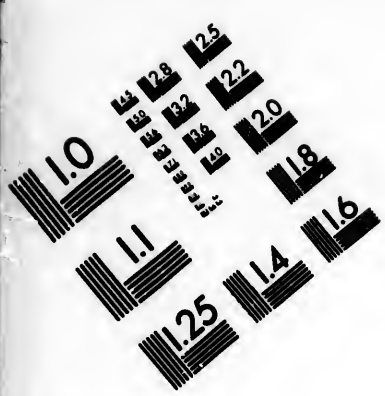

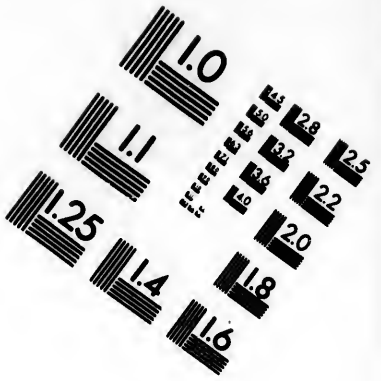

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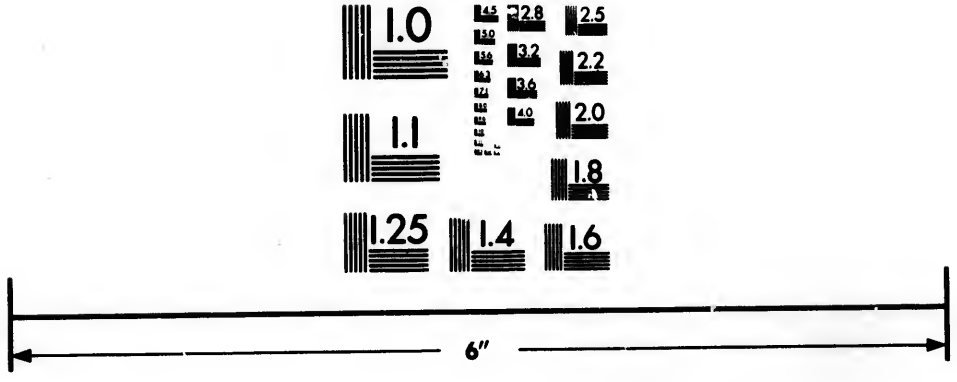

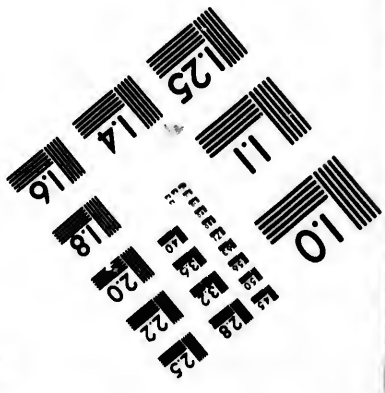

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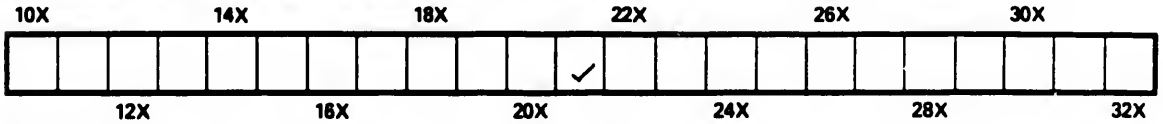

ESSAY

ON THE

Hessian Fly, Wheat Midge,

AND OTHER INSECTS INJURIOUS TO

THE WHEAT CROPS.

BY THE REV. GEO. S. J. HILL, B.A.,
RECTOR, MARKHAM.

TO WHICH WAS AWARDED BY THE BUREAU OF AGRICULTURE AND STATISTICS

THE SECOND PRIZE.

Mox et frumentis labor additus.

TORONTO:
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ERRATUM—PAGE 40.

For "Mix et frumentis," &c., read "Mox et," &c.

PRIZE ESSAY.

CHAPTER I.

INSECTS DESTRUCTIVE TO THE WHEAT CROP.

CONTENTS:

Importance of the subject proposed.—One worthy of the attention of a wise and paternal Government.—The best means of increasing qualified Observers.—European Governments have taken similar steps.—Exertions of Privy Council in England regarding Hessian Fly in 1788.—Premium offered by French Government in 1785.—By Society of Arts in London.—Angoumois Moth.—French Commissioners appointed concerning it.—Difficulty of investigating such subjects from the ignorance of those suffering most from Insects.—The name "Weevil" misapplied to every species of Insect attacking grain.—Importance of properly classifying Insects.—Stages of an Insect's life.—Transformations.—Farmers and Gardeners should become acquainted with them.—Seven Orders of Insects.

When we consider the vastness of the interests depending upon the wheat crop, forming as it does the most valuable item of Canadian exports, and the chief article of food for our population, we cannot be surprised at the anxiety which is common amongst all classes of the community with regard to the alarming devastation of that important crop by insects of various kinds. The mysterious character of the visitation and the uncertainty which generally exists, respecting the origin, nature, and habits of these creatures, adds not a little to the alarm which their ravages have caused; it well becomes then, a wise and paternal Government to take such steps as may serve to procure the greatest amount of information on this subject, and thus increase the number of qualified observers throughout the country, by whose combined exertions some effectual method of guarding against these ravages may be adopted. This course has been pursued under similar circumstances by some of the most enlightened countries of Europe, who have not considered the interests of Agriculture a subject beneath their notice, or the devastations of insects which might scourge their countries with famine, as a matter of little consideration.

We learn from Young's Annals of Agriculture,* that when an alarm was excited in England in 1788, by the probability of importing in cargoes of wheat from North America the insect known by the name of the Hessian fly, the privy council sat day after day anxiously debating what measures should be adopted to ward off the danger of a calamity more to be dreaded, as they well knew, than the plague or pestilence. Expresses were sent off in all directions to the officers of the Customs at the different out ports respecting the examination of cargoes—despatches were written to the Ambassadors in France, Austria, Prussia, and America, to gain that information, of the want of which they were so sensible; and so important was the business deemed, that the minutes of Council and the documents collected from all quarters fill upwards of two hundred octavo pages.†

In the year 1785, many provinces in France were so ravaged by cock-chafers,

* Annals xi. 406. † Kirby & Spence.

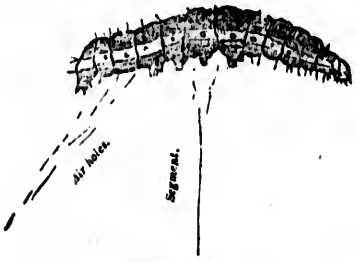
that a premium was offered by Government for the best mode of destroying them. The Society of Arts in London, during many years, held forth a premium for the best account of this insect and the means of checking its ravages, but without having produced one successful claimant. For more than a century an insect destructive in granaries has prevailed in the western parts of France, and has gradually been extending in an easterly and northerly direction. In the province of Angoumois it continued to increase for many years, till at length the attention of Government was directed to its fearful depredations. This was in 1760, when the insect was found to swarm in all the wheat fields and granaries of Angoumois, and of the neighbouring provinces, and the afflicted inhabitants were thereby deprived not only of their principal staple, wherewith they were wont to pay their annual rents, their taxes, and their tithes, but were threatened with famine and pestilence from the want of wholesome bread. Two members of the Academy of Sciences of Paris, the celebrated Duhamel du Monceau and M. Tillet, were then commissioned to visit the province of Angoumois, and inquire into the nature of this destructive insect. The result of their inquiries was communicated to the Academy, in whose history and memoirs it may be found, and was also subsequently republished in a separate volume.*

Such then are some of the instances where Governments have endeavoured, by offering premiums and enlisting the services of scientific persons, to procure such information as may serve to avert the calamities caused by destructive insects amongst the valuable products of the soil. And no small part of the difficulty which arose in making such investigations, was caused by the ignorance of the farmers with regard to the nature of the insects from whose ravages they had suffered so much. One would have supposed that men who had lost entire crops by an insect whose transformations must have come under their notice in every stage of its existence, ought to have been able to give all the information which was required respecting its nature, propagation, and economy. So far, however, was this from being the case, that many of those from whom information was sought, seemed to be ignorant whether the insect was a moth, a fly, or what they termed a bug, indeed so various and contradictory were the statements regarding the Hessian Fly, submitted to the celebrated entomologist, Sir Joseph Banks, by the Privy Council of England in 1788, that though he had a large mass of materials before him, he was unable to reach any satisfactory conclusion, and it remained for the American Entomologist, Say, to determine, satisfactorily, the species and genus of the insect in question. The frequent misapplication of names, by persons unacquainted with Natural History, is one of the greatest obstacles to the progress of science, and shows how necessary it is that things should be called by their right names, if the observations communicated respecting them are to be of any service. For instance, the name "weevil" is used in this country to describe any insect that destroys the wheat plant; it is given to at least six different kinds of insects, two of which are moths, two are flies, and two are beetles. Now nearly four thousand species of weevils have actually been scientifically named and described. When mention, therefore, is made of "the weevil," it may well be a subject of doubt to which of these four thousand species reference is made; if the scientific name of the species in question were made known, this doubt would at once be removed. Every intelligent farmer is capable of becoming a good observer, and of making valuable discoveries in Natural History, but if he be ignorant of the proper names of the objects examined, or if he give to them names which have previously been applied by other persons to entirely different objects, the result of his observations will be to confuse instead of throwing light upon the subject.

* Histoire d' un Insecte qui devore les grains de l'Angoumois, 12mo., Paris, 1762.

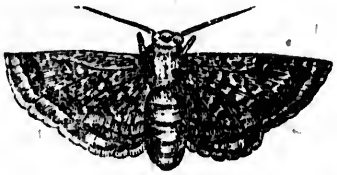
It will be well therefore to give the names of the orders under which different insects may be classed, before we proceed to consider the nature, habits, and economy of those which are to form the subject of this essay. This subject is particularly important to all persons who are interested in agricultural pursuits. The array of scientific names and terms which it presents may seem formidable, but the few that will be required in treating of the Hessian fly, weevil, &c., may be understood and impressed upon the memory without much difficulty. The advantage of these scientific names is, that they are understood by well educated persons in all parts of the world, whereas the common names by which insects are known in different countries are very limited in their application, and are also often misapplied. The technical words or phrases used by the farmer, the blacksmith, or the carpenter, in their different callings, seem to the inexperienced difficult and unintelligible, yet to the skilful workman are full of meaning and seem quite appropriate. So, too, to the lover of Natural History, the terms of science lose their forbidding and mysterious appearance, and become as familiar to him and as full of meaning as the technical words used by the mechanic are to him in the pursuit of his trade or art.

Before we proceed to the classification of insects, it will be well to prefix a few remarks on their structure, and explain the meaning of the different terms used, together with a short, and consequently imperfect sketch of their anatomy, and the transformations they undergo.



CATERPILLAR—FIG. I.

PUPA—FIG. II.



MOTH—FIG. III.

MOTH.

The word *Insect* is derived from the Latin, and means cut into or notched, and is designed to express one of the chief characters of this tribe, their bodies being marked by several cross-lines or incisions, the parts between these lines being called segments or rings, and consist of a number of jointed pieces more or less moveable on each other. Insects do not breathe through their mouths, but through little holes called spiracles, generally nine in number, along each side of the body. Some, howevever, have the breathing holes placed in the hinder extremity, and a few young water insects breathe by means of gills. They are never spontaneously generated from decayed animal or vegetable matter, but

are produced from eggs. A few, such as some plant lice, do not lay their eggs, but retain them within their bodies till the young are ready to escape. Others invariably lay their eggs where their young, as soon as they are hatched, will find a plentiful supply of food immediately within their reach.

There are three periods in the life of an insect, more or less distinctly marked by corresponding changes in the form, powers, and habits. In the first, or period of infancy, an insect is technically called a *larva*. Linnæus, with happy application, adopted this name from the Latin word signifying a *mask;* justly considering that the real form of the insect while it remained under this covering was disguised or *masked*. There are two terms in common language corresponding to this, although by no means so expressive, and in themselves indefinite. The larvæ of butterflies, moths, and insects of the same class (lepidoptera) are called caterpillars; while those which are white, somewhat inactive, and are found either in the ground, or enclosed in other substances, bear the common name of grubs or maggots. This name *larva* is applied not only to caterpillars, grubs, and maggots, and to other insects that undergo a complete transformation, but also to young and wingless grasshoppers, and indeed to all young insects before the wings begin to appear. In this period of their lives, during which they eat voraciously, and cast their skins several times, they continue a longer or a shorter period, some only a few days or weeks, others several months or years. It is in this larva or caterpillar state that they mostly do the greatest injury to vegetation.

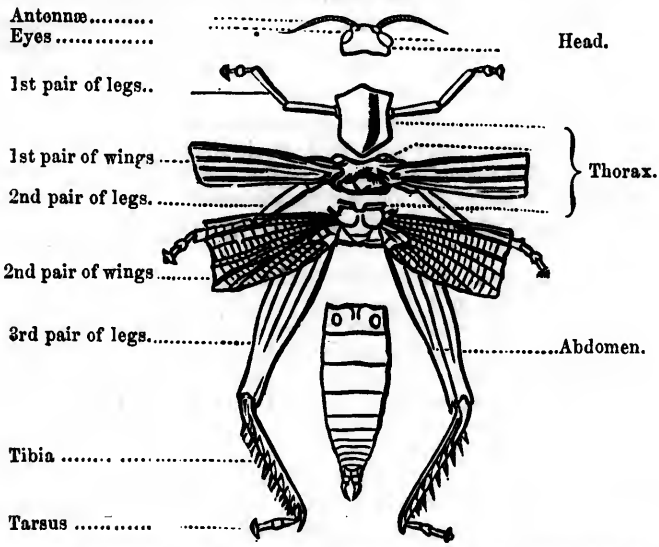
After the larva has attained its full size, the second change takes place, wherein those insects that undergo a partial transformation, retain their activity and their appetites for food, continue to grow, and acquire the rudiments of wings, while others at this age entirely lose their larva form, take no food, and remain at rest in a death-like sleep. This is called the *pupa* state, from a slight resemblance that some of the latter present to an infant trussed in bandages, as was the fashion among the Romans. The *pupæ* from caterpillars are commonly called *chrysalids*, because some of them, as the name implies, are gilt or adorned with golden spots.

We come now to the third and last state of an insect. After continuing a certain time in the pupa or chrysalis state, it again casts its skin and issues forth a perfect and full grown moth, fly, or beetle, to deposit its eggs for future generations. When an insect assumes its adult or perfect state, Linnæus termed it an *imago*, because having laid aside its mask, and cast off its swaddling bands, being no longer disguised or confined, or in any respect imperfect, it is now become a true representative or *image* of its species, and is qualified to fulfil the laws of nature in perpetuating its kind.

The body of a caterpillar generally consists of a head and twelve segments. In winged or adult insects, two of the transverse incisions are deeper than the rest, so that the body seems to consist of three principal portions, the first of these is the head, the second or middle portion the thorax or chest, and the third or hindmost the abdomen or hind-body. The eyes of adult insects, though apparently two in number, are compound, each consisting of a number of single eyes closely united, and incapable of being rolled in their sockets. The eyes of grubs, caterpillars and other completely transforming larvæ, are not compound, but consist of five or six eyelets clustered together on each side of the head. Some, such as maggots, are blind. Near to the eyes are the *antennæ*, two jointed members, corresponding in situation with the ears of other animals, and are supposed to answer the purposes of feeling and hearing. The mouth of some insects is made for biting or chewing, that of others for taking food by suction.

The parts belonging to the thorax are the wings and the legs. The former

are two or four in number, the under side of the thorax is the breast, and to this are fixed the legs, which are six in number in adult insects, and in the larvæ and pupæ of those that are subject only to a partial transformation. The parts of the legs are the hip joint, by which the leg is fastened to the body, the thigh (*femur*), the shank (*tibia*), and the foot which sometimes consists of one joint only, more often of two, three, four, or five pieces (*tarsi*) connected end to end, like the joints of the finger, and armed at the extremity with one or two claws. The abdomen or hindmost and largest part of the body, contains the organs of digestion, and other internal parts, and to it also belong the piercer and the sting with which many winged or adult insects are provided. The parts belonging to the abdomen of larvæ are various, but are mostly designed to aid them in their motions, or to provide for their respiration.



It is most important that all persons interested in gardening and agriculture should become acquainted with the transformations that insects undergo, and of which a short sketch has been given above. They will never be able to check their ravages effectually until they have acquired some knowledge of their habits and modes of existence. For instance, with regard to noxious caterpillars, how few are aware that they proceed from the eggs of butterflies, moths, &c., and that the best method of preventing their attacks is to destroy the female fly before she has laid her eggs. If the research was carried still further so as to detect the pupa, the work might be more effectually accomplished. Kirby and Spence, in their introduction to entomology, tell us that in Germany the gardeners and country people, with great industry, gather whole baskets full of a destructive caterpillar, and then bury them, thinking by this means they have rid themselves of the pest; but they might as well try to drown a fish with water, for these caterpillars, as they undergo their next transformation beneath the ground, instead of being destroyed by this manœuvre, are placed in a position most favorable to their appearing in greater numbers the following year. Again, Providence has ordained that certain insects should be active agents in destroying the noxious species, and preventing their increase. The wheat fly, for instance, is the prey of three parasitical insects, yet ignorant persons have

taken these destroyers of our enemies for their parents; we learn from this how necessary it is that agriculturists should be enabled to distinguish their friends from their enemies.

The utility of a knowledge of the natural history of insects in the practical arts of life is forcibly shown in the case of Linnæus, "who at once gave to natural science its language and its laws, and also pointed out its economical advantages." On one occasion this great naturalist was consulted by the King of Sweden upon the cause of the decay of the ship timber in the royal dock-yards. He traced the destruction to the depredations of insects, ascertained their history, and then directing the timber to be sunk under water during the season when these insects made their appearance in the winged state and were engaged in laying their eggs, he effectually secured it from future attacks.* These insects have increased to an alarming extent in some of the dock-yards of France, and in one of them at least, have become very injurious, wholly in consequence of the neglect of warnings given by a naval officer, who was also an entomologist, and pointed out the source of the injury, together with the remedy to be applied.

In order to facilitate the study of insects, of which the varieties are so numerous, it will be necessary to adopt some kind of classification; the basis of this classification is founded upon the structure of the mouth in the adult state, the number and nature of the wings, and the transformations. The first great divisions are call orders, of which the following seven are very generally adopted by naturalists.

I. COLEOPTERA—(*Beetles*)—In these insects the mouth is furnished with jaws, but destitute of any proboscis, the upper wings appear as two hard cases, protecting the under pair, which alone are organized for flight—transformation complete—larvæ, called grubs, generally provided with six true legs, sometimes also with a terminal prop-leg; more rarely without legs—pupa with the wings and the legs distinct and unconfined. Many of these insects, particularly in the larva state are very injurious to vegetation.

II. ORTHOPTERA—(*Cockroaches, Crickets, Grasshoppers, &c.*)—Insects with jaws, two upper wings thick and opaque, overlapping a little on the back; two under wings larger and thinner, and folded in plaits like a fan—transformation partial—larvæ and pupæ active, but wanting wings.

III. HEMIPTERA—(*Bugs, Locusts, Plant-lice, &c.*)—Insects without jaws, but having a horny beak for suction; four wings, the upper harder than the lower, coriaceous (or leathery) and folded—transformation partial—larvæ and pupæ nearly like the adult insect, but wanting wings.

IV. NEUROPTERA—(*Dragon Flies, May Flies, Lace-winged Flies, &c.*)—Insects with jaws, four reticulated or netted wings, the hinder ones largest, without any sting.

V. LEPIDOPTERA—(*Butterflies and Moths*)—The perfect insect without jaws, and lives by suction, the proboscis being spirally coiled, four wings highly developed, covered with bran-like scales—transformation is complete. The larvæ are caterpillars, having six true legs, and from four to ten fleshy prop-legs—pupa with the cases of the wings and of the legs indistinct and fastened to the breast.

VI. HYMENOPTERA—(*Ants, Wasps, Bees, &c.*)—Insects with jaws, four wings, glassy, and marked with strong nerves, the hinder pair being the smallest

*Kirby and Spence.

—tail usually armed with a sting—larvæ mostly like maggots; some like caterpillars—Pupæ with the legs and wings unconfined.

VII. DIPTERA—(*Flies, Mosquitoes, Gnats, &c.*)—Insects with a horny or fleshy proboscis, two wings only, and two organs called ballancers or poisers behind the wings. The larvæ are maggots—transformation complete.

CHAPTER II.

COLEOPTERA.

Cockchafers—Spring Beetles—Wire-worm—Weevils—Nature and habits of these Insects—Their devastations—Best means of preventing them.

The insects comprised in this order are very numerous, we shall here simply notice those which are injurious to the wheat crop; these are the *Cockchafers* or *May Flies*, the *Elater* or spring beetles, with their destructive larvæ the *wire-worm*, and one of the numerous family of *weevils*.

Beetles, it will be remembered, are biting insects, and are provided with two pairs of jaws moving sidewise; their wings are covered and concealed by a pair of horny cases or shells, meeting in a straight line on the top of the back, and usually having a small triangular or semi-circular piece called the scutel, wedged between their bases. Hence the order to which these insects belong is called *Coleoptera*, a word signifying wings in a sheath. Beetle, in old English *betle, bytl*, or *bitel*, means a biter or insect that bites.

The Cockchafer belongs to the genus *melolontha*, a word used by the Greeks, to distinguish the same kind of insects which were supposed by them to be produced from or with the flowers of apple trees, as the name itself implies. The following are the general characters of the family of Melolonthadæ, or Melolonthians—the body is oblong oval, convex, and generally of a brownish colour, the head is enclosed in a corselet, which is slightly narrowed in front, and most commonly attached to the elytra or wing-case behind. The antennæ are composed of ten joints terminating in a mass like a plume, which the insect displays at will, sometimes to the number of seven leaves, larger and more perfectly developed in the males than females. The bodies of melolontha are very often velvet like, and covered with hairs and imbricated scales, differently coloured like the butterflies. The powerful and horny jaws are admirably fitted for cutting and grinding the leaves of plants, upon which these beetles subsist, their double claws supporting them securely on the foliage, and their strong and jagged fore legs being formed for digging in the ground, point out to us the place of their transformations.

The cockchafer (*Melolontha vulgaris*) is hatched from an egg, which the parent deposits in a hole about six inches deep which she digs for the purpose. The eggs are oblong, of a bright yellow colour, and are placed regularly side by side; each female lays from one to two hundred, which she abandons as soon as deposited, generally ascending to the surface again, and perishing in a short time. From the eggs are hatched in the space of fourteen days, sometimes longer, little whiteish grubs or maggots, each provided with six legs near the head and a mouth furnished with strong jaws. They now feed upon the roots of plants with great voracity, and sometimes commit ravages of so deplorable a kind as totally to disappoint the best founded hopes of the husbandman. As they increase in size and strength, they become able to make their way with ease under ground, and continue their ravages upon the roots of plants. When the grub has attained its greatest size, it is an inch and-a-half long, and half-an-inch thick, perfectly white with a red head, having a semi-circular lip, and a strong pair of jaws. It has two antennæ, but is destitute of eyes. The subterranean

existence of these animals is extended to four years, and as their food is not accessible during the cold weather, they bury themselves sufficiently deep in the soil to be safe from the frost, and pass the winter in a state of torpidity. When the spring restores them to animation and activity, they revisit the upper stratum of the ground, having at each annual awakening undergone a change of skin. At the end of three years they have acquired their full growth as larvæ. —they then cease eating, and void the residue of their food. If opened at this period, the skin is found to be completely filled with a mass of white, oily matter, resembling cream, apparently destined as a reserve for the alimentation of the insect during the period of its remaining in the form of a nymph, which is scarcely less than six months. To undergo their final change, these larvæ bore into the earth to the depth of two feet or more; there, by its motions from side to side, each grub forms an oval cavity which is lined with some glutinous substance thrown from its mouth. The larva being thus secured, passes into the pupa state by bursting its skin, coming forth as a soft whitish nymph, exhibiting the rudiments of elytra, antennæ, &c. The insect then gradually acquires consistence and colour, becoming of a brownish hue, and thus it remains until the month of February, when the thin fibre enclosing the body is rent, and three months afterwards the perfected beetle digs its way to the surface, escaping from its grovelling mode of life, to soar through the air and disporting in sunshine and shade. From this circumstance the German name *Maikaefer*, and the English *May bug* or *beetle* has been given. From Kirby and Spence we learn that the larvæ of the cockchafer will destroy whole acres of grass. They undermine the richest meadows and so loosen the turf, that it will roll up as if cut with a turfing spade.* These grubs did so much injury to a poor farmer near Norwich, that the court of that city allowed him £25, and the man and his servant declared that they had gathered eighty bushels of the beetle. It was for the destruction of these grubs that the Government of France and the Society of Arts in London offered the premiums as mentioned above in the introduction to this essay. Attempts have been made to turn these insects to good account, by procuring oil from them. M. Breard, Mayor of Honfleur in France, and proprietor of an oil mill, having offered one franc per bushel for cockchafers, procured seventeen bushels, from which he obtained twenty-eight quarts of good lamp oil. A kind of grease has also been made from them in Hungary.†

In their winged state, these beetles, with several other species, act as conspicuous a part in injuring the trees, as the larvæ do in the destruction of herbage, young wheat, and other plants; after escaping from the ground in their perfect state, they pass the greater part of the day upon trees, clinging to the underside of the leaves, in a state of repose. As soon as evening approaches, they begin to buzz among the branches, and continue on the wing till near midnight. Their flight is very irregular, darting hither and thither, hitting against objects in their way with a force that often causes them to fall against the ground. They frequently enter houses at night, attracted by the lights. The boldness with which they will rush against objects, seeming to threaten an attack without the power of causing harm, has caused them to be called *dors*, that is darers; while their seeming blindness and stupidity have become proverbial in the expressions "blind as a beetle," and beetle headed. The ravages they commit amongst the leaves of trees and shrubs is sometimes so great as to resemble a visitation of locusts, and is the cause of much misery to the inhabitants of those districts infested by them. Mouffet relates that in the year 1574, such a number of them fell into the river Severn, as to stop the wheels of the water mills; and in the Philosophical Transactions, it is stated that in the

*Kirby and Spence. †Ibid.

year 1688 they filled the hedges and trees of Galway, in such infinite numbers, as to cling to each other like bees when swarming; and when on the wing, darkened the air, annoyed travellers, and produced a sound like distant drums. In a short time the leaves of all the trees, for some miles round, were so totally consumed by them, that at midsummer the country wore the aspect of winter.*

Every attentive observer must be familiar with the appearance of the cock-chafer as it flutters about in the warm evenings of May, although many are not aware of the destruction it commits amongst plants and trees in its larva as well as in its perfect state; as these beetles frequently commit serious ravages on fruit trees it may be well to mention that they can be effectually exterminated by shaking them from the trees in the morning upon clothes spread to receive them when they fall, after which they should be thrown into boiling water to kill them, and may then be given as food to swine. As the methods of destroying the grubs of this beetle are similar to those employed for eradicating the wire-worm or grub of the spring-beetle—they will be mentioned when treating of the latter insect.

The *Elater*, or spring-beetle, belongs to a group of coleopterous insects, forming the type of the order *Elateridæ*, many of which species are the parents of the numerous kinds of *wire-worms* which so dreadfully infest the crops of the farmer. These wire-worms are not to be confounded with the American wire-worm—a species of *Iulus*—which is not a true insect, but belongs to the class MYRIAPODA, a name derived from the great number of feet with which most of the animals included in it are furnished, whereas the true wire-worm has only six feet. The body of the elater is comparatively long, the head is sunk to the eyes in the thorax, the antennæ are of moderate length, and more or less notched on the inside. The legs are short and slender and the feet are five-jointed; on the under side of the breast, between the bases of the first pair of legs, there is a short blunt spine, the point of which is usually concealed in a corresponding cavity behind it. When the insect by any accident falls upon the ground, its legs are so short and its back so convex, that it is unable to turn itself over, it then folds its legs close to its body, bends back the head and thorax, and thus unsheaths its breast spine, then by suddenly straightening its body, the point of the spine is made to strike upon the edge of the sheath, which gives it the power of a spring, and reacts upon the body of the insect so as to through it perpendicularly in the air; thus, by a half somerset, they have the power of regaining their natural position; hence the entomological name of elaters, and the popular name of spring-beetles, skip-jacks, click-beetles, &c. The elaters are of various colours, some are of a reddish brown, some mouse coloured, and some black.

The eggs of these beetles are very minute, of a yellowish white colour and slightly oval. The larvæ are at first almost invisible to the naked eye; they grow slowly, and become when full grown three-fourths of an inch in length; they have a wire-like form, a smooth surface, and extreme toughness, hence they are called *wire-worms*. They live five years in the proper state of larvæ, and cast off their skin, probably at three successive periods as they increase in size. The wire-worm is of a pale ochreous colour, becoming darker when dead, with a few hairs scattered over its skin; the back is round, the belly rather flat, the head wedge-shaped; there are twelve abdominal segments, the three first being furnished with six short legs. There are two little antennæ in front of the head, they have each three joints, and similar to the palpi in form; on each side of the head behind the antennæ is a minute dot, like a little eye. When the wire-worm arrives at maturity it descends a considerable depth into the earth, and

*Kirby and Spence.

forms there an oval cell; it then casts its skin again and becomes a pupa. The pupa is long and narrow in form like the perfect insect, but is of a yellowish white colour; the insects commonly remain in this state two or three weeks. When the appointed time for their transformation comes, they burst from their tombs and arrive at the surface perfect beetles.

The most important crop which suffers from the wire-worm is wheat. A writer in the Linnean Transactions estimates the loss of crops of this grain sown upon clover leys, recently broken up pastures, pea and bean stubbles, at about a twentieth part of the whole; the proportion is sometimes greater, and sometimes the destruction is so excessive as to require the whole field to be ploughed up. The attacks in general do not begin until spring, and are indicated by the dying off of the lower leaves, and in the worst cases by the falling of the plant. The wire-worm attacks other crops besides wheat, such as oats and barley; oats when sown on newly broken leys suffer excessively, but wheat suffers the most among the grain crops, and white turnips among the green ones. The writer just above mentioned estimates the loss of wheat in England from the ravages of the wire-worm annually at 60,000 bushels.

Three of the most effectual preventives of the ravages of the wire-worm are, judicious fallowing, the judicious breaking up of leys and pastures, and the judicious surface treatment of ploughed lands. A clean and careful summer fallow, when accompanied with such a thorough burning of rubbish as will surely destroy both the eggs and larvæ of these beetles, is a perfect remedy against wire-worms, and if it occurred at regular intervals would always be a more or less powerful hindrance to their obtaining any lodgement, more especially if all the couch grass and other similar weeds whose roots might afford sufficient sustenance to the worms till the corn crop had struck root, were carefully gathered and burnt. In breaking up any old pasture a breast-plough should be used, to take off *not more than two inches* of the turf in the first instance, which will secure the crop from any attacks of the wire-worm; for an additional depth of two inches has so encouraged the pest that it has been known to destroy an entire field of wheat. The advantage of the shallow paring is, that the roots of the herbage die; whereas, if the sod is ploughed four inches deep they lie and vegetate, and afford sufficient sustenance to the worms until the wheat plants are forward enough to furnish them with a more agreeable food. Planting the soil with white mustard or woad has been found an effectual method of banishing the wire-worm in England, there being something in those crops very obnoxious to these insects; but this remedy is not applicable to Canada as such crops are not grown here.

Another good remedy for wire-worms is the application, by sprinkling, top-dressing, or intermixture with manure, of some substance which without injuring the plants, would kill the larvæ. Any strong saline solution would probably have the desired effect, and at the same time would benefit the soil. Nitrate of soda thus applied proved in one case most beneficial. Lime and soot if applied to the soil before sowing any grain will, it is affirmed, kill the wire-worms. Common salt on light lands is highly efficacious in destroying them. In England they slice potatoes, turnips and other vegetables, and place them over the field or garden which attract the larvæ, and they are then picked off every morning by women and children appointed for this purpose.

Bierkander, a Swedish observer, who tried many experiments in order to destroy these pests, found after all that hand-picking is one of the best remedies. On one occasion he employed a child to follow the plough and pick up the worms, by this means three hundred and fifty-one were collected in a piece of land 600 feet long and 56 broad. He considered it would be serviceable if children always followed the plough and gathered these yellow worms into a

bottle, as they would by that means be considerably diminished, and perhaps in time completely exterminated.

Birds of many kinds, both tame and wild, are greedy destroyers of wire-worms; the chief are ducks, turkeys, common poultry, night-hawks, and above all rooks. These last will fearlessly follow the plough to feed upon the wire-worms and other insects; the form of his bill, his strength and assiduity especially adapt him for detecting these larvæ in their hiding places. A writer on this subject states that he had repeatedly examined the crops of rooks: in six young that had been shot, the crops were nearly filled with wireworms; in the crops of others he found the larvæ of the cockchafer and other grubs. The following remarks by a Mr. T. G. Clithero are very interesting: "In the neighbourhood of my native place, in the county of York, is a rookery belonging to [redacted] Vavasour, Esq., of Weston, in Wharfdale, in which it is estimated that there are 10,000 rooks: that one pound of food a week is a very moderate allowance for each bird, and that nine-tenths of their food consists of worms, insects, and their larvæ. Here, then, there is the enormous quantity of 468,000lbs., or 209 tons of worms, insects, and their larvæ, destroyed by the rooks of a single rookery in one year. To every one who knows how very destructive to vegetation are the larvæ of insects as well as worms fed upon by rooks, some slight idea may be formed of the devastation which rooks are the means of preventing."

These facts regarding the destruction of injurious insects by birds are well worthy of the earnest attention of Canadian farmers; too many of whom show such a want for taste in neglecting to plant shrubs and trees about their premises, and thus deprive insect-devouring birds of necessary shelter and encouragement to increase in cleared settlements; nature has wisely provided a remedy for nearly every evil, but by not paying attention to the economy of nature, man, by his shortsightedness, too often deranges its operations, and renders its wise provisions useless. Although the ravages of these wire-worms are not so alarming in their extent in Canada as they have proved in Europe, yet, as the settlements become older, and the slovenly farming so often witnessed is pursued, we may expect their ravages to increase. Our insect-eating birds ought therefore to be cherished and encouraged for their valuable services in destroying these plagues. Although we have no rooks we have crows, which may be seen in spring feeding on the grubs turned up in a newly ploughed field; possibly, as the climate of Canada becomes ameliorated and the winters less severe, colonies of rooks may be induced to take up their residence amongst us.* Those who have never seen a rookery are referred to that quaint description of one which is so happily portrayed by Washington Irving in his "Bracebridge Hall."

In addition to birds, many quadrupeds such as the weasel, skunk, rat, and mole, are devourers of these beetles, which are also sometimes the prey of other species of coleopterous insects. In France the golden ground beetle (*Scarabæus auratus*) devours the female dor or chafer at the moment when she is about to deposit her eggs. This beetle, with several others equally predaceous, are found on this continent, and contribute to check the increase of the destructive Melolonthadæ.

The WEEVIL is the next of the coleopterous order of insects which will engage a portion of our attention. This tribe is very numerous—nearly 4000 species having been scientifically named and described—in consequence of this fact many have ridiculed the idea of attempting to make the agricultural community acquainted with the leading characteristics of those species which are injurious to vegetation—more especially to the wheat crop. Now, it so happens that only *one* species of the weevil, the *calandra granaria*, or *curculio granarius*

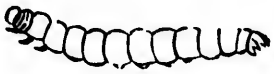
*Since the above was written the author has learnt that an attempt to introduce rooks from England into Virginia, U. S., has been tried once but proved a failure.

of Linnæus is found to destroy wheat; and it does not attack the growing crop, but the stored grain. As has been mentioned before, the name "weevil" has been given in this country to at least six different kinds of insects, two of which are moths, two are flies, and two are beetles; this has caused a great deal of confusion, and many communications to agricultural and other journals from intelligent and observant persons have been of no practical use in consequence of this misapplication of names. A few remarks, therefore, on the grain weevil, although it is not actually injurious to vegetation, may be useful as tending to prevent future mistakes.

THE WOLF—*Magnified.*

Nat. Size.

CATERPILLAR.



CATERPILLAR—*Magnified.*

The weevils belong to a group called *Rhynchophoridæ*, or snout-bearers. The characters of this group are well defined and enable a very superficial observer readily to distinguish its species from those of all other families, except perhaps the *Xylophagi*, or wood-eaters. The snout or beak of a weevil is its grand characteristic. Another distinctive mark of the whole family is furnished by the antennæ, which are usually knobbed at the end, and are inserted on the muzzle or snout, on each side of which there is generally a short groove to receive the base of the antennæ when they are turned backwards. Their feelers are very small, and for the most part concealed in the mouth. Few weevils are much observed on the wing, many which confine themselves to the ground have the elytra or wing cases soldered together at the suture, and are incapable of using them. The body is usually more or less arched lengthwise, and in many instances is pear-shaped. The legs are short, not fitted for running or digging. The feet are four-jointed, thus distinguishing them from the melolonthians, the feet of which have five joints. They make use of their snouts not only in feeding, but in boring holes into which they afterward drop their eggs.

WHEAT WEEVIL.—*Calandra Granaria.*

(*Natural Size.*)

WHEAT WEEVIL.—(*Magnified.*)

The larvæ of the snout beetles are mostly short fleshy grubs, of a whitish colour, and without legs. The head is covered with a hard shell, and the segments of their bodies are very convex. These characters will serve to distinguish them from the larvæ of flies. Their jaws are strong and horny, and with them they gnaw those parts of plants which serve for their food. It is in the larva state that weevils are most injurious to vegetation. Some of them bore into and spoil fruits, grain, and seeds; some attack the leaves and stems of plants, causing them to swell and become cankered; others penetrate into the solid wood, interrupt the course of the sap, and occasion the branch above the seat of

attack to wither and d... Most of these grubs are transformed within the vegetable substances upon which they have lived, some however, when fully grown, go into the ground, where they are changed to pupa, and afterwards to beetles.

The true *wheat weevil* (*Calandra granaria*) is a slender beetle of a pitchy red colour, about one-eighth of an inch long; its antennæ are scarcely longer than the head and the rostrum or snout; the terminal joint of its antennæ is a somewhat ovate club. The snout is slender and rather long, its thorax is elongate and a little narrowed in front, and covered with long oblong punctures; its elytra do not cover the abdomen, and are marked with deep lines, faintly punctured in the bottom. The larva is a small whitish worm about a line in length, comprising nine segments; the body soft, and the only external organs a pair of strong jaws. The pupa is white and somewhat transparent, and lies within the envelope of a grain of wheat like the kernel of a nut within the shell. The female deposits her eggs upon the wheat after it is housed, and the young grubs when hatched, immediately burrow into the wheat, each individual occupying a single grain, the substance of which it devours so as to leave nothing but the hull; and this destruction goes on within, while no external appearance leads to its discovery, loss of weight being the only evidence of the mischief caused among the grain. The fecundity of the female is so vast, that in a single season (according to one authority) upwards of 23,000 individuals may descend from one mother; Kirby and Spence say 6000 descendants may spring from a single pair; even from this calculation we may estimate the countless millions, equal in their effects to an Egyptian plague, which may spring up when the breeders are numerous. The perfect insect, also, feeds upon the grain, attacking kernels which have not been used by the larvæ, and eating portions of their substance; it does not appear to consume much of the interior of the grains, but seems to inflict damage principally by its numerous piercings and fractures of their envelopes.

There have been many remedies proposed against the attacks of the corn weevil. The passing of the grain through a fanning machine, as near as possible to the time when the great proportion of the insects are transforming from larvæ to pupæ, is cheaper and easier than any other proposed method, and if all the damaged grains were blown away, as from being very light they probably would, the insect might in a season or two, by this means, be expelled from the premises hitherto infected. These weevils may be effectually destroyed by kiln-drying the wheat; there is danger, however, of over-drying or calcining the grain by this process. Another scheme proposed, which is much approved, is to provide a small heap of grain, (barley is the best, as the insects are fondest of it,) this is to be placed near the principal store, which is then to be continually moved about; the weevils fond of quiet, will resort to the undisturbed heap. When collected there in sufficient numbers, they may be scalded in the heap with boiling water; this practice has been attended with highly favourable results. Grain that is kept cool, well ventilated, and is frequently moved, is said to be exempt from attack.

The *pea weevil* (*Bruchus Pisi*) is one of the most destructive of this family to the growing crops of the farmer. It is known in this country by the incorrect name of the pea-bug, but it is a weevil, and is supposed to be a native of the United States. The original meaning of the word Bruchus means devourer, a most appropriate name for this insect, so destructive to the pea crop.

Few people are aware how many insects they swallow unconsciously, while enjoying the luxury of early green pease. If the pods are carefully examined, small discoloured spots may be discovered inside, each one corresponding to a similar spot on the opposite pea. If this spot be opened, a small whitish grub destitute of feet will be found; this is the larva of the pea weevil, which lives

upon the substance of the pea, and arrives at its full size by the time that the pea becomes dry. This larva bores a round hole from the hollow in the centre of the pea to the hull, but leaves the latter and generally the germ untouched. Hence these damaged peas will frequently sprout and grow. The larva is transformed to a pupa within its cell in the pea, in the autumn, and before the spring, casts its skin again, becomes a beetle, and gnaws a hole through the thin hull in order to make its escape, which frequently does not happen before the peas are planted for a crop. The weevil lays its eggs singly in the punctures which it makes in the tender pod, just as the peas are formed, the grubs as soon as they are hatched penetrate the pod and enter the peas, making a hole so fine as hardly to be discovered, and which is soon closed up. Sometimes every pea in a pod will contain a weevil grub, and in some parts so great has been the injury, that the inhabitants have been compelled to give up the cultivation of this crop.*

In order to destroy this pea weevil, one plan recommended is to keep the seed peas one year over before planting them, in tight vessels. Others recommend putting the peas in hot water just before sowing them, by which means the weevils will be killed, and the sprouting of the peas will be quickened. Late sown peas escape the attacks of this weevil, as they are limited to a certain period for depositing their eggs.

The curculio which attack plums, peaches, and many other fruits, also causing a black warty disease on the branches of plum trees, is a beetle of the weevil tribe, called *Rhynchænus Nenuphar*, or *Curculio Nenuphar*, but as a description of these would be foreign to the proposed object of the present essay, we will not now dwell upon them.

The rice weevil (*Calandra Oryzæ*) is very destructive in the Southern States to the growing crops of rice, it also attacks stored grain; the remedies for them, are the same as those mentioned for the grain weevil, *Calandra Granaria*.

CHAPTER III.

ORTHOPTERA.

No Insect under this order particularly destructive to Wheat.—Locusts.

This order of insects will need but a very brief notice from us on the present occasion, for although it embraces the family of locusts, so well known for ages as extensive destroyers of vegetation, yet as Canada has so far escaped their ravages, they cannot receive a place in an essay devoted principally to insects injurious to the wheat crop. We may observe in passing, that locusts at various times have appeared in great abundance in different parts of the United States. In the State of Maine they often appear in great multitudes, and are greedy destroyers of the half-parched herbage. In 1749 and 1754, they were very numerous and voracious—no vegetables escaped them—they even devoured the potato tops; and in 1743 and 1756, they covered the whole country and threatened to devour every thing green. So great was the alarm they occasioned, that days of prayer and fasting were appointed on account of the threatened calamity. Their voracity extended to every vegetable, even to the tobacco plant and the burdock. The garments also of labourers, hung up in the field while they were at work, were destroyed in a few hours.† In 1838 the vicinity of Baltimore, Maryland, was infected by insects of this kind, and the crops of the Mormons, in the territory of Utah, have suffered dreadfully from their ravages.

* Harris. † Harris.

CHAPTER IV.

HEMIPTERA.

Chinch Bug.—Thrips.—Devastations and Remedies.

Under this head or order are classed the numerous family of Aphides and Bugs, which infest plants and commit great depredations. Of these, the *Chinch Bug* and *Thrips* are found to be hurtful to the wheat crop.

The *Chinch Bug.* The word bug is used by entomologists for various kinds of insects, all, like the bed-bugs, having the mouth provided with a slender beak, which, when not in use, is bent under the body, and lies upon the breast between the legs. Bugs have no jaws, but live by sucking the juices of animals and plants, which they obtain by piercing them with their beaks. Owing to the peculiar construction of the wing-covers of these insects, the hinder half of each being thin and filmy like the wings, while the fore part is opaque, the order is called *Hemiptera*, literally half wings. There are other insects having the same kind of beak, whose wing-covers are entirely transparent, and are yet classed under this order, because they so much resemble them in structure and habits. Bugs undergo three transformations, but retain nearly the same form in all their stages, the transformations consisting of a gradual developement of wing-covers and wings, and increase in the size of their bodies.

Kerby and Spence in their Introduction to Entomology, mention the chinch bug in the following terms:—"America suffers also in its wheat and maize from the attack of an insect, which, for what reason I know not, is called the "chintz bug-fly." It appears to be apterous, and is said in scent and colour to resemble the bed-bug. They travel in immense columns from field to field, like locusts, destroying everything as they proceed, but their injuries are confined to the States south of the 40th degree of north latitude. From this account the depredator here noticed should belong to the tribe of *Geocorisæ*, Latreille; but it seems very difficult to conceive how an insect that lives by suction, and has no mandibles, could destroy these plants so totally."

This description of the chinch bugs is not quite correct. They are not confined to the States south of the 40th degree; for Harris found one in his own garden in Cambridge, Massachusetts, and also received specimens from Wisconsin and Illinois. He also ascertained that the chinch bug is the *Lygæus leucopterus*, or white-winged Lygæus described by Mr. Say. In its perfect State it is is not apterous, but is provided with wings, and then measures about three-twentieths of an inch in length. It is readily distinguished by its white-wing covers, upon each of which there is a short central line, and a large marginal oval spot of a black colour. The rest of the body is black and downy, except the beak, the legs, the antennæ at base, and the hinder edge of the thorax, which are reddish yellow, and the fore part of the thorax which has a grayish lustre. The young and wingless individuals are at first bright red, changing with age to brown and black, and are always marked with a white band across the back. The eggs of the chinch bug are laid in the ground, in which they have been found in great abundance, at the depth of an inch or more. They make their appearance on wheat about the middle of June, and may be seen in their various stages of growth on all kinds of grain, on corn, and on herds grass, during the whole summer.*

The *Thrips* are such exceedingly minute insects, that to the naked eye they seem but as little specks, or rather like short lines, not exceeding the length and thickness of the letter *i*. In spring, these minute creatures may be found running about the petals of flowers, particularly the dandelion; but in summer

* Harris.

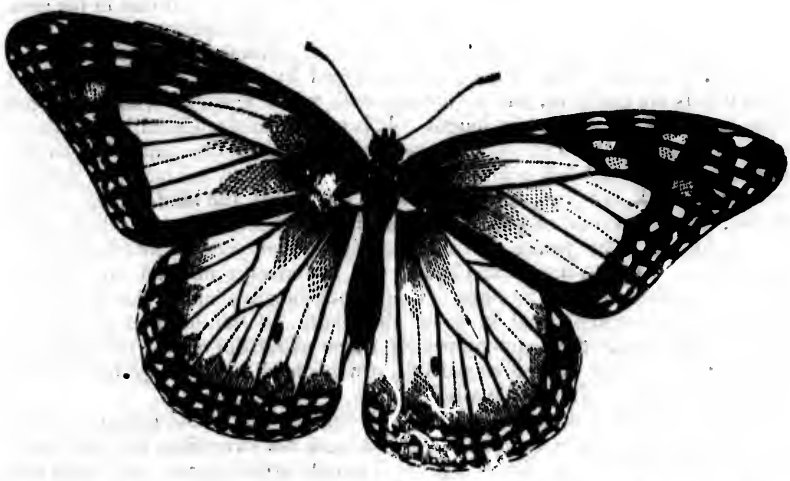
and autumn they fly into houses in considerable numbers, alighting upon the hands and face, and occasioning that troublesome irritation which many people experience during hot weather, without knowing the cause. These insects are highly noxious to the farmer, by deriving their nourishment from the embryo grains of the wheat plant, insinuating itself between the internal valve of the corolla and the grain, it inserts its instrument of suction in this last, and causes it to shrivel by depriving it of all its juices. In 1805 one-third of the wheat crop on the richest plains of Piedmont was destroyed by this seemingly insignificant little insect; in the same year the wheat in England also suffered from the same cause. In its larva state this insect is smaller than the maggot of the wheat fly; it is orange coloured, and is provided with six legs, two antennæ, and a short beak, and is very nimble in its motions. It may probably be destroyed by giving the grain a thorough coating of slacked lime. The *Aphides* or plant-lice to which family the thrips belong, are exceedingly prolific; Reaumur computes that each aphis may produce about 90 young, and that, in consequence, in five generations the descendants from a single animal would amount to the astonishing number 5,904,900,000, or nearly six billions.

CHAPTER V.

LEPIDOPTERA.

Angoumois Moth.—Noctua Cubicularis, or Grain-Worm.—Tinea Granella, or Grain-Moth.—Anacampsis Cerealella, or Angoumois Moth.—History.—Devastation.—Remedies.

This order comprises butterflies, hawk-moths or splinges, and moths. Their larvæ are called caterpillars, than which there are no insects so commonly and so universally destructive; they are inferior only to locusts in voracity, and exceed them in their powers of increase. As each female usually lays from two hundred to five hundred eggs, some idea may be formed of the millions which would spring from one hundred butterflies in the course of three or four



generations. Caterpillers generally subsist on vegetable food, hence their injuries to vegetation are very great, and must have attracted the notice of every attentive observer.

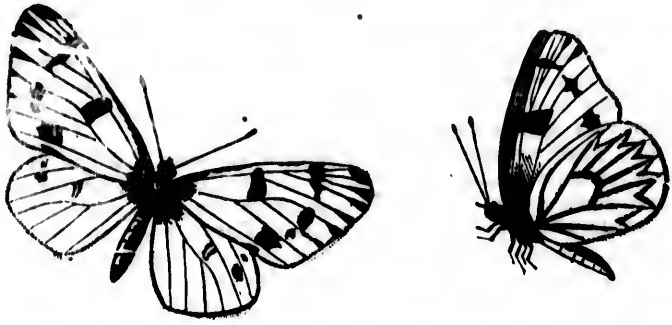
The word *lepidoptera* means scaly wings. The mealy powder with which the wings of butterflies and moths are covered, when magnified by a powerful lens are found to consist of little scales, lapping over like the scales of fishes. The body of these insects is also more or less covered with the same kind of scales, together with hair or down in some species.

All lepidopterous insects may be arranged under three primary divisions which are perceptible to the most inexperienced observer:

1st. The Butterflies (*Papiliones*) have the antennæ knobbed at the end, and fly by day only.

2nd. The Hawk-Moth (*Sphinges*) generally have the antennæ thickened in the middle, and tapering at each end. They fly in the morning and evening twilight.

3rd. The Moths (*Phalenæ*) the antennæ taper from the base to the extremity, and are either naked or are feathered on each side. They fly mostly by night.



The insects of this order, that are injurious to wheat, are the larvæ of the *noctua cubicularis*, the *tinea granella*, and the *anacampsis cerealella*, all of them moths, and the two latter confining their depredations to stored grain.

Noctua Cubicularies.—The larvae of these moths are small caterpillars, which have been found very injurious to the wheat crop in England, by eating the grain before and after it is ripe. It is figured and described by Mr. John Curtis, in the Journal of the Royal Agricultural Society of England. They also exist in North America and are known by the names, *wheat-worm*, *gray-worm*, and *brown-weevil*. The name of *grain-worms* has likewise been applied to them, hence, they may have sometimes been confounded with the larvæ of the wheat-midge, *Cecidomyia Tritici*; they are, however, completely distinct, and do not belong to the same order of insects. The larva is from three to five-eighths of an inch long, of a yellowish brown color, it has twelve legs, and has the power of spinning and suspending itself by a thread. It feeds on the kernel in the milky state, and also devours the germinating end of the ripened grain. It is found in great numbers in the chaff when the grain is threshed. Unlike the maggots of the wheat-fly, with which they have been confounded, they remain devouring the grain until after the time of harvest. They have been seen in immense numbers upon barn floors after the grain has been threshed, but they soon crawl away and conceal themselves in crannies where they most likely undergo their transformations. They are supposed by some to be identical with the clover-worm. They may be distinguished from the maggot of the wheat-midge by their brownish colour, being three-eighths of an inch in length, having legs, and capable of suspending themselves by a thread of their own spinning. Whereas the wheat-midge maggot is of a deep

yellow colour, only one-tenth of an inch long, destitute of legs, and unable to spin a thread.

These destructive caterpillars may be separated from the wheat by threshing and winnowing; the chaff containing them should be put into large tubs and boiling water poured upon it sufficient to kill all the insects.

Tinea Granella, or corn moth.—This insect sometimes attacks grain in the sheaf, but principally infests granaries, feeding on all sorts of grain, but most partial to wheat. The perfect moth does not exceed half an inch in length; its wings when laid over each other slope at the sides. The upper wings are whitish coloured, with dark brown and dusky spots; its body is brown variegated with white, and its head has a thick tuft of yellowish-white hairs. Thirty eggs or upwards are laid by each female; they are so minute as to be scarcely observable to the naked eye; one or two are attached to each grain of wheat. The larva is speedily hatched, and immediately bores its way into the grain, closes up the opening by which it entered, and remains in the interior till it eats up every thing but the husk; this process it keeps on repeating in different grains till it is full grown; it glues together all the grains which it has used, and tracks all the path over which it passes with a silken and somewhat excrementitious web; when full grown it leaves the chain of emptied grains on which it has fed, and runs across all the neighbouring grain, covering it with greyish-white webs.

The full grown caterpillar is about half an inch long and has 16 feet, its body is yellowish-white, its head brownish-red, and its neck marked with two transverse brown stripes. When running across the grain they are in search of a retreat in which to undergo their transformation, they get into cracks in the floor and around the corn bin, and each spins arounds itself an oval pod or cocoon about the size of a grain of wheat, from which in due time the full grown moth escapes. This insect prevails in all parts of North America and has been mistaken for the corn weevil.

In order to destroy these insects when the existence of the chrysalids is known or auspected, the floor walls and roof of the granary ought to be well swept with a hard brush, or washed with some caustic solution, such as the ley of wood ashes. When the caterpillars have effected a lodgment and the corn is not to be used for sowing, the whole of the grain should be kiln dried.

ANGOUMOIS MOTH.

Magnified Catterpillar.

Natural Size Catterpillar.

Magnified Moth.

Natural Size Moths.

Anacampsis Cerealella, or *Angoumois Moth*, has been found to be more destructive in granaries in some provinces of France than the preceding kind. In its perfect state it is a little moth of a pale cinnamon-brown colour above, having the lustre of satin, with narrow broadly fringed hind wings of an ashen or leaden colour, two thread-like antennæ, a spiral tongue of moderate length, and two tapering feelers turned over its head. It lays from sixty to ninety eggs, placing them in clusters of twenty or more on a single grain. From these are hatched, in from four to six days, little caterpillars not thicker than hairs. They immediately disperse, and each one selects for himself a single grain and burrows into it at the most tender part, commonly where the

germ springs forth. Remaining concealed there it devours the mealy substance within the hull; and this goes on so secretly that the loss is only detected by the softness of the grain or by deficiency in the weight. The caterpillar is not more than one-fifth of an inch long, of a white colour with a brownish head, six small pointed legs, and ten very small prop legs. Having eaten out the heart of the grain, which is enough for all its wants, it spins a silken web or curtain to divide the hollow grain lengthwise into two unequal chambers, the smaller containing the rejected fragments of its food, and the larger cavity serving instead of a cocoon, wherein the insect undergoes its transformations. The insects of the first, or summer brood, come to maturity in about three weeks, remain but a short time in the chrysalis state, and turn to winged moths in the autumn, and at this time may be found in the evening in great numbers, laying their eggs on the grain stored in barns and granaries. The moth-worms of the second brood remain in the grain through the winter, and do not change to winged insects till the following summer, when they come out, fly into the fields at night, and lay their eggs on the young ears of the growing grain. Besides the two principal broods others are produced during the whole summer, the production of the insects being retarded or accelerated by differences in the temperature of the air. When damaged grain is sown it comes up very thin, the infected kernels seldom sprout, but the insects lodged in them remain alive, finish their transformations in the field, and in due time come out of the ground in the winged form."*

The Angoumois moth is unknown in England; but has been found in several parts of the United States, more particularly those between the thirty-sixth and fortieth parallel of north latitude; it has also been found in New England where the cold weather has probably checked its progress. There is reason to believe that it has been introduced into the States from Europe, *and persons fond of introducing seed wheat from foreign parts into this country should be on their guard, lest they bring in this plague also.*

These moths may be effectually destroyed by drying the damaged grain in an oven or kiln, at a heat of one hundred and sixty-seven degrees, Fahrenheit, for a period of twelve hours. Or the heat may be reduced to one hundred and four degrees and the time lengthened to two days. Fumigation in close vessels with the gas of burning charcoal, is an effectual remedy which has the advantage of neither imparting a bad flavour to the grain, or impairing its powers of vegetating. A low temperature checks the propagation of the corn moth; the larvæ not being able to survive the winter in those places where the thermometer falls to zero.

CHAPTER VI.

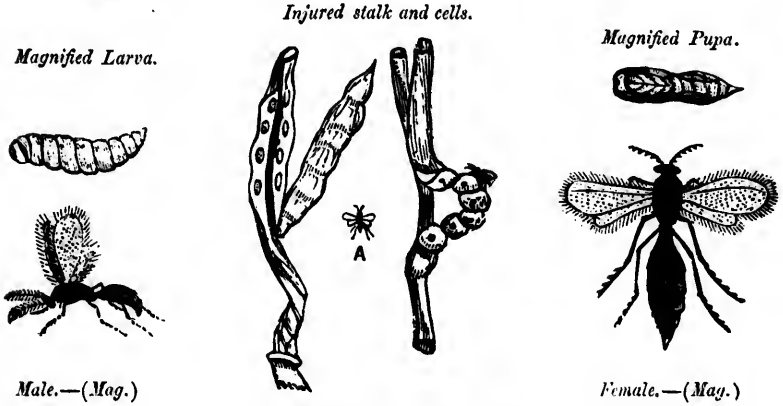
HYMENOPTERA.

Joint-worm—Habits—Ravages—and Preventives.

Under this order comes the Joint Worm, (*Eurytoma hordei*) an insect which has committed great depredations in the wheat crops of Virginia and other parts of the United States. The body of the Eurytoma Hordei is jet black, and slightly hairy. The head and thorax are opaque, and rough with dilated punctures. The hind body is smooth and polished. The thighs, shanks, and claw joints are blackish; the knees and other joints of the feet are pale yellow. The females are twelve or thirteen-hundredths of an inch long. The males are rather smaller, and are distinguished from the females by the following characters.

*Harris, who compiled the above from the "Memoires" of Reaumur.

They have no piercer. The joints of their antennæ are longer, and are surrounded with whorls of little hairs. The hind body is shorter, less pointed behind, and is connected with the thorax by a long stem or peduncle. The female lays several eggs in the outer sheath of the stalk of the wheat plant, above the joints, sometimes in the joint itself, the substance of which becomes enlarged and distorted. The hollow of the stem becomes entirely obliterated at some parts by the pressure of the enlarged sheath, while the surface exhibits several long pale spots, slightly elevated like a blister. Each of the blistered spots covers an elongated cavity, which contains a footless worm or maggot about the eighth of an inch in length, of a pale yellow colour, of an oval form, and divided into thirteen segments.*



JOINT WORM.—(*Eurytoma hordei.*) [A] *Nat. Size.*

The ravages of the joint worm, according to Harris, in the wheat fields of Virginia, were first observed in Albemarle County, about ten years ago, and have since extended to an alarming extent in many of the adjacent counties; the loss occasioned amounting often to one-third of the crop, in some cases, the farmers did not reap as much as they sowed. As the disease is seated mostly near the base of the straw, in or near the second or third joint, the greater part of the diseased portions will be left in the stubble when the grain is reaped. Most of the insects remain unchanged in the stubble until the following year, consequently it is of no use to plough under the stubble, as it has been found in Massachusetts that the insects undergo their transformations when so turned under ground, and easily make their way to the surface when the transformations are completed. The most effectual method then of destroying these insects is to burn the stubble containing them. All the refuse and straw unfit for fodder should likewise be burnt. These precautions should be observed for several successive years, and if carefully performed, will almost be sure to exterminate the *Eurytoma*.

"At the Joint Worm Convention, held at Warrentown, Virginia, in 1854, the following method was recommended:—Prepare well the land intended for wheat, and sow it in the beginning of autumn, with the earliest and most thrifty and hardy varieties, and do nothing to retard the ripening of the crop, by grazing or otherwise. Use guano or some other fertilizer liberally, particularly when seeding corn land or stubble. Burn the stubble on every field of wheat, rye, or oats, and all thickets or other harbors of vegetable growth, contiguous to the crop. Sow the wheat in as large bodies, and in as compact forms as prac-

* Patent Office Report, U. S., 1854.

ticable, and if possible, neighbours should arrange amongst themselves to sow adjoining fields in the same year. Feed all the wheat, or other straw, which may be infected, in racks or pens, or on confined spots, and in April set fire to all refuse fragments about the racks, and on or before the first of May carefully burn all the straw which has not been fed. The refuse of wheat, such as screenings, &c., should also be destroyed, as the pupa case is hard, and not easily softened by dampness or wet.."†

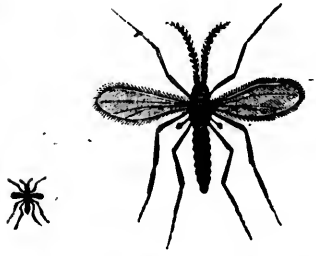
These directions are worthy of careful attention, as being the remedies proposed by those who have become painfully and practically acquainted with this destructive insect. A free use of manure and thorough tillage, by promoting a vigorous and rapid growth of the plant, is likely to render it less liable to suffer from the attacks of this insect. Large fields, sown with a liberal supply of seed, will probably escape better than those that are smaller and thinner sown, as the insects will not be able to penetrate so far when about to lay their eggs. Hence the advantage of neighours combining where possible, to have their wheat sown in a large block.

CHAPTER VII.

DIPTERA.

Cecidomyiæ—Hessian Fly—Wheat-midge—History—Devastations—Remedies.

Under this order are classed all insects having only two wings, with two little knobbed threads in the place of hind wings, and a mouth formed for sucking or lapping. The word Diptera signifies *two-winged*. The young insects hatched from the eggs of gnats and flies belonging to this order, are fleshy larvæ, usually of a whitish colour, and without legs.



Nat. Size.

Joints of Antennæ. Male.—(Mag.)

Ventral view of the terminal segments of the abdomen. (Mag.)

HESSIAN FLY. *Male.—(Mag.)*

The far-famed Hessian fly, and the wheat midge, belong to the family called *Cecidomyiadæ*, or gall gnats. The insects of this family are very numerous, and most of them in the maggot state live in galls or unnatural enlargements of the stems, leaves and buds of plants, caused by the punctures of the winged insects in laying their eggs. The Hessian fly, wheat midge, and some others, differ from the majority in not producing such galls. The proboscis of these insects is very short, and does not contain the piercing bristles found in the long proboscis of the biting gnats and mosquitos. Their antennæ are long, composed of many little bead-like joints which are more distant in the males than in the other sex, and each joint is surrounded with short hairs. Their eyes are kidney shaped; their legs long and slender; their wings have only two, three, or four veins in them, and are fringed with little hairs round their edges; when not in use their wings are generally carried flat on the back. The hind body of

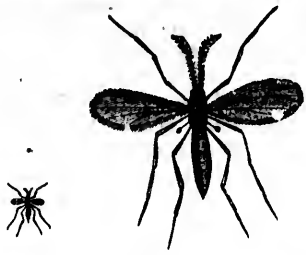
* Harris.

the female often ends with a retractile, conical tube, wherewith they deposit their eggs. Their young are little footless maggots, tapering at each end, and generally of a deep yellow or orange colour. They live on the juices of plants, and undergo their transformations either in these plants, or in the ground.

The *Hessian fly*. The American Entomologist, Say, was the first who satisfactorily determined the species and genus of this insect, under the name of *Cecidomyia destructor*. It obtained its common name from a supposition which seems well founded, that it was brought to this continent in some straw by the Hessian troops under the command of Sir William Howe in the War of the Revolution. The statement of Sir Joseph Banks in his Report to the British Government in 1789, that "no such insect could be found to exist in Germany or any other part of Europe," is not correct, for this insect or one like it, had long been known in the vicinity of Geneva; an account of it was given by Duhamel in his "Practical Treatise of Husbandry,"* and in a communication made to the Duke of Dorset, in 1788, by the Royal Society of Agriculture of France. It was not until the autumn of 1833, that this destructive insect, or a species closely allied to it, was observed in Hungary, whether from its previous rarity it had been overlooked, or had not found its way into the Austrian dominions, is not known. Kollar† states that it appears from a report transmitted to the Arch-Duke Charles, that in the beginning of June the ears of wheat were observed to droop and the straw to bend, on his estates at Altenburgh, although the crop was previously in fine condition. In a few days, patches on the poorest soil in different parts became entangled, as if matted together by heavy rains or high winds, which were supposed at first actually to have been the cause. This soon proved to be unfounded, for the mischief gradually spread from the poor to the best lands, until the whole crop was blighted. Two-thirds of the straw at least was laid in less than a week, and the work of devastation was completed by the heavy fall of rain which took place during the latter part of June. The straw thus prostrated produced only small abortive ears; the few grains they contained were shrivelled, and would scarcely ripen, and the straw was of a very bad quality. On examining the roots of those plants which had died off, the soft straw where the larvæ had stationed themselves in families, within the sheath of the leaf, appeared withered, tough, and brown, yet not wounded. At this period the larvæ were transformed into pupa, which were found in clusters inside of each leaf sheath, at the first joint next to the crown of the root. On the estates of the Duke of Saxe Cobourg, at Weikendorf, and in other parts of the neighbourhood, whole fields were destroyed. In the year 1834, it was discovered in Minorca, near Toulon in France, and in the vicinity of Naples. It never seems to have been detected in Great Britain, and was first observed on this continent in the year 1776, in the neighbourhood of Sir William Howe's debarkation on Staten Island, and at Flat Bush, on the west end of Long Island. Having multiplied in these places, the insect gradually spread over the southern parts of New York and Connecticut, and continued to proceed inland at the rate of fifteen or twenty miles a year. They reached Saratoga, two hundred miles from their original station, in 1789. They were found west of the Alleghany Mountains in 1797, having apparently advanced about thirty miles every summer. Wheat, rye, barley, and even timothy grass were attacked by them, and so great were their ravages in the larva state, that the cultivation of wheat was abandoned in many places where they had established themselves. In a communication by Mr. J. W. Jeffreys, published in the sixth volume of Buel's "Cultivator," it is stated, that soon after the battle of Guilford in North Carolina, the wheat crops were destroyed by the Hessian fly in Orange County,

* Page 90, 4to., London, 1759. † Kollar's Treatise.

through which the British Army, composed in part of Hessian soldiers, had previously passed. Harris, to whose valuable work we are indebted for these statements, seems to think that in this instance the chinch bug (*Lygæus leucopterus*) may have been taken for the Hessian fly, and he says, it shows how prevalent was the belief respecting the introduction of this fly by the Hessian troops, which opinion he thinks deserving of some credit.*



Nat. Size. HESSIAN FLY. *Female.—(Mag.)*

Joints of the Antennæ—(Mag.)

The head, attennæ, and thorax of the Hessian fly are black, the hind body is tawny, more or less widely marked with black on each wing, and clothed with fine grayish hairs; the body measures about one-tenth of an inch in length. The egg tube of the female is rose-coloured, the wings are blackish, except at the base where they are tawny and very narrow; they are fringed with short hairs, rounded at the tip, and expand one quarter of an inch or more. After death the hind body contracts and becomes almost entirely black. The legs are pale red or brownish, and the feet black. The antennæ are surrounded with whorls of short hairs, the number of joints vary from fourteen to seventeen, besides the basal point which seem double. The form of the joint differs according to the sex; those of the male being globular, and those of the female, except at the base, oblong-oval.†

Two broods of this insect are brought to maturity in the course of a year, and the flies appear in the spring and autumn, earlier or later according to the latitude of the place. It has been asserted by some that the flies lay their eggs on the grain in the ear; whether this be true or not it is certain that they do lay their eggs on the young plant long before the grain is ripe, generally speaking as soon as the grain is sprouted, and begins to show a leaf or two, the flies appear in the fields, and having paired, begin to lay their eggs, which occupies them for several weeks. In the eighth volume of the *Cultivator*, there is an

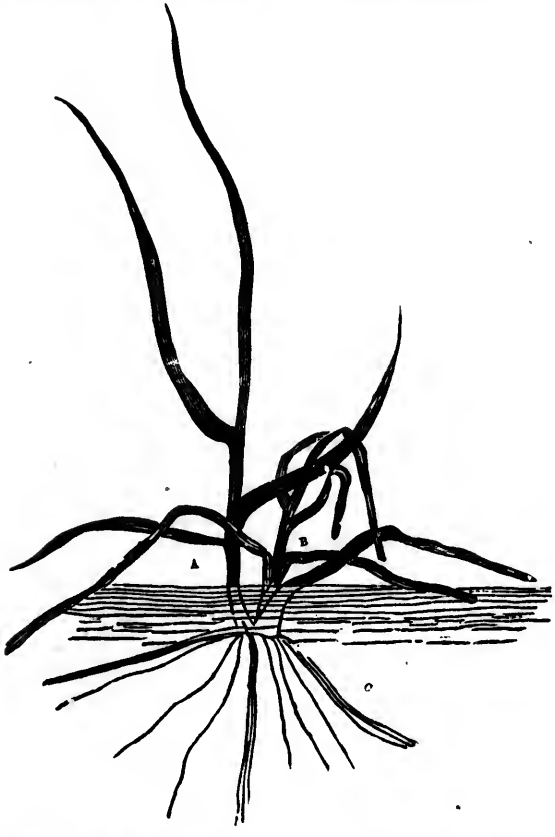
Stem of Autumn wheat with the white colored maggot upon it.

Stem with the maggot in pupa or "flax seed" state.

account, by Mr. E. Tilghman, of Queen Ann County, Maryland, of these insects, and the manner in which they deposit their eggs. He says: "By the second

*Harris. † Harris.

week of October, the first sown wheat being well up, and having generally put forth its second and third blades, I resorted to my field in a fine warm afternoon to endeavour, to satisfy myself, whether the fly did deposit the egg on blades of the growing plant. Selecting a favorable spot, I placed myself in a reclining position in a furrow, and had been on the watch but a minute or two, before I discovered a number of small black flies alighting and sitting on the wheat plants around me, and presently one settled on the ridged surface of a blade of a plant completely within my reach and distinct observation. She immediately began depositing her eggs in the longitudinal cavity between the little ridges of the blade." Dr. Chapman, who wrote in 1797, says, that the Hessian fly lays her eggs in small creases of the young leaves of the wheat. Mr. Havens, who wrote a history of this insect, which is contained in the first volume of the Transactions of the Society for the promotion of Agriculture in New York, says, that the fly lays her eggs on the leaves. In the fortieth number of the *Connecticut Farmer's Gazette*, Mr. Herrick says: "I have repeatedly, both in autumn

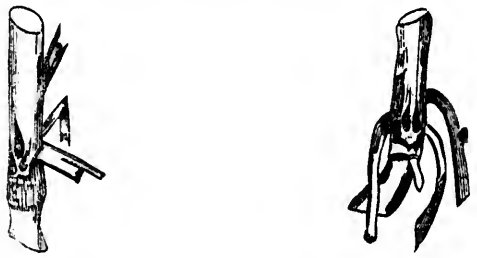


Appearance of a healthy [A] and of a diseased [C] shoot of wheat in autumn, the worms lying at [C].

and spring, seen the Hessian fly in the act of depositing eggs on wheat, and have always found, that for this purpose she selects the leaves of the young plant. The eggs are laid in various numbers on the upper surface of the strap-

shaped portion, or blade, of the leaf." The number on a single leaf, he says, is often twenty or thirty, and sometimes much greater. The egg is about a fiftieth of an inch long, and four thousandths of an inch in diameter, cylindrical, translucent, and of a pale red colour. Under favourable circumstances, if the weather prove warm, they will hatch in four days.

"The maggots or larvæ, when they first come out, are of a pale red colour. They immediately crawl down the leaf, and work their way between it and the main stalk, passing downwards till they come to a joint, just above which they remain, a little above the surface of the ground, with the head towards the root of the plant. Having thus fixed themselves they become stationary, and never move from the place till their transformations are completed. They do not eat the stalk, neither do they penetrate within it, as some persons have supposed, but they lie lengthwise upon the surface, covered by the lower part of the leaves, and are nourished wholly by the sap, which they appear to take by suction.



Appearance of larvæ of the Hessian fly in the pupa (flax seed) state, on stems of wheat plants from which the leaves have been stripped.

They soon lose their reddish colour, turn pale, and become clouded with whitish spots; and through their transparent skins, a greenish stripe may be seen in the middle of their bodies. As they increase in size, and grow plump and firm, they become imbedded in the side of the stem, by the pressure of their bodies on the growing plant. One maggot thus placed seldom destroys the plant, but, when two or three are fixed in this manner around the stem, they weaken and impoverish the plant, and cause it to fall down, or to wither and die. They usually come to their full size in five or six weeks, and then measure about three-twentieths of an inch in length. Their skin now gradually hardens, becomes brownish, and soon changes to a bright chestnut colour. This change usually happens about the first of December."*

The insect in this form, has been commonly likened to a flax-seed, and this has been called the flax-seed state. While this change of the colour and texture of the skin is going on, the body of the insect, gradually becomes detached from the skin, and lies within it a motionless grub. This flax-seed shell has been correctly called a *puparium* or *pupa* case, because the pupa is subsequently matured within it. The process of growth goes on, and, by and by, on opening the leathery skin or puparium, you find the pupa so far advanced that some of the members of the future fly are discernible through the skin which envelopes and fetters it on all sides. Towards the end of April, and in the fore part of May, as soon as the weather becomes warm enough, the insects are transformed to flies, making their escape by breaking through one end of their shells.†

"Very soon after the flies come forth in the spring, they are prepared to lay their eggs on the leaves of the wheat sown in the autumn before, and also on the

* Harris. † Harris.

spring sown wheat, which begins, at this time, to appear above the surface of the ground. They continue to come forth and lay their eggs for the space of three weeks, after which they entirely disappear from the fields. The maggots hatched from these eggs, pass along the stems of the wheat, nearly to the roots, become

VIEW OF DORMANT LARVA TAKEN FROM THE LARVA CASE.

Fig. 1. Fig 2. Fig. 3. Fig. 4 Fig. 5. Fig. 6.

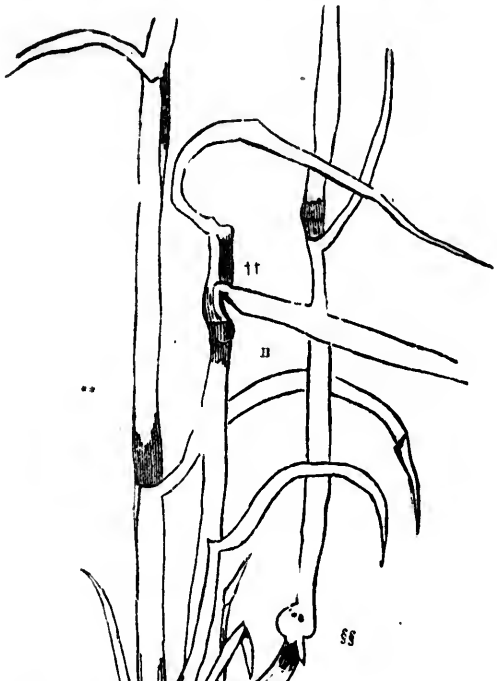
1. Magnified appearance of the worm when taken out of its larva case. 2 Magnified dorsal view of the worm or active larva. 3. Magnified view of the "flax seed" or larva case. 4. Magnified ventral view of the same. 5. Magnified lateral view of the same. 6. The pupa removed from the pupa case.

stationary, and take the flax-seed form in June and July. In this state they are found at the time of harvest, and when the grain is gathered they remain in the stuble in the fields. To this there are some exceptions, for a few of the insects do not pass down so far as to be out of the way of the sickle when the grain is reaped, and consequently will be gathered and carried away with the straw. Most of them are transformed to flies in the autumn, but others remain unchanged in the stubble or straw till the next spring. Hereby, says Mr. Havens, it appears evident that they may be removed from their natural situation in the field, and be kept alive long enough to be carried across the Atlantic; from which circumstance it is possible they might have been imported in straw from a foreign country. In the winged state, these flies, or more properly gnats, are very active, and though very small and apparently feeble, are able to fly a considerable distance in search of fields of young grain. Their principal migrations take place in August and September in the Middle States, where they undergo their final transformations earlier than in New England. They sometimes take the wing in immense swarms, and being probably aided by the wind, are not stopped in their course by mountains or rivers."* On their first appearance in Pennsylvania, they were seen to pass the Delaware like a cloud. Their numbers were so great that in wheat harvest the houses swarmed with them, to the extreme annoyance of the inhabitants. They filled every plate or vessel that was in use, and five hundred were counted in a single glass tumbler, exposed to them a few minutes with a little beer in it.†

Several means have been recommended for lessening or preventing the ravages of the Hessian fly; perhaps the most effectual method will be *to burn the stubble* immediately after harvest, and then ploughing and harrowing the land; as the greater proportion of the pupæ, from the spring laid eggs, remain in the stubble after harvest, it is evident that burning the stubble must get rid of so many of them. It is also recommended to procure seed from uninfected districts, but it is requisite that whole neighbourhoods should join in this precaution and persevere in it for two or more years in succession. It has been found in the States that *luxuriant crops more often escape injury than those that are thin and light.* From this we learn the importance of thoroughly working the land and bringing it to a high state of tilth before sowing wheat in it; a liberal use of fertilizing manures, and every thing that can be done in the way of early sowing or any thing that will insure a vigorous and forward state of the crop, will, in a great measure, act as preventives against the devastations of these destructive insects. Sowing the fields with wood ashes in the proportion of two bushels to an acre, in the autumn, and again in the first and last weeks in April, and as late in the month of May as the sower can pass over the wheat without injury to it has been found useful. Mr. Herrick, a writer in the American

*Harris. †Kirby and Spence.

Journal of Science, recommends, that, the stouter varieties of wheat ought alwa,s to be chosen, and the land should be kept in good order. If fall wheat is sown late, some of the eggs will be avoided, but the risk of winter killing the plants will be incurred, added to which they will still be liable to the insects depositing their eggs in the spring. Favourable reports have been made upon



Appearance of a healthy (**) and two diseased stalks of wheat, at harvest-time. (††) Stalk broken, from being weakened by the worms. (§§) Base of sheath swollen from worms having lain under it, and perforated by parasites coming from those worms. —*From Dr. Fitch's Report.*

the practice of allowing sheep to feed off the crop late in the autumn, and it has also been recommended to turn them into the fields again in the spring, in order to retard the growth of the plant till after the fly has disappeared; but this method must be regarded as very hazardous; and probably the practice of burning the stubble, procuring seed from uninfected districts, or fumigating infected seed with the gas of burning charcoal in tight vessels, or submitting it to the vapour of *chloroform* in similar vessels, together with judicious management of the soil, will be found the best means of lessening the evils arising from the depredations of this noxious insect.

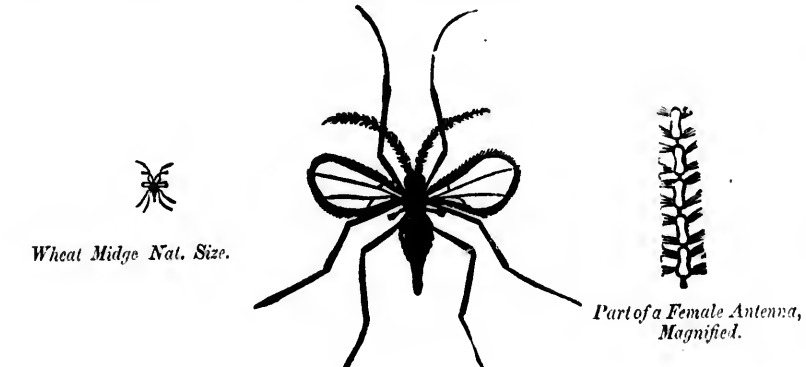
A benevolent Providence has ordered that the eggs, larvæ, and pupæ of the Hessian fly should be the prey of a host of parasitical insects. A large proportion, probably more than nine-tenths of every generation of this fly is thus

destroyed, according to Mr. Herrick's statement. These parasites are all minute Hymenopterous insects, similar in their habits to the true ichneumon flies. The chief parasite of the pupa is the *carapheon destructor* of Say, a shining black four-winged fly, about one-tenth of an inch in length. This has often been taken for the Hessian fly, from being seen in wheat fields in vast numbers, and from its being found to come out of the dried larva-skin of that fly. In the month of June, when the maggot of the Hessian fly has taken the form of a flax seed, the carapheon pierces it, through the sheath of the leaf, and lays an egg in the minute hole thus made. From this egg is hatched a little maggot, which devours the pupa of the Hessian fly, and then changes to a chrysalis within the shell of the latter, through which it finally eats its way, after being transformed to a fly. This last change takes place both in the autumn and in the following spring. Some of the females of this or of a closely allied species come forth from the shells of the Hessian fly, without wings, or with only very short and imperfect wings, in which form they somewhat resemble minute ants.

Two more parasites, which have not yet been described, also destroy the Hessian fly, while the latter is in the flax-seed or pupa state. The egg parasite of the Hessian fly, Mr. Herrick says, is a species of *platygaster*, which is very abundant in autumn, when it lays its own eggs, four or five together, in a single egg of the Hessian fly. This, it appears, does not prevent the latter from hatching, but the maggot of the Hessian fly is unable to go through its transformations, and dies after taking the flax-seed form. Meanwhile its intestine foes are hatched, come to their growth, spin themselves little brownish cocoons within the skin of their victim, and in due time are changed to winged insects, and eat their way out.

So wonderful are the ways of God! All creation teems with life, and overflows with the glory of the Creator, exhibiting in myriads of instances the most exquisite contrivances for the production of beneficial parasitical animals, and the destruction of noxious ones, each minute insect performing its own proper functions, and showing an exact fitness for the purpose for which it was appointed by the infinite wisdom of Him who created all things and pronounced them good.

The WHEAT-MIDGE, (*Cecidomyia tritici*) or wheat-fly, as it is commonly called, is nearly allied to the Hessian fly, or *cecidomyia destructor*, both are de-



Wheat Midge Nat. Size.

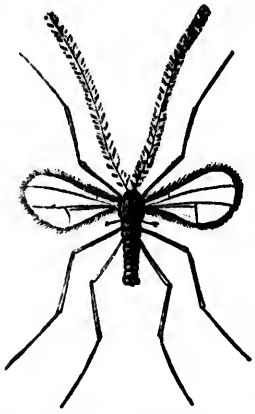
Part of a Female Antenna, Magnified.

Magnified female clear winged Wheat Midge—(Cecidomyia Tritici.)

structive to the wheat crop, but differ in their mode of operation. The larvæ of the Hessian fly feeds upon the stem of the plant, exhausting its juices and

causing it at length to wither and fall. The wheat-fly, *cecidomyia tritici* lays, its eggs in the young ear of wheat just as it blossoms, where the young maggot as soon as it is hatched feeds on the pollen and juices of the ovary of the blossom, thus destroying the reproductiveness of the floret in which it is lodged, so that the seed never forms and the young germ shrivels up and decays.

"The wheat-fly is very minute, scarcely exceeding the twelfth part of an inch in length, and resembling a small gnat or midge. The female is orange-coloured, her eyes are intensely black, meeting on the crown, and covering nearly the whole head. The antennæ are pale brown, long as the body and clothed with longish hairs, they consist of twelve joints, which, except two at the base, are oblong, oval, and narrowed somewhat in the middle. The abdomen is rather short and tapering to the apex, which is furnished with an ovipositor nearly thrice as long as the body. The wings are incumbent in repose, longer than the body, yellowish white, and beautifully irideseent, or rainbow like, and fringed with delicate hairs. The two halteres, or poisers, are large and capitate. The six legs are long, slender, and nearly of equal length. The thighs and shanks are equally long. The tarsi, or feet, five jointed. The claws are very minute. The male is more rarely seen, they are usually smaller than the females and somewhat paler in colour. The antennæ of the males are twice as



Part of a Male Antenna.

Foot of Wheat Midge highly magnified.

Magnified Male of the clear-winged Wheat Midge.

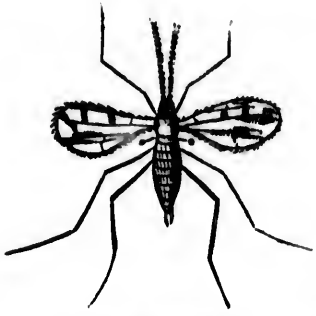
long as the body and consist of twenty four-joints, which, except the two basa ones, are globular. The ovipositor of the female is not seen, and would not by a stranger be supposed to exist in the ordinary condition of the fly; but is readily discovered by pressing the anus, or at the season of oviposition, or laying the eggs."*

The wheat-midge makes its appearance in wheat fields just about the time when the ear is beginning to emerge from its leafy envelope, most commonly in the early part of June. It readily escapes the observation of persons ignorant of its character, or not looking out for it, but to an intelligent observer it may be seen on calm evenings swarming about in small undulating clouds, in the manner of gnats and other kindred species, and it is occasionally seen also in the mornings and during the day. Each female usually chooses as the receptacle of her eggs an ear just emerging from the sheath, and she introduces them by means of her ovipositor into the floret, and while doing so keeps her arms nearly at right

*Rural Cyclopedia.

angles with the margin of the florets glume, or outer husk. She is so engrossed with her occupation that she is not easily disturbed, and may even go on with her operations though a magnifying glass should be held close to her by an observer; and she slowly introduces her ovipositor, and slowly parts with her eggs, and then cautiously and deliberately withdraws the instrument. So many as

Wheat Midge at rest, with its wings in their natural position—magnified.



Spotted winged Wheat Midge [C.Cerealis] *magnified.*

Magnified wing of spotted winged Wheat Midge.

thirty-five flies may sometimes be seen at one time upon one ear. Mr. Kirby, after some vain attempts to see the eggs pass through the long retractile tube, eventually witnessed that curious phenomenon. "I gathered," said he, "an ear upon which some of the insects were busy, and held it so as to let a sunbeam all upon one of them; examining its operations under the three glasses of a pocket microscope, I could then very distinctly perceive the eggs passing, one after another, like minute air-bubbles through the vagina, the aculeus being wholly inserted in the floret." The eggs in passing through the oviduct, receive a coating of glutinous matter, which causes them to adhere firmly to the glumes or outer husk of the floret; and they are deposited in small clusters varying in number from two to upwards of twenty, and they amount in the aggregate to so vast a multitude as might seem to threaten terrible desolation or even utter destruction to wheat crops. The eggs are oblong, transparent, and of a pale buff colour, and are hatched in the course of ten or fourteen days. The minute maggots which proceed from them have the same general form as other dipterous larvæ, and are at first transparent and colourless, but soon begin to assume hues of straw colour, yellow, saffron, and orange, according to their age. They then feed upon the young germ, perhaps eating the pollen or fructifying principle of the flower, thus preventing the impregnation of the grain, so that the seed never forms, and the parts of fructification lose all their virus and shrivel and decay. So many as forty-seven have been counted in one floret, and even the smallest number ever present seem to be perfectly competent to do the work of destruction. The flies are not confined to wheat alone, but deposit in barley, rye, and oats, when these plants are in flower at the time of their appearance. The maggots have been found within the seed scales of grass, growing near to wheat fields. Being hatched at various times during a period of four or five weeks, they do not all arrive at maturity together. They do not exceed one eighth of an inch in length, and many, even when fully grown, are much smaller. In warm and sheltered situations, and in parts of fields protected from the wind by fences, buildings, trees, or bushes, the insects are said to be much more numerous than in fields upon high ground or other exposed places, where

the grain is kept in constant motion by the wind. Grain is commonly more infested by them during the *second* than the first year, *when grown upon the same ground in succession*, and it suffers more in the vicinity of old fields, than in places more remote. They prey on the wheat in the milky state, and cease their ravages when the grain becomes hard. They do not burrow in the kernels but live on the pollen, and soft matter of the grain, which they probably extract from the base of the germs. It appears from various statements, that very early and very late wheat escapes with comparatively little injury; the amount of which, in other cases, depends upon the condition of the grain at the time when the maggots are hatched. When the maggots begin their depredations soon after the blossoming of the grain, they do the greatest injury; for the kernels never fill out at all. When attacked in a more advanced state the grains present a shrivelled appearance. The hulls of the shrunk grain will always be found split open on the convex side, so as to expose the embryo.

Towards the end of July and the beginning of August, the full grown maggots leave off eating, and become sluggish and torpid, preparatory to moulting their skins, which takes place in the following manner. The body of the maggot gradually shrinks in length within its skin, and becomes more flattened and less pointed. The torpid state lasts only a few days, after which the insect casts off its skin, leaving the latter entire, except a little rent in one end of it. The cast skins are exceedingly thin and colourless, and, through a microscope are seen to be marked with eleven transverse lines. Numbers of the skins may be found in the wheat ears immediately after the moulting process is completed. Sometimes the maggots descend from the plants and moult on the surface of the ground, where they leave their cast skins. Late broods are sometimes harvested with the grain, and carried into the barn without having moulted.

Kernel of Wheat, the chaff pulled down to show the maggots in their usual situation.

A MATURE MAGGOT.—*Highly Magnified.*

After shedding its skin the maggot recovers its activity, writhing about, but taking no food. It is shorter, somewhat flattened, and more obtuse than before, and is of a deep yellow colour, with an oblong greenish spot in the middle of the body. Within two or three days after moulting, the maggots either descend of their own accord, or are shaken out of the ears by the wind, and fall to the ground. They do not let themselves down by threads, for they are not able to spin. Nearly all of them disappear before the middle of August, and they are rarely found in the grain at the time of harvest. In an account of the damage done by these insects in Vermont, in the summer of 1833, it is stated, that, after a shower of rain, they have been seen in such countless numbers on the beards of wheat, as to give the whole field the colour of the insect. Mr. E. Wood, of Winthrop, Maine, makes the following remarks: "This day, 9th August, a warm rain is falling, and a neighbour of mine has brought me a head of wheat which has become loaded with worms. They are crawling out from the husk or chaff of the grain, and were on the beards, and he says he saw great numbers of them on the ground." From this it appears that the descent of the insects is facilitated by falling rain and heavy dews.

Having reached the ground, the maggots soon burrow under the surface, some

times to the depth of an inch, those of them that have not moulted casting their skins before entering the earth. Here they remain, without further change, through the following winter. In June they are transformed to pupæ. This change is effected without another moulting of the skin. The pupa is entirely naked, not being enclosed either in a cocoon or in the preparium formed by the outer skin of the larva, and has its wings and limbs free and unconfined. The pupa state lasts but a short time, a week or two at most, and probably in many cases, only a few days. Under the most favourable circumstances, the pupa works its way to the surface before liberating the included fly; and when the insect has taken wing, its empty pupa skin will be seen sticking out of the ground. In other cases, the fly issues from its preparium in the earth, and comes to the surface with flabby wings, which soon expand and dry, on exposure to the air. This last change occurs mostly during the months of June and July, when great numbers of the flies have been seen apparently coming from the ground, in fields where grain was grown the year before.

The ravages of the wheat midge are not equally great in every place, and are very variable in their character, insignificant one season and excessive in another; but, in the aggregate of years, they are much greater than most farmers are aware of, or would readily believe. Mr. Kirby estimated the loss in a field of 15 acres which he particularly examined, at one-twentieth of the whole produce; or at an average of about two grains in each ear. Mr. Gorrie estimated the loss in the late sown crops in Perthshire, in 1828, at one-third of the whole produce, Mr. Bell, of Mid-Loch, writing in June, 1830, expresses apprehensions respecting the crops of Scotland, fully in accordance with Mr. Gorrie's estimate, and says: "Another year or two of the wheat-fly will make two-thirds of the farmers here bankrupts." Mr. Sidney says: "The author can assert that in the autumn of 1845, he found great quantities of the larvæ, not only in a first rate wheat district in Norfolk, but in other parts of the country. Ear after ear was examined by him, and the contents shown to farmers who never before had even heard of such things, and who were perfectly astonished when they saw them. Often has he also entered a barn and taken up a handfull of dust from the floor where wheat had been winnowed, turned out the little orange-coloured devourers, now in their membraneous cases, one after another, but scarcely ever met with any person who had previously noticed them. If they had been seen they took them for the seeds of some kind of weed.

This insect has been observed for several years in the northern and eastern parts of the United States and in Canada. It has been mistaken for the grain weevil, the Angoumois grain-moth, and the Hessian fly, and its history has been so confounded with that of another insect, also called the grain worm, in some parts of the country, that it is difficult to ascertain the amount of injury done by either of them alone. This grain worm has been already described in this essay, as the larva of a moth called *Noctua cubicularis* (order Lepidoptera), these larva are provided with legs, and suspend themselves by a thread of their own spinning; they remain depredating upon the ears of corn until after the time of harvest; and these characteristics will easily enable persons to distinguish them from the writhing maggot of the wheat-midge, destitute of legs and unable to spin a thread. The larvæ of the *Noctua cubicularis* crawl about. The maggot of the wheat-midge, move in a wriggling manner, and by sudden jerks of the body.

"The wheat-midge, or wheat-fly as it has sometimes been called, was first seen in America about the year 1828, in the northern part of Vermont, and on the borders of Lower Canada. From these places its ravages have gradually extended, in various directions from year to year. A considerable part of Upper Canada, of New York, New Hampshire, and of Massachusetts, have been visited

by it, and in 1834, it appeared in Maine, which it has traversed, in an easterly course, at the rate of twenty or thirty miles a year. The country over which it has spread, has continued to suffer more or less from its alarming depredations, the loss by which has been found to vary from about one-tenth part to nearly the whole of the annual crop of wheat; nor has the insect entirely disappeared in any place, till it has been *starved* out by a change of agriculture, or by the substitution of *late sown* spring wheat for other varieties of grain."*

In the report upon the census of the Canadas for 1851, so carefully and correctly compiled by Wm. Hutton Esq., we learn, that, "the worst wheat crops in Canada West in the year 1851, were in those counties where the weevil (wheat midge) was most prevalent. It committed the most serious depredations, in very many cases having rendered whole fields of most promising wheat, not worth the threshing. This fly, which deposits its larvæ (eggs) in the blossom of the wheat in order to feed upon the milk of the grain as it ripens, was unfortunately in that year most abundant in the counties of Frontenac, Lennox, Addington, Hastings and Prince Edward, and is travelling gradually west at the rate of about 9 miles every summer, and remains from 5 to 7 years in a locality. The only prevention yet discovered has been to sow early seed on early land, and very early in the Autumn, so that the wheat may blossom before its enemy takes wing, the period for which depends much upon the earliness of the season. So destructive was the fly in 1851, that the fine agricultural county of Lennox produced only 6 bushels per acre, Hastings about 10, and Prince Edward, Addington and Frontenac about 11. It had not in that year reached the county of Northumberland, but was very destructive in that county in the following year, 1852."

In this extract we find the popular name "weevil" used in speaking of the wheat-fly or midge; from page 18 of this essay it will be observed that the true grain weevil is a coleopterous insect, a slender beetle with a long snout, which does not attack growing crops of wheat, but confines its depredations to stored grain. The account given of the wheat fly in the Census Report is otherwise substantially correct and will be found to agree with that set forth in the pages of this essay.

The wheat-midge is generally believed in England, to have strong preferences and dislikes in reference to the commonly cultivated wheats, and has been supposed or observed to do prime injury to some, secondary injury to others, and little or no injury to others. One reason why some wheats are little affected by it may be, that they are generally sown at a time, which, conjointly with their habits, occasions their coming into ear at a period when the midge is not in a condition to attack them; and another reason why the same or other varieties enjoy comparative safety may be that they have too hard an envelop to be readily pierced by the midge's ovipositor. "The species of Woolly eared, Lammas red, and Rivet wheat," says Mr. Sherriff, "have been stated in East Lothian, to resist the attack of the fly. The two first mentioned kinds come into ear about a week sooner, the last about a week later than those commonly cultivated, and to these peculiarities owe their occasional escape, earing either before or after the general depositing of eggs takes place. The fly, however, does not always appear in strict conformity with the growth of the wheat plant, and the earing of different species is late or early, compared with the general crop, according to the time at which they are sown. The eggs of the wheat-fly are generally deposited when the ear is escaping from the sheath,—and when delayed beyond this period, the grains either become diminutive, or the maggots perish; and, therefore, a species of wheat in some measure impervious to the ovipositor

*Harris.

of the fly at this stage of the plant's growth must tend to mitigate the ravages of the fly. There is such a species cultivated in many countries, the name of which is the Polish wheat, *Triticum polonicum*. It is characterised by a large exterior chaff, which closely envelops the cups when the ear is escaping from the sheath, and at this time defends the flower in a great measure from the fly's ovipositor. I have grown the polonicum on a small scale amongst other kinds; and although it did not altogether escape the attack of the fly, it was much less injured than any of those which came into ear at the same time."

As the Polish wheat is very far from being eminent in other good agricultural qualities, the farmer must look for some other kind superior in quality yet possessing an equally thick chaff. Mr. Gorrie in the course of comparative experiments during the prevalence of the wheat-midge in 1829, found a wheat belonging to the species *Triticum tingidum*, nearly akin to the Rivet wheats, possessing a tall vigorous stem, yielding a very large produce, though inferior in quality to those of the common winter wheat, to be completely proof against the midge. "I had a fall of it," says he, "growing in the centre of a field of common wheat, which came into ear on the 22nd of June, exactly at the same time with the common variety. At that period I visited the field every evening for a week, and although the flies were numerously and busily employed on every ear of the common wheat (the half of which they destroyed), I, and my friends who went frequently with me, could only detect one solitary fly at work on the new variety; and although the ear was marked, no maggots could therein be aterwards discovered." The field of 15 acres examined by Mr. Kirby was planted partly with common white wheat, and partly with common red; and the result of his examination was, that the white wheat was destroyed at the rate of not quite 2½ grains per ear, while the red was injured at the rate of not quite 1½ grains per ear.

But all these experiments, it is feared, are more or less deceptive; and the different results may have been owing to the accidental circumstance of one crop being more exactly in the stage of fitness for the insect's use than another, or to the influence of the gregarious habits of the midge, whose swarms usually assemble and remain in the neighbourhood of the spot where they first make a settlement; and the farmer had better, perhaps aim at bringing the common varieties of wheat into early development before the time of oviposition of the fly, or delaying the season of blossoming until after the fly has laid its eggs, rather than trust to the reputed anti-fly properties of any variety.

Kirby recommended remedies or preventives directed immediately against the life or operations of the perfect fly as most likely to prove successful. "By a set of experiments first made upon a small scale," says he, "the intelligent farmer may possibly find out some method that will prevent this insect from laying its eggs in the wheat. These should commence as soon as the ear begins to quit the *folium vaginans* or hose; and they ought to be continued until the germen is impregnated, or to use the rural phrase, the wheat is off the blossom. Perhaps fumigations of tobacco or sulphur, if made when the wind is favourable, might render the ear disagreeable to this insect." But either fumigation of any such kind or medical aspersions, or any other applications which might be suggested, in order to be made on a sufficiently entensive scale to produce decided effect, would probably cost as much trouble and expense as the crop would be worth.

Remedies against the matured larvæ or pupæ have been recommended by some. "It is possible," says Mr. Duncan, "that Mr. Gorrie's plan of ploughing the wheat stubbles, and having what is called a skim coulter attached of such a construction as would cut and lay about an inch of the surface at the bottom of the furrow, would bury many of the pupæ at such a depth as to render their

resurrection improbable." This method, however, could not be adopted where the field was laid down with grass and clover seeds; which would also be a reason for not adopting the next remedy proposed, viz:

BURNING THE STUBBLE after the crop has been taken off. This, perhaps, as in the case of the joint-worm and Hessian fly will be found the most effectual method of lessening the numbers of the wheat-midge. When the stubble is short and scanty, the conflagration may be assisted by straw, or other inflammable matters, if it is rank the fire will be sufficient to heat the whole surface of the ground, and in all probability will destroy the greater part if not the whole of the pupæ, heat being speedily fatal to them. The farmer can take the precaution of laying down his clover and grass seeds with barley or some other spring crop, and even where clover has been laid down with wheat it would be better to sacrifice it, if at the same time, the destructive flies can be got rid of.

As a large proportion of the larvæ which live to become pupæ remain attached to the harvested grain till separated from it by the process of threshing, when they pass away with the chaff dust, and are apt to return directly or indirectly to the ground, care must be taken to prevent such a contingency, by carefully separating the chaff dust and burning it. A method of doing this has been suggested by Professor Henslow which is both simple and efficient. He says, "It occurred to me, that if a wire gauze sieve were placed before the winnowing machine in a sloping position, so as to allow the chaff to fall upon it, and then roll from it, the pupæ would pass through, and might be caught with the dust in a tray placed below the sieve. The plan was tried and found to answer satisfactorily; and doubtless might be made the means, were it generally adopted, of collecting and destroying myriads on myriads of the pupæ of this destructive fly.

"Several cases of the efficacy of fumigation in preventing the depredations of these insects, are recorded in the agricultural papers of the United States.* For this purpose brimstone has been used in the proportion of one pound to every bushel of seed sown. Strips of woollen cloth dipped in melted brimstone, and fastened to sticks in various parts of the field, and particularly on the windward side, are set on fire, for several evenings in succession, at the time when the plant is in blossom; the smoke and fumes thus penetrate the standing grain and prove very offensive or destructive to the flies, which are laying their eggs. A thick smoke from heaps of burning weeds, sprinkled with brimstone, around the sides of the field, has also been recommended. The Rev. Henry Colman, Commissioner for the Agricultural Survey of Massachusetts, says that lime or ashes strewn over the grain when in blossom, is a preventive which may be relied on with confidence. For every acre of grain, from one peck to a bushel of newly slacked lime, or of good wood ashes will be required, and this should be scattered over the plants when they are wet with dew or rain. Two or three applications of it have sometimes been found necessary."†

Harris says, that, in those parts of New England where these insects have done great injury, the cultivation of Fall wheat has been given up; and this course he believes to be the safest for some years to come. Spring wheat sown after the 15th or 20th of May, generally escapes the ravages of these destructive insects; but the time of sowing varies with the latitude and elevation of the place, and the forwardness of the season. Late sowing has almost entirely banished the wheat-flies from those parts of Vermont where they first appeared. Fall wheat, if grown, should be sown very early, so that the grain may have become hard before the flies make their appearance.

The wheat-midge is kept powerfully in check by some natural enemies sent in

* Cultivator, vol. V. page 186. † Harris.

mercy by Heaven as minute benefactors of our race. Particularly three species of ichneumons. One of these *Encrytus inserens* is black and shining, and about half the length of the wheat-midge; another, *Eurytoma penetrans*, is black with a brassy lustre, the abdomen glossed with blue, compressed and truncated behind; and the third, and most important, *Platygaster tipulæ*, is a minute black midge-like fly, with the legs and base of the antennæ red—the male quite black and rarely seen—the female of a pitchy colour, with a sharp ovipositorial point at her tail, exceedingly abundant and active in all infested fields in the months of July and August. Superficial observers have mistaken the ichneumon for the parent of the larvae of the wheat-midge, and have condemned it as the origin of the very evils it is destined to diminish. This little platygaster may be readily found on the glumes or chaffy covers of the wheat ears in the months of July and August. It runs rapidly over the ears and seems to know well those which are occupied by the larvæ of the midge. The female ichneumon deposits one ogg, and only one, in each of the larvæ of the wheat-midge. When these eggs are hatched, the young maggots which they produce, and which are the catterpillars of the ichneumons, feed upon the fleshy or muscular parts of the caterpillar they are attacking, carefully avoiding the vital parts. At length the caterpillar they have been thus devouring dies, or, as frequently happens, it changes to the state of chrysalis before it is destroyed. The ichneumon caterpillars also pass to the chrysalis state, and either remain within the body of the dead caterpillar, or come out before they assume the fly state. Each species of ichneumon is restricted in its attacks to one, or at most to a few, species of caterpillar; and the females instinctively proportion the number of eggs they deposit in each individual to the relative size of their own offspring and that of the insect on which they are destined to prey.

CHAPTER VIII.

Conclusion—Farmers can learn to distinguish noxious insects without becoming thorough entomologists—Birds useful in destroying Insects—Insects most destructive in poor crops—Importance of well working land—Fallows—Wheat-fly worst in old settlements—Travel from East to West—Whole neighbourhoods should combine in adopting remedies—particularly the one sometimes adopted of starving out the Wheat-fly.

From the foregoing pages it will be seen that all those insects which have caused so much loss to the farmer by their devastations amongst his principle crop, wheat, are intimately known and their origin and habits familiar to scientific men. Order is Heaven's first law, and the same Almighty power that keeps the planets in their courses, and orders their goings, does not disdain to govern the tiniest insects by the same immutable law. To trace this harmony and evidence of design in the works of the creator has been the study of the lovers of natural history; and the conviction that there was such a law, assisted them greatly in their investigations. The scientific arrangement of the different orders of insects is so perfect that although it has been computed that there are upwards of 400,000 varieties or species of them, yet a naturalist has but to mention its generic and trivial names, and thus by the aid of two words alone he can speak of any one of them so distinctly that an entomologist in any part of the world knows instantly the very species that is meant. Now, it is not to be supposed that every farmer can become an experienced entomologist; but, it is not too much to expect that he will endeavour to make himself practically acquainted with those destructive insects, whose effects he so often painfully experiences in the devastation of his most valuable crops. Their ravages are of so appalling a nature as sometimes to blast the best founded hopes of the husbandman, and threaten to entail all the horrors of famine upon the land; yet their

species are not very numerous, and in the preceding pages the intelligent agriculturist will find the result of the investigations of learned men in Europe and America with regard to the nature and habits of those insects most injurious to the wheat crop. It should be a source of encouragement to the farmer when threatened with their ravages, to reflect that he has not to contend with a minute enemy, whose nature and habits are shrouded in mystery: for not only have these been clearly and distinctly detailed by careful and experienced observers, but the results of their investigations are within his reach, and at the same time are of such a nature as easily to be understood. Destructive insects are under the control of a superintending providence; they have their appointed tasks and are limited in the performance of them; if a destructive species should for a while preponderate, yet counter checks are provided, and, as has been seen, many of them become the prey not only of birds and quadrupeds, but even of their own race. There is no reason to suppose that any new species are created from time to time; those that are now attracting observation from their remarkable depredations, have either been brought to this country from other lands or, by the clearing of the forests, being deprived of those shrubs and plants on which they subsisted, are in a manner compelled to resort to cultivated plants for food. The wanton manner in which insect-eating birds are destroyed, deprives man of a most valuable auxiliary in keeping noxious insects within bounds, and, even when not recklessly destroyed, the neglect of providing ornamental shrubs and trees about Canadian dwelling houses, entails the loss of the valuable services of these feathered destroyers of the insect race, who would otherwise be encouraged to increase and multiply, if the necessary shelter were provided. The naked and desolate appearance of Canadian farms without a single ornamental tree or shrub, has long been a reproach to the country; let it be hoped when farmers find that these plantations are not only ornamental but useful, they will take pains to procure them. In "Anderson's recreations," it is stated, that a cautious observer having found a nest of young jays, five in number, remarked that each of these birds while yet very young consumed at least fifteen full sized grubs in one day; he then goes on to calculate that this one family of jays, including their parents, would consume twenty thousand grubs in the course of three months; if these jays were encouraged to remain or return to the same spot, we can easily conceive what myriads of destructive grubs would be removed by these birds and their descendants in the course of two or three years.

But perhaps the too anxious desire of the farmer to hasten to grow rich, which leads him to over crop his lands, or prepare it in a hasty and slovenly manner, has proved one of the greatest encouragements to the devastations of noxious insects. It is well known that animals in a sickly state are always more liable to the attacks of vermin, and it is equally true of plants, that the want of a healthy and vigorous growth encourages the attacks of parasitical insects. From what has been stated in the previous pages it will be seen that this has proved to be the case both in Europe and America. Baron Kollar mentions that in a report made to the Arch-Duke Charles of Austria on the Hessian fly, its ravages first commenced on patches of the poorest soil, and then gradually proceeded to the plants growing on the best. And in the United States, according to the authority of Harris, it has been found "*that luxuriant crops more often escape injury than those that are thin and light.*"

From this the farmer will see the importance of thoroughly working his land and bringing it to the highest state of tilth. Too often he has been encouraged by the high prices which have lately been given for wheat, to put in that grain after peas or other spring crops; the consequence is that the larvæ of many destructive insects which abound in the stubble of such crops are turned under

with a slight furrow in a position most favourable to come forth in summer and destroy the plants of growing wheat, the well known inferior luxuriance of crops so put in proving an encouragement for the attacks of such insects.

A naked fallow will always be found the best preparation for the wheat crop. By it the soil becomes thoroughly pulverized and mellowed, and rendered fit for the reception and growth of the young plants, an opportunity is afforded to rake up all the weeds and roots of plants, which are often full of the eggs of insects, and which can then be burnt. The eggs, larvæ, and burrowing adults of insects are also destroyed by mechanical and chemical action, and partly by exposing them to the attacks of birds. Facility is also afforded for the early and effective sowing of the wheat, which cannot be done when it is sown after a crop raised the same summer on the ground. From the investigations of that eminent chemist Liebig, it has been found that a summer fallow enriches the land by the disintegration of its mineral constituents, the dissolving of its organic remains, and the general results within it of chemical and electric action, so that one-half of the manure which would otherwise be required is sufficient for the luxuriant growth of the crops that follow.

The weeds and rubbish that collect around large stones and stumps of trees, and the briars that are often allowed to gather in fence corners, all prove to be harbours and an encouragement for the resort of destructive insects; it has been found that in the neighbourhood of such places, crops suffer the most from their devastations. The farmer then, has an additional inducement why he should get rid of such unsightly objects, as he thereby not only improves the appearance and value of his property, but lessens the casualties to which his crops are subjected by the ravages of destructive insects.

The theory that the wheat flies are most destructive on poor and worn out soils, is borne out by the fact, that on this continent they have commenced their ravages in the oldest settlements and from thence have gradually followed the progress of emigration and consequent clearing of the land. In Canada their progress has been from East to West, and the only exception to this rule has been in the state of Maine, where they advanced in an easterly direction, possibly because the Western part of the state was first settled, and the flies have only followed their usual instinct, in first commencing their depredations in the old and worn out settlements and gradually spreading to the later cleared ones. From the Canada Census Report for 1851,* already quoted, we learn that the wheat fly is travelling gradually west at the rate of about nine miles every summer. When we connect with this circumstance the fact, that in Vermont and other places the wheat fly has been *starved out*, by abstaining from sowing Fall Wheat in those parts, and sowing the Spring Wheat so late as to escape the season in which the flies deposit their eggs, it becomes a matter for serious consideration whether it would not be well for the farmers in Canada in the neighbourhood of the infested districts, to agree not to sow any fall wheat for two to three years, and thus interpose a belt of country, from two to three or more miles in width, between the infected and non-infected districts. From the great prices which are procured for fat cattle, and the rough grains, it is a question whether the production of them would not be equally remunerative with that of wheat; added to which is the certainty of the fact, that sooner or later the farmers, unless some precautionary measures are taken, will suffer in their turn from the attacks of the fly, and possibly be compelled to adopt an alternative, which, had they observed in time, would have averted the plague not only from themselves, but from their neighbours further west.

Whatever measures may be adopted either in the way of prevention or

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William Hutton, Esq.

remedy, it will be necessary for whole neighbourhoods to combine in observing them, otherwise they will prove of no effect. In the foregoing pages the result of the observations and experience of persons who have been practically acquainted with the evils in question, have been set forth for the instruction and information of the Canadian farmer. The remarks have necessarily been very brief, but it is hoped that they will be sufficient to enable the agriculturist to identify the insects most injurious and beneficial to his crops, to become acquainted with their habits, and to point out the best methods of repelling or destroying those which are most detrimental either in the larva, pupa, or perfect state. This information is the more necessary, since the insects which are the most destructive, the Hessian fly, the wheat midge, and the joint worm, are so minute as scarcely to be distinguished by the naked eye, without careful observation, and consequently their presence is apt to be overlooked until their ravages show, too late, where they have been. The study of the natural history of these insects will tend to impress upon those observing them a conviction of the providential superintendence of an Almighty and all wise Creator. The losses which they suffer from the devastations of such minute creatures will teach them a lesson of humility, and impress upon them a sense of dependence upon Him whose servants these insects are, who can at any moment afflict them with these plagues, and who in mercy hath promised to restore to the well-doing "the years that the locust hath eaten, the canker worm and the caterpillar, and the palmer worm, my great army which I sent among you."

DISEASES OF WHEAT.

MILDEW, known in all ages—Various opinions respecting cause of—True origin of—Fungus plant *Puccinia graminis*—Remedies—Clay soils offer greatest resistance to mildew—Moist weather favourable to it—Judicious culture of the soil a good prevention—Early sowing—Clean state of land—Application of salt a good remedy—RUST—caused by a fungus plant—Two varieties *Uredo rubigo* and *Uredo linearis*—Remedies same as those for mildew—thick crops less liable to attack than thin ones—Frequent repetition of wheat crop encourages these diseases—No amount of manuring will justify frequent cropping with wheat—SMUT—Two species—*Uredo segetum*—*Uredo fœtida*—Astonishing fecundity of these fungi—Remedies—Steeping in certain solutions—Lime water—Ley from wood ashes—Brine—Glauber salts—Even crops suffer the least—Importance of thoroughly working the land—Healthy and vigorous crops best resist the attacks of insects and diseases—wheat thinned out by snow drifts liable to smut—reason why—importance of scientific researches into these diseases—Farmers cannot apply proper remedies until their true nature is discovered.

The principal diseases to which the wheat crop is liable are *mildew*, *rust*, and *smut*.

Mildew has been known and dreaded in all ages as one of the greatest foes of grain crops, and as one of the mightiest instruments employed in the hands of the Almighty when he has seen fit to scourge a land with the horrors of famine. Its devastating nature was well known to the ancient Israelites. When their crops were blasted with mildew, God, by his prophet Amos, reminded them, "I have smitten you with blasting and mildew, when your gardens and your vineyards, and your fig trees, and your olive trees increased, the palmer worm destroyed them"—and again by the prophet Haggai, "I smote you with blasting and with mildew, and with hail in all the labours of your hands." It was also known to the Greeks. Theophrastus, in his "History of Plants" written about 320 years before Christ, observed that it occurs more frequently to corn

than to pulse; the Greeks found by experience that crops growing on high lands were seldom attacked by this disease, but that when situated in hollow places, surrounded by hills, where the winds could not get at them, they were more frequently infected. To the Romans the mildew was known under the name of "rubigo." Pliny in his "History of Plants," tells us, that the prevailing opinion was that this disease arises from certain dews settling upon the corn and obtaining a burning quality from the intense heat of the sun. He, on the contrary, thought that the disease arose from cold, and that the infection first occurred during the absence of the sun, and always about the new or full moon. Columella says that mildew is induced by hoeing grain crops during wet weather. Horace in his Odes speaks of it as the "sterile rubigo" and Virgil alludes to it in his Georgics:

> "Mix et frumentis labor additus, ut mala culmos,
> Esset rubigo, &c."

The Greeks and Romans were conscious of the destruction it would inflict on their crops, and regarded it as an instrument of vengence directed by a particular deity, to whom they applied the same name as that by which the plague was known. A festival to propitiate this deity, entitled *Rubigalia* was instituted by Numa 704 years before the birth of Christ. Reddish coloured bitches were sacrificed because the lesser dog star was then in the heavens, and was considered unpropitious to corn.

In the prophet Joel, where the Almighty promises to the Jews, "I will restore to you the years that the locust hath eaten, the canker worm and the caterpillar, and the palmer worm,"—this passage is rendered in the Latin Vulgate, "Et reddam vobis annos, quos comedit locusta, *bruchus*, et *rubigo*, et *eruca*." Now, under the head weevil, it has been pointed out in this essay, that one of the most destructive insects injurious to the farmer is the *Bruchus pisi* or pea weevil, so that the latter part of this passage from the Vulgate may be rendered, "the *weevil*, the *rust* or *mildew*, and the *caterpillar*"—which singularly enough are the subjects of consideration in the present treatise.

The mildew has long been known in Great Britain as one of the greatest scourges of the farmer. A writer in the 9th volume of the Quarterly Journal of Agriculture treating of it says:—"Of all the other diseases which attack our cultivated plants, not one is so destructive as the mildew. It is the plague of our wheat crops. So constantly present is this destructive disorder, that in the fairest fields of wheat, grown in the richest corn districts of England, and in the most genial years, I never saw a single acre entirely uninfected. Every year the farmer is more or less injured by this disease; for the produce of each acre of wheat is unquestionably reduced annually several bushels. Yet those who suffer most by the loss, the farmers themselves, are almost universally ignorant of the fact, and their attention is rarely arrested by it till a year occurs in which their crop of wheat is nearly annihilated."

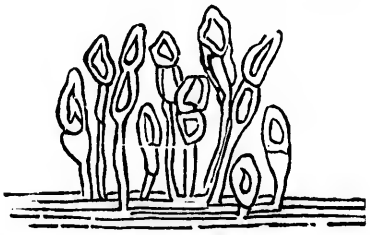
Opinions respecting the cause of mildew are various. It is ascribed in the writings of ancient naturalists, in the writings of modern agriculturists, and in the opinions of practical farmers of the present day to a number of causes, some of them very conflicting and some very absurd. As we have seen before, the Romans in the time of Pliny ascribed mildew to the settling of certain dews upon the corn, and to its obtaining a caustic quality from the heat of the sun. Pliny himself ascribed it to cold. The French agriculturists of the early part of last century imputed it to dry gloomy weather, about the time of the corn being at the height of its vegetation. M. Duhamel concurs with this opinion, saying—"I have many times observed that when a hot sun has succeeded dry hazy weather, the corn became rusted within a few days after. The distemper is not

common in clear and dry hot years; but when spring is wet, the finest fields of wheat run great hazard of being destroyed by the mildew, which generally appears upon the breaking out of the sun in the morning, after close and sultry weather, during which there has not been any dew."

M. Tillet ascribes mildew to a sharpness in the air in dry cloudy weather, which breaks the vascular tissue of the stems and leaves, and makes them discharge a thick oily juice of such a nature as to be changed by heat into a rusty powder.

Other writers of the last century supposed it to be a thick clammy vapour which settled upon the stems of the grain and so stopping the pores as to prevent perspiration, and impeding the circulation of the sap. A modern writer, Mr. R. Somerville, in a communication to the Board of Agriculture, ascribes mildew to the attacks of insects introduced with the manure; these insects however are found to be minute *acari*, which are almost always found upon decaying vegetable matter, and which in the case of mildew is the follower and not the cause of the disease.

The true origin of the Mildew has been found to be due to the regular parasitic growth of the *Puccinia graminis*, a fungous plant, belonging to the hypodermii division of the eutophyti class of coniomycetes. The name *Puccinia*, is derived from a Greek work which signifies "closely" or "thickly," and alludes to the crowded manner in which the minute fungi are packed in the tufts and patches in which they grow. When a stem of wheat begins to be mildewed, a number of dark coloured spots will be seen under the epidermis, some of an orange hue, and others of a dark brown tinge; in a short time the outer cuticle is ruptured, and through the openings are protruded dark clusters of spores, amassed in dense, diffuse tufts, often confluent or running into one another, so as to form long parallel lines, and commonly possessing at first a brownish



PUCCINIA GRAMINIS [*Common Mildew.*]

yellow colour, and changing afterwards to black. The spores or seed vessels generally grow immediately beneath the stomata, (or openings of the pores,) of the stems, and after they burst through the epidermis, they appear, under the microscope, like dense masses of pear shaped bodies, all distinct from one another, exhibiting diversities of form and outline, and each resting on a stalk into which it gradually tapers. Two compartments or chambers exist in every spore, and are filed with sporules, or the puff-like and surpassingly minute rudiments of another race of fungi. So wonderfully small are not only the sporules but the spores, that in the opinion of Sir Joseph Banks, from 20 to 40 spores may germinate in the hollow beneath any single stoma, (or mouth of a pore); while the stoma itself cannot possibly be detected by the naked eye, and requires to be seen through a good microscope.

The ribbed appearance presented by a stem of wheat when seen through a common magnifying glass, is caused by alternate longitudinal partitions of the epidermis or rind, the one set raised and imperforate, and the other set depressed

and furnished throughout their length with one or two rows of stomata or minute orifices, which in dry weather are closed, and in wet weather are open, and which serve the purpose of imbibing moisture according to the wants and condition of the plant. The leaves and glumes or chaffy covers of ears of wheat are provided with similar stomata, which also are to be found on the leaves, stems and branches of all plants, and are the means provided by nature through which plants obtain necessary moisture. Now these stomata, while imbibing moisture, also take in with it the sporules or seeds of the *puccinia graminis*. Each of these fungous plants sheds some hundreds of sporules, lighter and more minute than those of the puff ball; and as even a healthy crop of wheat produces myriads of *puccinia*, while a mildewed crop supplies inconceivably numerous myriads, we can imagine what vast invisible clouds of sporules are wafted by every wind during the sporing period, which lasts from May till October, and how they must become intimately mixed with all the dews and moisture which the thirsty plants imbibe. The Rev. Edwin Sidney, in his work entitled "Blights of the Wheat," says: "The rapidity with which mildew sometimes spreads is astonishing. Only let the circumstances be favorable, and millions upon millions of sporules seem ready to enter the stomata, and germinate beneath them. The atmosphere is charged to an inconceivable extent with such invisible organs of reproduction. Fries declares the sporules to be so infinite that they rise like thin smoke into the air by evaporation, and are dispersed in innumerable ways, as for instance, by the attraction of the sun, by insects, by wind, by elasticity, or by adhesion. He asserts that in one individual he calculated, on good grounds, that there were at least ten millions if not more. Thus a stoma can scarcely ever perform the function of inhalation without taking in more or less of these sporules; and it is a happy circumstance that they refuse to grow except in certain places, and under peculiar conditions, for if their vegetation were general the produce of the earth would be almost entirely consumed by them."

When the sporules of puccinia have entered the stomata of wheat, and effected a lodgement beneath the epidermis or rind of the plant, they both prey upon the tissues, and intercept a portion of the sap which ascends from the roots for the forming and nourishing of the grain; hence the grain never comes to perfection, but shrivels up, containing comparatively much bran and little flour, so that wheat which has been mildewed, has been found from accurate investigations to lose from 31 to 75 per cent. of flour.

Remedies of Mildew. From the above account of the nature of mildew we may easily perceive that it would be impossible wholly to exterminate the fungous plants which are the cause of it. But though it cannot be wholly exterminated, yet the power of controlling it remains in the hands of the observant and skilful agriculturist. The conditions of soil and culture, and the healthy or unhealthy state of the wheat plants, upon which the progress of mildew very much depends, may be powerfully modified by the skill and the arts of enlightened husbandry. All soils are subject to mildew, but some yield more readily to it than others. Clay soils offer the greatest resistance to it, in consequence of their tendency to keep up an equable temperature about the plants, and thus save them from frequent vicissitudes of heat and cold. Calcareous and sandy soils, on the contrary, from their opposite tendency encourage mildew on the crops raised upon them, hence the importance of an abundant mixture of clay among a sandy soil, at once improving its texture and lessening the tendency to mildew.

Moist and "muggy" weather has been found to be most favourable to the spread of mildew, and although the farmer cannot influence the weather, yet by judicious surface draining of all marshy places, and subsoil draining of all wet fields, much might be done to ameliorate the very climate, and remove the

cause of those damp unwholesome fogs which may often be seen to hover exclusively over moist situations, and which are a fertile cause of the spread of mildew.

The judicious culture of the soil, bringing it into such a state as is most favourable to the health and vigour of the wheat plant, has been found a good preventive. A writer in the Journal of the Royal Agricultural Society of England says :—"A general healthy state of the wheat plant without any over luxuriance of vegetation, is most likely to secure a crop against the attacks of the rust and mildew fungi; but whatever tends to render the plant sickly, whether it be excess of heat or cold, drought or wet, sudden changes of temperature, poverty of soil, over manuring, shade, &c., must be considered as a predisposing cause to these diseases." Another author remarks, "wherever the farming is of the best kind, and where drainage is good, the mildew fungus will not be found in any alarming degree. Just as the clean skin of animals is a defence against nauseous living parasites, so by an analagous method, the soil will be rendered free from the destructive fungi which cause mildew in corn. Improved domestic habits in our peasantry, are well known as tending to check the spread of epidemic diseases, and in the same way a better system of cultivation will avert diseases from our corn fields. Mildew was once more prevalent than it is at present, and doubtless its diminution is in a great measure to be ascribed to a better husbandry."

All varieties of wheat are liable to mildew, but some are more liable than others. The white is generally the earliest affected, and the bearded wheat the latest; the cuticle of the latter being of a firmer texture,* the openings of the stomata offer more resistance to the entrance of the sporules, and when any of these have entered, the harsh skin does not so readily yield to the outbursts of the fungi as they are being developed.

As a general rule *early sown wheat* is more likely to pass the time of blooming before the crop becomes attacked extensively. Late sown crops are green and full of sap at the very season when the moist chill dews of autumn are most rife, and are therefore more liable to the vigorous attacks of mildew. Excessive manuring, or any combination of circumstances which will tend to make a crop very rank, invites the attack and spread of mildew.

A clean state of the land is a preventive against mildew. *A foul state* is an encouragement. Weeds, especially those which come early to maturity, are all harbours for the mildew fungi, where they feed and multiply preparatory to severe and extensive attacks upon the wheat plant. "Mildew," says the Rev. Edwin Sidney, "will seldom prevail to any extent where the precaution of hoeing the land and keeping the surface clean is observed, but wherever there are many weeds on the land, the straw will be generally found more or less affected by it. The author can say from experience, that he has seldom, if ever, failed to meet with it in unclean lands."

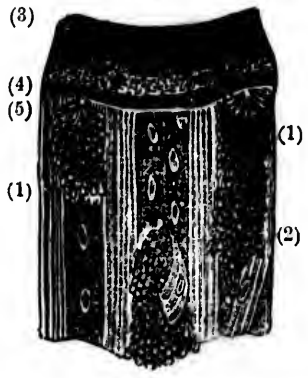
The steeping of seed corn in various mixtures is of no benefit in preventing mildew; it may possibly be a defence against the sporules that are lying in the ground and prevent their absorption by the roots of the plants, but they can offer no resistance to the attacks of the puccinia when the plants are in bloom and are assailed externally.

A solution of common salt has been found beneficial in killing the mildew fungus, and thus acting as a cure for the disease. Hence wheat grown by the sea side has been found to be free from attacks of mildew. Well authenticated instances of the advantages of using salt as a cure for mildew are on record, the remedy has been tried by many and found to be successful. The proportion of

*In consequence of containing more siliceous particles in its composition.

salt is one pound to a gallon of water, laid on with a plasterer's brush, the operator walking down one furrow and up another, thus sprinkling both sides of the land. Or the mixture may be applied with a watering pot; in either case, there must be a second person to replenish the supply to the operator. Two persons will thus sprinkle four acres a day. The *modus-operandi* of the salt destroying the puccinia is this: this plant being a fungus, its principal constituent is water, upon salt being applied, the watery particles are immediately absorbed, and thus the mildew plant is destroyed. The action of salt upon mushrooms, in making mushroom catsup, explains this theory.

RUST is also a disease of the wheat plant caused by a minute fungus of the coniomycetous order of plants. It is commonly ascribed by botanists to two species of the genus Uredo—*Uredo rubigo*, and uredo *linearis*, which probably are mere varieties of the mildew fungus or *puccinia*. It attacks wheat at all stages of its growth. The fungi have commonly an orange brown or rusty iron colour, when the spores are spherical the disease is termed *U. rubigo*, when they are oblong the fungus is called *U. linearis*. The plants when affected seem as if they were dusted with a rusty powder, especially after the sporules have burst through the epidermis or skin of the stem. It is said to prevail more among the rough chaffed wheats than others. The rust is not so injurious as the true mildew, though it causes great havoc when it appears in the later stages of growth of the wheat plant. The predisposing causes are the same as in the case of mildew; it is sometimes readily dissipated by an outburst of sunny weather, especially when attended with a healthy breeze playing over the growing crop. The remedies are the same as those mentioned for mildew. In the case of both mildew and rust it has been found that thick crops are less liable to

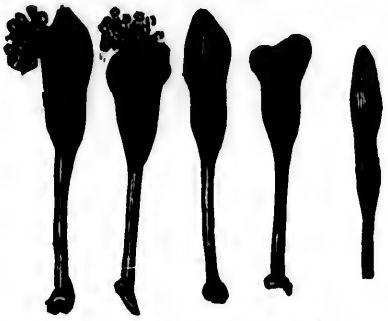


SECTION AND PORTION OF A STOCK OF WHEAT AFFECTED WITH RUST.

(1) (1) (1) Masses of the Rubigo. (2) Stomata, or breathing pores. (3) Cellular tissue. (4) Cuticle. (5) Epidermis.

their attacks than thin ones, that fields which have received a liberal supply of seed have resisted the disease when thin sown ones have been destroyed. A too frequent repetition of the wheat crop also encourages these diseases. Some farmers think if they only supply plenty of manure, they can go on growing wheat crops without end. This is a great mistake, and one into which Canadian farmers at the present time are too apt to be betrayed, in consequence of the high prices offered just now for wheat; the liberal supply of manure with which they hope to renew the vigour of the soil, does but increase the rankness of the straw, thereby encouraging the attacks of these diseases, while the ears of

grain, even if they escape disease, are only half filled, yielding after threshing a miserable shrunk sample, instead of bold plump wheat. The laws of nature are



Uredo Rubigo (*Common Rust.*)

invariable and cannot be disregarded with impunity, the productive powers of the soil have a limit, beyond which man, with all his fancied skill, cannot force them; and he who, in his haste to grow rich, endeavours to over-tax those powers, will find that he is only killing the bird which laid him the golden eggs.

Smut is a disease of the ears of growing grain, by which the substance which should form flour, becomes entirely changed into a black powder, similar to a puff ball, or dusty mushroom. It seems to have prevailed in the time of the Roman Empire, and is mentioned by Pliny and Columella. It has been ascribed by all classes of cultivators to a diversity of causes, which for the most part are all erroneous. Jethro Tull ascribed it to moisture; Lord Somerville to insects; Linnæus and Walker ascribed it to the same cause. Sir Humphrey Davy was of opinion that it was produced by a small fungus. Bauer, of Kew, who supplied some interesting articles to the Penny Magazine on the subject, discovered that it was occasioned by a very minute fungus, and from the researches of skilful men, aided by powerful microscopes, it has been ascertained that smut arises entirely from two minute fungi of the coniomycetous order.* The *uredo segetum* and the *uredo fœtida*.

These two species of fungi which produce smut, and whose spores constitute the fine, powdery, soot-like substance of the disease, have distinct characteristics, by which they may be easily distinguished from each other.

The *uredo segetum* has no smell, and attacks wheat, barley and oats. It sometimes affects the leaves and stems of the plants, but in general attacks only the ear—this it completely destroys. It first injures the interior parts of the flowers of the plants, so as to destroy their productive powers; it next makes the little stalks of the florets swell and become fleshy; it then consumes this fleshy mass, and at last appears through the chaff, scales or glumes, in the form of a soot-like powder. It generally comes to maturity some time before the crop is ready for the harvest, and the spores, which resemble fine lampblack in appearance, are profusely swept away and scattered by the winds before the grain is cut, so that although it may have committed great devastations, it is seldom seen at the time of harvest. It is comparatively rare in wheat, does not seem to occur at all in rye, is very common in barley, and still more so in oats. The straw of crops affected by this form of smut, is said to be very distasteful to cattle, and probably is very unwholesome.

* Derived from *konis*, dust, and *muktes*, mushroom.

The *uredo fœtida*, or smut ball, occurs only in the grain of wheat, has a disgusting smell, and is a well known and much dreaded disease. It occurs in the young grain at its earliest stage, and when fully developed occupies the whole interior of the grain. Mr. Bauer discovered it in the ovule of a young plant of wheat, sixteen days before the ear emerged from the hose, and twenty days before the sound ears, springing from the same root, were in bloom." At that early stage the inner cavity of the ovum is very small, and after fecundation, is filled with the albumen or farinaceous substance of the seed, and already occupied by many young fungi, which, from their jelly-like root or spawn, adhere to the membrane which lines the cavity, and from which they can be easily detached in small flakes with that spawn. In that state their very small pedicles may be distinctly seen. At first the fungi are of a pure white colour, and when the ear emerges from its hose, the ovum is much enlarged, but still retains its original shape, and the fungi rapidly multiplying, many of them have then nearly come to maturity, assumed a darker colour, and having separated from the spawn, lie loose in the cavity of the ovum. The infected grains continue growing, and the fungi continue to multiply till the sound grains have attained their full size and maturity, when the infected grains are easily distinguished from the sound ones, by their being generally larger and of a darker green colour, and if opened appear to be filled to excess with these dark-coloured fungi. But the grains infected with the *uredo fœtida* very rarely burst, and these fungi are seldom found on the outside of the grain, but if a grain be bruised, they readily emit their offensive smell, which is worse than that from putrid fish. When the sound grains are perfectly ripe and dry, and assume their light brown colour, the infected grains also change, but to a somewhat darker brown, retaining however the same shape that the ovum had at the beginning, the rudiments of the stigma also remaining unaltered."

The sporules of both U. segetum and U. fœtida are surprisingly minute. Not fewer than seven millions, eight hundred and forty thousand of the spores of the U. segetum would be required to cover one square inch. A single smut-ball of the U. fœtida contains about four millions of spores; some idea of the reproductive powers of these destructive fungi may hence be formed. They are supposed to find their way into the plants by entering the spongioles of the roots with the moisture, and then ascending with the sap. They are carried into the ground with the infected seed, and are thus readily absorbed by the root during the germination of the seed from which the plant has sprung. If the tainted seed be thoroughly cleansed, the plants will not be infected; this has been well ascertained, and hence the practice of washing seed-wheat universally prevails.

The chief preventive of smut is the steeping of seed wheat in some solution which, while it is powerful enough to kill the spores, yet will not destroy the vegetative powers of the grain. The spores which are dispersed at the time of thrashing are of an oily, greasy nature, and cling with considerable tenacity to the grains of wheat. Hence alkaline solutions, combining with this oily matter and forming soap, are found to be the best washes in which to steep seed wheat. Lime water, ley from wood ashes, and common salt, are all good and much to be preferred to violent poisons, which are very dangerous, and were perhaps first applied from the mistaken notion that smut was produced from insects. Fields in the vicinity of the sea are rarely injured, and never extensively, by the ravages of smut; this happens, no doubt, from the prevalence of saline particles. The effect of salt on the mildew fungi has been already noticed, and there is every reason to suppose that it will be found equally effectual in destroying the vitality of the sporules of the U. fœtida. Stale pickle, in which meat has been preserved, will be found very useful as a wash for seed wheat. If the grain be poured into a large tub containing pickle, the unbroken smut-balls will float to

the top and may be skimmed off. After the grain is thoroughly saturated it may be placed on a sieve or riddle and thus the wheat can gradually be drained, when it should be spread upon the barn floor and dried with fresh powdered lime, which may be scattered over it, and thoroughly mingled with the grain by raking it about.

A solution of sulphate of soda (glauber salts) in the proportion of 17¾ lbs. to 22 gals. of water has been found very efficient; as this salt does not readily dissolve, the solution should be made the day before it is wanted. Mr. Bauer recommends lime water, but perhaps nothing will be found more effectual, cheaper, or more easily procured than a pickle of salt and water.

A field of wheat that presents an even appearance, the stalks all being of equal height, suffers less from smut than an uneven field where some stalks are shorter than others, it will generally be found that the short wheat is all smutty; this may be accounted for in this way. When a field has been thinly sown, or when from winter killing or other causes the plants have been thinned out, those that are left are induced to stool out, and send up a fresh supply of stalks; these, of course, are later, and not so vigorous, as the parent stems, consequently they are more liable to the attacks of disease, and accordingly are the first to suffer from the smut. Farmers no doubt have often observed that wheat, growing near fences which have encouraged large snow drifts in winter, is always smutty. This is occasioned by the deep snow-drift killing out the wheat, or lying so long on the field after spring has set in, as to impair the vitality of the plants; consequently they become stunted and weak, and as a matter of course the first to be affected by smut.

From this we learn the importance of thoroughly working the land, and sowing a liberal supply of seed, in order that the crop may present as even an appearance as possible, and that the plants may be in such a healthy vigorous state as to enable them to resist the attacks of disease. In the older settlements of Canada the land has not that freshness and fertility it once possessed, consequently more seed is required than when the land was first cleared. For the same reason the soil requires more judicious management, and more attention to be paid to the rotation of crops, when wheat will be sown only in due turn, and after a thorough fallowing of the land. Throughout this essay, the bringing the land into a good state of cultivation, avoiding over cropping it with wheat, and so inducing a healthy and vigorous state of that grain when it is sown, has been pointed out as one of the best means of averting the devastations caused by the insects and diseases injurious to the wheat crop, that form the subject of the present treatise. As a general rule it will be found that the crops of the industrious, intelligent, and observant husbandman, will, in consequence of attending to such directions as above, (directions which are founded on experience, and approve themselves to common sense,) escape these calamitous evils, while those of the lazy, negligent, and slovenly farmer are sure to be the first to fall a prey to them.

It may be asked, if the seed is properly cleansed where does the smut come from that attacks the sickly and defective wheat plants? How can the snow drift that kills out the wheat affect the few plants that remain with smut? The answer to this is, that no doubt the spores of smut fungi which are carried about by the wind, are deposited on the fences, on briars and weeds, and on the stubbles of the crops which have been reaped; in the last case they are ploughed into the ground ready to attack any wheat plants that are predisposed by their sickly state to receive the infection through their roots, or in case of those spores which are lodged on the fences, &c., the unhealthy plants receive them into their system through their stomata, in the same manner as the mildew and rust

fungi impregnate the culms or stems of wheat with their spores, which obtain an entrance through the stomata on the surface of the plants.

This theory may be erroneous; but it will deserve a place until a better is substituted. Certain it is, that short and weakly plants of wheat, owing their defective state to the causes already mentioned, are the most liable to disease; and it will be well, therefore, even though we cannot account satisfactorily for the origin of the disease, to try and avoid those causes which predispose the plants to receive it.

And here we learn the advantage of those researches of scientific persons who have thoroughly examined and satisfactorily determined the true causes, nature and history of these diseases. So long as their true origin was unknown, it was impossible for the agriculturist to apply the proper remedies; he was contending in the dark with an enemy whose evil effects he experienced, but of whose nature he was thoroughly ignorant, and consequently all his efforts to subdue it were useless, and the remedies he applied inapplicable. But this is no longer the case; learned men have discovered the true origin of these diseases, and the result of their investigations has been gathered in the foregoing pages for the information and benefit of the intelligent farmer; the remedies and preventives mentioned may not be the most effectual, but now that the husbandman knows the nature of those evils which devastate his crops, he can use his own judgment, and bring his practical experience to bear upon the best method which may be employed to counteract their calamitous effects. No amount of human prudence or foresight can altogether prevent their attacks; but, when contending against them, the farmer will now have the satisfaction of knowing that, being acquainted with the origin and nature of the diseases, he has gained more than half the victory over them.