of them are taken from Fitch's report and the bibliographical list in Bergenstamm and Loew's *Synopsis Cecidomyidarum*.

- DUHAMEL. *Éléments d'Agriculture*. Par Duhamel du Monceau. Paris, 1771, i, p. 229.
- MORGAN, GEORGE. Pennsylvania Mercurry, June 8, Sept. 14, 1787.
- CLARK, THOMAS. Pennsylvania Mercurry, Sept. 14, 1787.
- VAUX and JACOBS. Philadelphia Packet, Aug. 21, 1788.
- HAVENS. Observations on the Hessian Fly. By Jonathan N. Havens. Transactions of the New York Society for the Promotion of Agriculture, Arts, and Manufactures, 1792. Second edition 1801, pp. 71-86.
- CHAPMAN, Dr. ISAAC. Memoirs of the Philadelphia Society for Promoting Agriculture, v, 1797.
- ENCYCLOPEDIA BRITANNICA, viii. Article Hessian Fly, pp. 489-495, 1797.
- DOBSON. Encyclopædia; or a Dictionary of Arts and Sciences and Miscellaneous Literature. Article Hessian Fly. Published by Thomas Dobson. 21 vols. Philadelphia, 1798-1803. viii, p. 489-495, 1798.
- MITCHELL. Encyclopædia Britannica. Address in. Transactions of the New York Society of Agriculture, i, p. 32. Article in Medical Repository, vii, p. 97, 1803.
- ANONYMOUS. Carey's American Museum, Phila., i, pp. 143, 324-326, 1786; iv, p. 47, 1788; xi, pp. 285, 301, 1792.
- MCLELLAN. Article in American Farmer, by H. McLellan, ii, p. 234, 1804.
- KIRBY and SPENCE. An Introduction to Entomology. By W. Kirby and W. Spence. 1815-26, i, p. 50.
- BOSC. Quelques aperçus sur l'insecte commun sous le nom de Mouche Hessoise, et sur un insecte parasite qui s'en nourrit. Par L. A. G. Bosc d'Antic. Annales de l'Agricult. France. Tom. 70, 1817, pp. 277-303.
- SAY. Some account of the insect known by the name of Hessian Fly, and of a parasitic insect that feeds on it. By Thomas Say. Journal of the Academy of Natural Sciences, i, pp. 45-48, with a plate, 1817. See also Magazine of Natural History, vol. i. (Kirby).
- ANONYMOUS. An account of the wheat insect of America, or the *Tipula vaginalis tritici*, commonly called the Hessian Fly. American Monthly Magazine and Critical Review, August, 1817, New York, i, pp. 275-279.
- COCKE. Address by John H. Cocke to Albemarle Agricultural Society of Virginia, 1817.
- MERRIWEATHER. Articles, by Dr. Merriweather and others, in the Richmond Inquirer, National Intelligencer, and American Farmer, 1817 *et seq.*
- GARNETT. Article by James M. Garnett in the American Farmer, ii, p. 174, 1820.
- TILGHMAN. Article by Edward Tilghman in the American Farmer, ii, p. 235, 1820. Also in Cultivator, viii, p. 82, May, 1841.
- WORTH. Article by James Worth in the American Farmer, ii, p. 180, 1820.
- HICKOK. Essay by Judge Hickok in Memoirs of the New York Board of Agriculture, pp. 169-171, 1823.
- BIRNIE. On the efficacy of certain steps to preserve wheat from the fly and smut (Hessian Fly). By C. Birnie. New England Farmer, iii, p. 171, 1824.
- BUEL. Paper by Judge Buel in the Memoirs of the New York Board of Agriculture, iii, pp. 325-338, 1826.
- WESTWOOD. Article Cecidomyia, by J. O. Westwood, in British Cyclopaedia of Natural History.
- KOLLAR. Naturgeschichte der schädlichen Insecten in Bezug auf Landwirtschaft und Forstkultur. Wien, 1837. English translation by J. and M. London, with notes by J. O. Westwood. London, 1840, pp. 118-123.
- MORRIS. On the *Cecidomyia destructor*, or Hessian Fly. By Margaretta H. Morris. Proceedings of the Academy of Natural Sciences of Philadelphia, 1841, pp. 66-68; iii, 1847, p. 238; iv, 1849, p. 194. Transactions of the American Phil. Society of Philadelphia, ser. 2, viii, 1843, pp. 49-51.

- COATES. Remarks on the Present State of the Evidence in Regard to the Hessian Fly. By Benjamin H. Coates, M. D. 1841.
- . Note on the natural alliances of the genus *Cecidomyia*, intended to facilitate identification. By B. H. Coates. Proceedings Acad. Nat. Sci. Phila. 1842, i, pp. 191-192.
- . On some larvæ in wheat stalks. By B. H. Coates. Proceedings Acad. Nat. Sci. Phila., 1842, i, pp. 45, 54-57.
- BERGEN. Remarks on the Hessian Fly. By Garret Bergen. Cultivator, viii. Albany, Ang., 1841.
- HERRICK. A brief preliminary account of the Hessian Fly and its parasites. By Edward C. Herrick. American Journal of Science and Arts, xli, Oct., 1841, New Haven, pp. 153-158.
- . Observations on the Hessian Fly. By E. C. Herrick. Report of the Commissioner of Patents for 1844. Washington, 1845. Appendix, pp. 161-167. See also letters to Dr. T. W. Harris in entomological correspondence of T. W. Harris, and the Connecticut Farmers' Gazette, No. 40.
- HARRIS. A Report on the Insects of Massachusetts Injurious to Vegetation. By Thaddeus W. Harris. Cambridge, 1841, pp. 421-433. Reprint, 1842. Second edition, Boston, 1852. Third edition, with illustrations, 1862.
- . Article by T. W. Harris in New England Farmer, 1842, xx, pp. 409-410.
- . Entomological Correspondence of Thaddeus William Harris, M. D. Edited by Samuel H. Scudder. Occasional Papers of the Boston Society of Natural History, i, Boston, 1869, 8°, pp. 181-207.
- CURTIS. Observations, etc., including a saw fly, the Hessian Fly, the wheat midge, and the barley midge. By John Curtis. Journal of the Royal Agricultural Society of England, 1845, vi, pp. 131-136, pl. 1. Separately printed, London, 1845, 8°, p. 28, pl. 1.
- . Farm Insects. By John Curtis. London, 1860, p. 258.
- WESTWOOD. Article on the Hessian Fly. By John O. Westwood. Gardeners' Chronicle, London, 1847, p. 604.
- YUKES. Notice by J. D. Yukes. Patent Office Report, Washington, 1850.
- FITCH. The Hessian Fly: its history, character, transformations, and habits. By Asa Fitch, M. D. [originally published in the American Journal of Agriculture and Science, iv, v, 1845, and now revised by the author]. Transactions of the New York State Agricultural Society, vi, 1846, Albany; 1847, 8°, pp. 316-373, with a plate. Printed separately, Albany, 1846, 8°, p. 63, with a plate; and also Albany, 1847, 8°, p. 60, with a plate.
- . Seventh report on the noxious and other insects of the State of New York. By Asa Fitch, M. D. pp. 133-144, with a plate, 1862.
- MOTSCHULSKY. Article by Victor Motschulsky in Journal du Ministère de l'Intérieur, 1852.
- HIND. Essay on the Insects and Diseases Injurious to the Wheat Crops. By H. Y. Hind, Toronto, 1857, pp. 38-74.
- SICHEL. Article by Jules Sichel in Annales des Sociétés Entomologique de France, 1856, iv, Bulletin, p. 8.
- LOEW. Über die den Roggen in den Prov. Schlesien und Posen vernichtende Fliegenmade. By H. Loew, in Zeitschrift Entomol. schles. Verein für Insektenkunde, 1858, xii.
- . Die neue Kornmade und die Mittel, welche gegen sie anzuwenden sind. Zullichan. Sporerler, 1859, 8°, p. 29.
- OSTEN SACKEN. Article by R. Von Osten Sacken in Stettin entomologische Zeitung, 1862, p. 80.
- HABERLANDT. Article by Haberlandt. Verhandlungen zool.-botan. Gesellschaft, Wien, 1834, p. 401.
- KÜNSTLER. Article by Künstler. Verhandlungen zool.-botan.-Gesellschaft. Wien, 1864, pp. 407, 779; 1871, p. 15.
- WALSH. Brief notices by B. D. Walsh, editor of the Practical Entomologist, 1867, pp. 10, 37.
- STIERLIN. Article by Stierlin in Mittheilungen der Schweiz. entomol. Gesellschaft, 1868, ii, p. 157.
- COHN. Untersuchungen über Insectenschaden auf den schlesischen Getreidefeldern im Sommer 1839, 1869, p. 12.
- KALTENBACH. Die Pflanzenfunde aus der Klasse der Insekten. Stuttgart, 1874, pp. 734, 738, 741.
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MAP
 SHOWING APPROXIMATE DISTRIBUTION
 of the
HESSIAN FLY & WHEAT MIDGE.

A. SPACKARD JR.

Hessian Fly
 Wheat Midge
*Limit of Wheat cultivation
 in eastern United States,*

Scale of Statute Miles
 50 100 150 200 250 300 350 400

