MISCELLANEOUS ESSAYS

ON

ECONOMIC ENTOMOLOGY

BY THE

STATE ENTOMOLOGIST

AND HIS

ENTOMOLOGICAL ASSISTANTS.

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H. W. ROKKER, STATE PRINTER AND BINDER.
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NOTE.

A recent opinion of the Attorney General makes it doubtful whether the State Entomologist of Illinois has a right, under the laws referring to that office (to some extent inconsistent and conflicting), to prepare any other than a biennial report; and a change in practice of the State Board of Contracts leaves no doubt whatever that a report published this year could not be illustrated. As an elaborate monograph of insects injurious to Indian corn was intended as the principal part of my entomological report for 1885, and as this article certainly should not be published without a large number of excellent figures, I have decided, under existing circumstances, not only to withhold this paper, but also to refrain from presenting any formal report for 1885, leaving it to the State Legislature to provide for the proper illustration of the reports hereafter, and to remove the present inconsistencies of the law. Unwilling, however, that the work of the office for the past year should be without representation in the Transactions of the State Board of Agriculture, with which the entomological report has been annually published for the last ten years, I have submitted to the Board, at the request of its Secretary, C. F. Mills, Esq., the following miscellaneous essays on economic entomology, summarizing the results of such part of our operations as may well be published without cuts.

A running account of the principal entomological events and observations of the year is followed by a somewhat elaborate report of experiments with insecticides for the codling moth and curculios in apple orchards; other articles are offered presenting the results of recent observations and experiments upon the corn plant louse, upon some of the most destructive of our common grasshoppers, and upon a miscellaneous series of insects of Livingston county; and a list of corn insects with a bibliography of the economic literature relating to them is also published as an introduction to a monograph on insects affecting corn, to be presented hereafter.

S. A. Forbes,
State Entomologist.

University of Illinois, March 1, 1886.

THE ENTOMOLOGICAL RECORD FOR 1885.

By S. A. FORBES.

To the economic entomologist the season of 1885 was not especially noticeable, except for an extraordinary outbreak of two or three of our common species of grasshoppers in the western part of the State. It seems, however, not impossible that the year will be remembered also for the first indications of one of the customary periodic uprisings of two of our most destructive insects, viz: the chinch bug and the army worm, both of which were evidently upon the increase in certain parts of the State, and likely to multiply injuriously another year, provided the weather is favorable for their reproduction.

Frequent complaint having reached me of injuries to lawns by ANTS of the various species which throw up mounds of earth, I have recommended the use of bisulphide of carbon to destroy these colonies, invariably, according to the accounts of my correspondents, with success. A hole six inches deep should be made through the middle of the mound, an ounce or more of bisulphide of carbon being afterwards poured in. The hole should then be filled and packed with earth. The volatile poisonous fluid will rapidly evaporate with deadly effect upon the ants. Thinking it likely that gasoline might be substituted for this somewhat expensive, dangerous, and highly disagreeable fluid, we experimented with the former liquid upon a colony of these insects at Champaign. Placed under a bell jar and exposed to the fumes of gasoline, the ants commenced to die in eight minutes, although not all had perished at the end of two hours. In sixteen hours, however, all were dead. Tried in the field, the experiment was a practical failure, three ounces of gasoline poured into a hole made in the middle of an ant hill having, practically, no effect at the end of twenty-one hours. This result was confirmed by a second trial. Although the odor of the gasoline lingered in the earth two and a quarter hours after the application, the ants were apparently not incommoded. It is possible, however, that larger quantities might produce the effect sought for.

The EUROPEAN CABBAGE WORM (*Pieris rapæ*) has clearly been less abundant during the past season throughout that part of the State under our observation, than during the year preceding. The same scarcity was noted by several of my correspondents. Dr. Goding, for instance, writing from Livingston county on the 24th July,

reported that it was difficult to find a single cabbage worm in the field; and Dr. Boardman, in August, informed me that they were very much less abundant in Stark county than usual. This difference, so favorable to the horticulturist, was due apparently to the continued prevalence of the destructive disease of the cabbage worm first reported by me in September, 1883.

Numerous examples of its extraordinary destructiveness occurred in the course of our observations. Visiting a cabbage field near Champaign late in August, the owner of which had reported a few days previously that it was being destroyed by the cabbage worm, we failed to find, on twenty minutes' search, a single living larva, the leaves being, however, badly riddled, and the dried and blackened remnants of the dead cabbage worms giving unmistakable evidence of their recent presence.

Hoping to arrange experiments for the artificial propagation of this disease at a distance, where it had not yet appeared, I wrote to several of my entomological correspondents, inquiring whether it was discernible in their vicinities. From Dr. Lintner, State Entomologist of New York, I learned that it had appeared in that State, information to the same effect coming also from Mr. Goff, of the New York Experiment Station. In a subsequent letter, the latter gentleman contributed also the interesting information that Prof. Arthur, the botanist of the Station, had experimented with reference to the contagious character of the disease by feeding portions of the bodies of larvæ, recently dead, to still living and healthy worms, the effect being the speedy sickness and death of those thus treated. From William Saunders, Esq., of Ontario, Canada, I learned, Oct. 5, that there seemed to be no traces of the disease among the cabbage worms of his vicinity. Prof. Snow, of Topeka, Kansas, informed me, likewise, that it certainly had not appeared in that vicinity; and Mr. E. W. Doran, of Loudon, Tennessee, Assistant Entomologist of that State, reported to me, as late as October 19, that he was unable to detect any evidence of its occurrence there. In Iowa, however, I learned indirectly that it had appeared in the fields in the vicinity of Ames; but whether as a consequence of the gradual extension of the area occupied by it, or as a result of the experiments instituted for its propagation there the previous year, my informant was in doubt.

As no precise description of this affection has been published, as far as I am aware, I give herewith one soon to appear in an article on the Contagious Diseases of Insects, now in press in the Bulletin of the State Laboratory of Natural History.

In this insect *flacherie* is distinguishable with great ease and certainty by conspicuous external symptoms, the color alone of affected larvæ being, in fact, entirely characteristic and unmistakable. The natural color of a healthy cabbage worm is a light lively green, sometimes slightly tinged with yellowish, but without any approach to an ashy or milky hue. As the first symptom of *flacherie*, however, the larva commences to turn pale, this paleness increasing more or less rapidly until the color is almost milky white, only slightly tinged with greenish. This discoloration is uniform and simple, no other tint usually appearing until after death. Then,

however, the color deepens to a sooty gray, commonly uniform, but sometimes first appearing about the center of the length of the larva. Occasionally this deeper color appears a little before death, but it is not then of equal depth over the whole surface.

In the actions of the insect there is little to indicate any change of state, except a gradually increasing sluggishness, slowness of movement, and loss of appetite. These are later to appear than the pale discoloration above mentioned, and even shortly before death a larva may show considerable impatience if roughly handled. When the disease is well developed, the caterpillar is very feeble, and will remain motionless for a long time; or if it attempt to crawl where some strength is needed, as horizontally on a vertical surface, it may lose its hold with its jointed limbs and cling only by its central prolegs, the fore and hinder parts hanging limp and helpless at right angles to the remainder of the body.

Most commonly an escape of fluid from the vent is among the earlier symptoms of the affection, at first greenish or whitish, and later a dirty gray, or even a chocolate brown. Rarely this fluid exudes also from the mouth. The amount of it is usually sufficient to stain considerably the surfaces over which the larva crawls; but sometimes this symptom is wholly absent. Occasionally the intestine is found empty after death, but almost invariably it is well filled with food, much of which retains its native color, digestion being, in fact, evidently suspended during the course of the disease. I have found in only a single instance an appearance of bubbles of gas in the alimentary canal. Usually the mass of the alimentary contents seems to lie inert in the stomach, undergoing neither digestion nor decay.

The color of the fluids of the healthy larva is a very pale transparent green, the blood containing only lymphoid corpuscles in greater or lesser number; but if a proleg of a diseased specimen be snipped off, and a cover glass be pressed against the cut surface, the droplet exuding will be of almost milky whiteness, or, in the latest stages of the disease, a dirty gray. Rarely, where there has been much escape of fluid from the vent, the juices of the larva will be thick and scanty, so that it requires some pressure to force out a very small quantity. If a minute droplet of the milky fluid obtained by snipping off a proleg be examined under a high power of the microscope, it will be found to contain innumerable myriads of very minute spherules, varying in diameter, according to the individual, from .5 μ to 1 μ. Usually their average size does not surpass .7 μ. It is the infinite multitude of these which gives to the fluids of the diseased caterpillar their milky look, and, likewise, unquestionably it is they which cause the ashy appearance of the surface, the skin being thin and delicate, so that the color of the fluid contents shows through. The diseased blood is so thick with these minute corpuscles that little else can be ordinarily seen in it. Sometimes, however, degenerated lymphoid corpuscles of the blood will be noticed, recognizable by their size and spherical contour, but differing from the normal corpuscles in their darker tint and coarsely and irregularly granular structure. These darker, granular corpuscles are always dead, no longer exhibiting amœboid movement, and have usually a spherical form. Not infrequently

débris of the fatty bodies is apparent in the form of large irregular cells, floating freely in the fluid; but these cells themselves will be found to contain immense numbers of the minute spheres already mentioned. In fact, if a little portion of the soft remnant of the fatty bodies be removed, spread upon a cover, and examined with a power of a thousand diameters, it will be seen that the cells of these organs are the seat of an extreme degeneration, the entire contents of many of them being wholly replaced by the spherical granules mentioned above. Occasionally a cell containing a nucleus will be found, but more commonly all distinction of contents has disappeared.

If the body of a diseased larva be cut across and a cover glass be pressed against the cut end of the intestine, or, still better, if the larva be opened lengthwise, and the stomach removed and laid open separately, so that a droplet of the pure contents of the alimentary canal may be obtained, the fluid portion of these contents will be seen to swarm with infinitesimal granules similar in appearance to those found in the blood, except that they are, on an average, often appreciably larger and are occasionally more or less oval in outline. These same forms may also be found in the fluid excreta escaping from the vent of the still living larva. If the specimen has been dead some time, so that the sooty discoloration of the surface has occurred, the fluids both of the alimentary canal and of the body at large will often be found to contain, besides myriads of the above spherules, various other forms clearly recognizable as septic bacteria,—among these, members of the genus Bacterium, easily distinguishable by their oval form and by the manner in which they actively propel themselves across the field of the microscope. Rod-like bacilli may also appear in the fluids at this time, equally active, and evidently moving by means of flagella, especially in the vicinity of the bubbles of air which may be included in the fluid under the cover glass. Occasionally these latter bacterial forms may be found in smaller numbers even before death, very rarely in the perivisceral fluids, but not very uncommonly in the contents of the alimentary canal. Still they are infinitely less abundant than the Micrococcus-like spheres already mentioned, even long after the death of the larva.

The most characteristic *post mortem* phenomenon is the rapid softening, decay, and deliquescence of the body, the whole of which may be converted, in an hour or two after death, into a dirty fluid mass which the rotten skin is barely sufficient to hold together. This breaks at a touch, allowing the fluid contents to escape.

More recent studies of transverse sections of the bodies of diseased larvæ, prepared as microscope slides, have given me a number of additional interesting facts with respect to the pathological conditions of this disease, a brief account of which may with propriety be given here.

As determined by a study of the tissues of larvæ diseased but far from dead, the principal center of the affection was seen to be in the alimentary canal, the fatty bodies, and the blood. The mucous membrane of the pharynx, œsophagus, and rectum was but little

altered, but that of the chyliferous or digestive stomach was greatly disorganized. The inner ends of the long cylindrical cells with which the alimentary canal is here lined were always broken down, and much of the remainder was occupied by minute spherical granules, most of them, apparently, micrococci, this degeneration occasionally extending through nearly the whole depth of the epithelial layer. Sometimes, in fact, the basement membrane was almost denuded and the wall seemed upon the point of perforation; but no actual solution of the basement membrane and muscular coat of the stomach was noticed in any of the sections examined. The cells of the fatty bodies were commonly so far replaced by collections of finely granular matter, that the true structure of these bodies was almost indistinguishable. Applications of caustic potash to the sections, and consequent partial solution of the tissues, commonly showed, however, that this was due to an infiltration of these tissues rather than to a complete degradation of them. All the exposed surfaces of structures within the perivisceral cavity were usually covered with aggregations of the spherical granules characteristic of the disease, which often formed layers or masses 12 μ or 15 μ thick. These granules, not definitely distinguishable in the mass, partly owing to their dense aggregation, and partly, also, to their concealment by the coagulation of the blood, were, nevertheless, unmistakably the same as those swarming so thickly in the fluids of diseased larvæ while still living. I could not detect any especial degeneration of the nerve centers, or of the nerve tissues, or, in fact, of any of the other vital organs, with the occasional exception of the Malpighian tubules. The hypodermis, however, was sometimes more or less disorganized, probably in those parts of the body presenting a blackish discoloration during life. Over such areas the hypodermal cells were broken down, their structure lost and replaced by a granular detritus. In these sections, prepared from specimens kept for some months in alcohol, the spherical granules stain with great difficulty and readily decolorize.

In the course of a series of experiments performed upon the CODLING MOTH (*Carpocapsa pomonella*), this species received at our hands extraordinary attention in all its relations. An elaborate account of our observations respecting its life history and its susceptibility to remedial measures is given in another article, and I add here only facts showing the abundance of the species during the present season. Of nearly 10,000 apples examined from trees used as checks upon our experiments, and which, consequently, had not been treated with any insecticide, 59 per cent. had been infested by the codling moth,—a proportion doubtless unusually great, and due in part to the extraordinary scarcity of apples following a year of great abundance.

That dread enemy of the cereal crops, the notorious ARMY WORM, (*Heliophild unipuncta*) seems to be making head in southern Illinois, having evidently occurred in injurious numbers throughout all that part of the State from Bond and Wabash counties to Alexander and Gallatin. Our information concerning this species covers the counties of Alexander, Bond, Gallatin, Jackson, Perry, Wabash, Wayne, and White, in all of which this pest was injurious to pastures and meadows, and was occasionally reported to have made a visible impression upon the crop of corn in June. I do not hear of

any effort made by the farmers of that region to arrest its progress, either by the general application of poisons or by the older resource of ditching across the line of march and crushing the accumulations.

The LESSER APPLE LEAF ROLLER (*Teras malivorana*) is reported to have so intensified its injuries this season as almost completely to obstruct, in some localities, the business of growing young apple-trees for the market. At Normal, especially, in the grounds of the Home Nursery Company, the mischief worked on the susceptible varieties has been of a very discouraging character, and has even disposed the proprietors to transfer their apple business to a western state. Possibly, however, the trees would have withstood the attacks of this leaf roller if these had not been seconded by those of the green apple leaf hopper (*Empoa albopicta*), which, by sucking the sap from the leaves at the time the leaf roller is denuding them, more than doubles the final effect on the tree.

As a result of a short series of experiments made with kerosene emulsion and with lime, at Normal, I learned that no liquid or powdery application could reach a sufficient number of the larvæ secluded in the rolled and webbed leaves to make it at all worth using for its immediate effects. If, however, the young trees were occasionally sprayed with an arsenical poison, and especially if this treatment were begun rather early in the season, I have no doubt that perfect protection from this insect would be afforded. While the poison would be little likely to reach the larvæ rolled in their silken nests, it would nevertheless take effect as they extend their webs to cover fresh surface.

Concerning the ROOT WEB WORM (*Crambus zeëllus*, Fernald), seriously injurious to young corn in May and June, much additional information is still to be desired, and I report here the facts already made out, in the hope that other observers may thus be induced to assist in the completion of the life history of the species, and may help us to a fuller knowledge of its habits and of its injuries to vegetation.

Although working somewhat like the cutworms, it belongs to another family of moths (the Pyralidæ or snout moths), and may easily be distinguished from these pests by its habits and by the character of its injuries. If a hill of corn damaged by this insect be carefully examined, a mass of dirt, loosely webbed together, will invariably be found just beneath the surface of the ground, close beside the young stalk or among the larger roots. If the nest (irregular in shape, and commonly an inch or two in length) be opened, a reddish, bristly, active worm, half an inch, or a little more in length if full grown, will be found hidden within, the matted earth evidently serving as a retreat from danger.

The central part of the nest is commonly occupied by a silken tube, which extends more or less vertically downward into the earth, often opening at the surface close beside a stalk of corn, by a round orifice about the size of a wheat straw. This tube is commonly an inch and a half or two inches in length, and within it the worm may be found concealed. Sometimes the web lies horizontally, or nearly so, with its opening at the surface next the stalk, often with the web attached to the latter, or even fastened by

threads some distance above the root. Some webs are placed vertically, lying close beside the stem. They frequently occur under clods, and occasionally one was seen scarcely protected at all.

The injury to the corn is extremely characteristic, and cannot be mistaken when once understood. The web worm evidently leaves its burrow to feed upon the leaves, at first the lower one and then those nearer the top of the stalk, commonly eating off the ends of the leaves or gnawing irregular holes near the middle of the larger ones. The lower leaf of the infested plant is ordinarily eaten wholly away. Occasionally I have found a leaf cut off and drawn partly into the burrow of the worm; and sometimes the kernel of corn was eaten in the ground. The stalk of the affected plant will be found gnawed irregularly beneath the earth, sometimes wholly severed, as by a cutworm, but more commonly scarified, or bored lengthwise, either superficially or through the centre of the stalk. From one to eight or ten larvæ may be found in a single hill. In a field near Champaign, on land in pasture for fifteen years, plowed up about May 5 and planted to corn from five to ten days thereafter, I found the corn so badly injured by this insect that the owner had decided to replant the greater part of it. No difference in amount of injury could be correlated with difference in soil or surface, the worms being as abundant on low ground as on high, and as indifferent, seemingly, to character of soil.

Near Mount Pulaski, June 16, we found a field of corn which had been practically destroyed by this insect about two weeks before, and had consequently been plowed up and replanted. This field had been in pasture for a number of years and was broken up for the first time the preceding fall. The web worms had not, apparently, been seriously disturbed by the replanting, but had already attacked the young corn of the second growth, and to this were doing considerable damage.

As the larvæ in the Champaign field were, several of them, full grown, and the greater part of them nearly so, it is certain that the eggs were laid in the sod before it was broken up. The root web worm consequently breeds in grass. This view is confirmed by information concerning this insect from J. P. Norton, of Libertyville, Lake county. A field of twenty acres, plowed up from greensward in spring and planted to corn, was said by him to have been immediately cut down by the root web worm as it came up, and the webbed larva was found, in each case, just below the surface, about the roots of the corn, not missing, according to his report, a single hill. On the other hand, Mr. R. S. Mills, of Dwight, Illinois, (in whose field I first studied the species, two years ago,) writes me that the ground upon which the corn was injured had been alternately in corn and oats for six preceding years, and for three or four years before that, in corn.

The species was sent us last year from various localities in Henry, McLean, Mason, and Livingston counties, and doubtless occurs everywhere throughout central Illinois. From the Crop Reports of the State Department of Agriculture, I learn that this insect, a description of which had been but recently published, was noted by the crop reporters of the Department in Carroll, Cass, Stark, and

Livingston counties, and in Henry county in June. It is not altogether certain, however, that the insect referred to by these correspondents was in all cases the species here under consideration.

I base a surmise of the occurrence of this pest in Rock Island county upon a report received by my assistant, Mr. Hunt, from two farmers near Milan. They had noticed a worm making a web at the roots of the corn and eating the leaves while young, afterwards working at the roots, often cutting the corn off just below the surface of the ground. Several acres of sod corn were completely destroyed by these insects, only here and there a hill being left. As I know of no other corn larva which constructs a web in the earth at the roots of the plant, it seems highly probable that our species is here indicated—possibly confused also with some cutworm attacking the corn at the same time.

Our first specimens were taken May 19, at which time many of them were only about half grown. In our breeding cages, the larvæ changed to pupæ in the earth at some time during the latter half of June, and the adult moths emerged from the 1st to the 22d of July. The average size of the larvæ in the Champaign field leads me to doubt whether it is possible that they can have resulted from eggs laid in the spring, especially as diligent collecting from the first opening of the season did not yield us a single moth of the species from which these worms descend. The brood observed by us must have practically completed its development before the end of July. Whether a second brood occurs or not, is wholly uncertain, and to this point especial attention is asked of those at work in fields of corn throughout the summer.

The root web worm is of a pale reddish brown color, without stripes, and marked only by rather large shining dark spots, each bearing a long black hair. The head is dark chocolate brown, with a few long yellowish hairs. Upon the front is a Y-shaped white mark, which does not coincide with the sutures of this region, the branches of the Y lying some distance outside the corresponding sutures, and the common stem being relatively short. The top of the first segment behind the head is yellowish, with a white median line, whitish anterior edge, and an oval black spot on the sides, near the middle of the lateral margin. Surface with a few scattered long dark hairs. The second and third segments bear two rows of piliferous spots, the anterior consisting of four large square spaces, the posterior of two, sometimes united with each other. From the fourth to the tenth segment these spots are in two transverse rows of four each, those of the front row being nearly square and at least as large as the spaces between them, and those of the hind row transverse, elongated, about twice as long as wide. Directly before and outside of each proleg is a narrow, curved, shining tubercle bearing several long hairs. The breathing pores are all dark brown, the anterior one the larger, and the two posterior next in size. The under surface of the worm is a little paler than the upper. Length of a full-grown specimen, .6 inch; its greatest width, .1 inch.

The chrysalis or pupa is smooth, shining pale brown, the abdomen a little darker, without hairs or spines. The eyes are reddish brown, head bilobed above. The abdomen has a blunt horny tip. Length, .4 inch; breadth, .1 inch.

The moth measures across the wing .75 inch to an inch. Head and thorax are pale leaden gray. Two feelers, the labial palpi, extend forward in front of the head a distance equal to the length of the head and thorax taken together. The fore wings are a dull leaden gray, mixed with ashy and white, especially on the outer pair, and crossed outside the middle by two angulated, dull ochre-yellow lines more or less overlaid with dark brown. The line bordering the wing is dark brown, and a brownish cloud extends obliquely in from near the front outer angle of the wing to the second transverse line. A narrow ochre-yellow line, somewhat curved, extends from the middle of the base of the wing to the second line near the anal angle. The outer margin of the wing is regularly excavated below the apex; fringes pale metallic lead color. Hind wings smoky, with lighter fringes; underside of the body and all the wings pale dusky.

Minute mites, which attacked the pupæ in our breeding cages, and were apparently responsible for the loss of nearly all the larvæ we attempted to rear, probably also attack the worm in the field. At Champaign, an undergrown example was found, May 28, infested by this mite, a number of which were running freely over the surface of the larva.

Besides this, I determined by dissection that certain predaceous beetles, especially abundant in fields infested by the web worms, had also been feeding upon them. Further than this we have no knowledge of natural checks upon the increase of the species.

The injuries inflicted occur so early as to permit a replanting in most seasons in case they should be of serious import, and this species is consequently to be classed with the cutworms so far as the effect of its injuries to corn are concerned.

If the corn is to be replanted, advantage should be taken of the fact that all the larvæ are collected in the old hills of corn remaining from the first planting. If the usual practice is followed by plowing up the old corn as soon as the new is planted, these larvæ will of course immediately resort to the sprouting grain and continue their mischief there; whereas, if the old corn be left as late as consistent with the proper cultivation of the crop, the new planting will probably secure a sufficient start to escape serious injury. The web worm matures from the middle of June to the first of July, and then ceases its mischief, so that a little delay in plowing up the old corn may save the new.

It is easy to dislodge these larvæ without injury to the corn, since their presence may be detected by the peculiar appearance of the plant, and the worms themselves are secreted within an inch or less of the surface, close about the stalk attacked. By passing the finger around such stalks, the larvæ may be readily unearthed. Where badly infested fields are not too large, and the help of a boy or two is available, I do not doubt that it will pay to capture the worms in this manner.

As a mere beginning with remedial experiment I directed, early in June, some applications of the kerosene emulsion to larvæ of this insect enclosed in small boxes of earth, each containing about eight cubic inches. Repeated applications of one dram of

kerosene emulsion poured upon the surface of the earth was invariably fatal to the enclosed worms. (The emulsion was composed of suds, one pound of soap to ten gallons of water, churned with an equal quantity of kerosene. The amount of kerosene used was consequently one half a dram.)

In the "Country Gentleman" for May 30, 1872, I find an interesting note from a subscriber living in Queens county, New York, which it seems to me may possibly relate to the root web worm:

"Yesterday," he says, "I was surprised to find that the young corn had almost entirely disappeared, and upon examination of the hills worms like the specimen sent herewith were found just beneath the surface of the ground, that had evidently worked the destruction of the growing crop. From one to five or six were found in proximity to a hill. They are enveloped in a web, and have the faculty, when detached from it, to spring somewhat after the manner of the worms often found in cheese.

"Their method of destruction appears to be in eating the young shoot just under the surface of the ground, until it falls over and dies, after which they gnaw the stumps downward toward the kernel, thereby probably preventing the plant from shooting out again, as it does after the ravages of the worm known as the cut or black worm.

"The field in which the corn is planted was a sward, but the grass last summer on it appeared to be dead; whether the same insect or worm caused that, I do not know."

The Hessian fly (*Cecidomyia destructor*, Say) has continued during the last year its career of devastation in southern Illinois with a very unusual persistence. As a general rule, a year of extraordinary abundance of this insect is followed by one of immunity from its ravages; but for three successive years in the counties of Fayette, Effingham, and Clay, the Hessian fly has abounded in numbers to prevent the harvesting of many fields of wheat, and to inflict very serious injury upon many more As a consequence, last autumn, I heard seriously debated the advisability of general abandonment, throughout the infested region, of the cultivation of wheat until the Hessian fly had disappeared.

From our own observations and collections of the last three years, and from information contributed by very intelligent correspondents who have spent years in the midst of the Hessian fly, I infer the strong probability of two important items in the life history of the species: (1) the emergence as imagos, before harvest, of a great part of the larvæ found in the wheat in May; (2) the development of an additional brood in volunteer wheat, the flies of which appear in autumn early enough to deposit their eggs and produce a third brood of larvæ before the advent of winter. These facts suggest the possibility of greatly checking, if not practically arresting, the multiplication of the Hessian fly in our latitude by the following simple procedure: According to the best agricultural practice, the stubble is plowed for wheat immediately after harvest. In case there has been little or no shelling out of the grain in the field, a little may be sown before plowing, so that enough may grow, either of volunteer

wheat or of that from this sowing, to tempt all the flies then abroad to deposit their eggs early in the season. Previous to sowing the wheat for a crop (and this may now be done early to advantage), this young wheat should of course be killed by a rotary harrow or some similar instrument, in which case, if this action be intelligently timed, all the young or half-grown larvæ in this growing grain will of course be destroyed. If such procedure were general throughout a neighborhood, there seems very good reason to suppose that a vast number of the flies must be destroyed, only those remaining which had not emerged in time to deposit their eggs before this final sowing of the fields—a percentage probably too small to do serious mischief.

My information is also to the effect that wheat sown in the latter part of August is often much less liable, in southern Illinois, to be seriously damaged by the fly than late sown fields. In the early sown grain the larvæ transform and the flies emerge before winter, the wheat having time, before its growth is arrested by the season's cold, to rally, by tillering, against the damage done. Late sown wheat, on the other hand, if attacked by the fly, is certain to be seriously damaged, because it has no opportunity to recuperate, and whether attacked by the fly or not, is extremely likely to be killed by the winter. It is not an uncommon thing in southern Illinois, in seasons not especially remarkable for severity, for fifty per cent. or more of the winter wheat to be winter-killed as a consequence of the late date at which it was sown, in the hope of protecting it against the dreaded fly.

Since my article on the Parasites of the Hessian Fly, in my Entomological Report for 1884, another on the same subject has been published by Dr. Riley in the Proceedings of the United States National Museum for 1885. In this paper the parasitism of *Eupelmus allyni* upon the Hessian fly, implied in my own Report, is positively asserted; a new species of parasite, *Tetrastichus productus*, is described and treated; and the species described by myself, under the name of *Pteromalus ? fulvipes*, is described by Dr. Riley as *Merisus subapterus*. As he had both winged and wingless specimens of the species, his generic identification is probably correct. I had seen only the latter form, and consequently did not attempt to positively fix the genus of the species, described. As my description antedates that of Riley by some weeks, the name of the species must stand *Merisus fulvipes*, Forbes.*

The CLOVER SEED MIDGE (*Cecidomyia leguminicola*, Lintner), first described by Lintner as *Cecidomyia trifolii*, in 1879, (the present name being afterwards substituted for the above) was first reported in Illinois, as far as I can learn, by W. F. Carpenter, of Steward, Lee county, in 1882, in a note to the "Prairie Farmer," the date of which I have not at hand; but in a recent letter Mr. Carpenter informs us that he first observed the pest in Illinois in 1878 or 1879, and that it kept increasing in his locality from year to year

*As the generic identification of the species described by me under the name of *Pteromalus pallipes* has been called in question by the editor of "*Entomologica Americana*" (upon what ground it is impossible for me to imagine), it is proper to say that the species in question belongs strictly to the genus Pteromalus, as limited by Thompson in his "*Hymenoptera Scandinaviæ*," but not to any of the subgenera recognized by him.

so that the crop had not been worth saving. As it was first observed by Lintner in New York in 1877, it is difficult to say whether this was originally an Eastern or Western species, or whether it may not have secretly pursued a less offensive course for some years in various parts of the country. In northern Illinois it has been especially injurious this year, notice of its ravages coming to the office from the Farmers' Club of Marengo, in October. From some infested clover heads obtained through the Secrery of the Club, N. J. Wheeler, we had the good fortune to breed five specimens of a new parasite enemy of this midge,—a chalcid belonging to the genus Tetrastichus, and apparently of a species undescribed. Previous to this, two species of parasites have been reported as preying on it,—*Eurytoma funebris*, Haw., and *Platygaster error*, Fitch. Additional insect enemies were detected in our breeding cages,—one of them a small heteropter, so abundant everywhere that it may well serve a useful purpose in lessening the numbers of this clover pest. The facts concerning this insect were well worked out by my assistant, C. M. Weed, and I give them as reported in his notes. Finding in the breeding cage some larval specimens of *Triphleps insidiosus*, Mr. Weed isolated one of them with a larva of the seed midge in a small glass dish October 10, and found the larva dead, with shriveled skin, on the morning of the 12th. Another larva was then imprisoned with the bug, and this the latter immediately attacked. "As soon as the bug felt of it with his antennæ he pierced the skin with his beak. The larva struggled violently for about twenty seconds, but the bug did not let go, avoiding the body of the writhing larva by constantly retreating. At the end of twenty seconds, the larva ceased all motion and appeared perfectly dead. May it not be that a poison was ejected from the beak of the bug? For six minutes the bug continued sucking the body juices without removing his beak from the place where it was inserted (about the middle of the body), but he soon withdrew it and inserted it again near the middle, where it remained for nine minutes, when it was again changed to a place still nearer the middle. Eight minutes later the beak was again withdrawn and inserted near the head, where the bug continued vigorously sucking for six minutes, when it seemed to have enough. Thus he was sucking his victim about twenty-nine minutes."

Further, Mr. Weed determined the interesting fact that this midge is likewise possibly subject to the attack of a small caterpillar which he found lurking in one of the heads of clover. As the larva was seen to feed on the midge mite only in confinement (under which circumstances many lepidopterous larvæ become carnivorous), and as it was not preserved in condition for successful study, the particulars of the observation are not reported.

The WHEAT BULB WORM (*Meromyza americana*), which has been mentioned in my two preceding Reports, has scarcely come to our notice during the past year, but an item of information recently obtained from Mr. J. J. Nussbaumer, of Okawville, Washington county, is of such economic interest as to be well worthy of record. The wheat of that vicinity was last year badly damaged, as supposed, by the Hessian fly, but Mr. Nussbaumer tells me that, examining

plants in damaged fields in early spring, he found, not the brown flaxseeds of the Hessian fly, well known to every one, but pale watery larvæ between the bases of the leaves just above the root, corresponding closely, according to his description, to the larvæ of *Meromyza americana*, treated in my previous reports under the popular name of the "wheat bulb worm." It is consequently entirely possible that locally, in southern Illinois, the damage to wheat, attributed to the Hessian fly, is really due to this insect.

The common WIREWORMS (larvæ of Elateridæ) have been neither more nor less destructive than usual in corn fields, during the past season. The fact was repeatedly noticed that in fields two years from sod, injury to corn was much more evident than the year preceding, or in other fields of the same vicinity in sod one year ago. This fact is doubtless to be attributed to the death of the grass in the sod the second year, and the consequent concentration on the corn of all the wireworms in the field. Corn on sod was destroyed by the wireworms the first year on the farm of Mr. E. A. Chester, near Champaign, but the ground had been used during the fall, winter, and spring, as a feed lot for cattle and sheep, so that the sod had been nearly destroyed. In a field near Champaign, more than half of which had been destroyed by wireworms, (the whole field being as a consequence plowed up and replanted) a prolonged search failed to discover a single wireworm, except in the hills of corn,—in each of which from two or three to six or eight were present. The impropriety of the common practice of replanting is obvious. By planting between the rows of young corn and plowing up the latter at once, the wireworms are scattered and their food destroyed, and they are forced to attack the new corn just planted; whereas, if this were allowed to get a start before the corn of the first planting was plowed up, the probabilities of loss would be greatly lessened.

For the purpose of determining more precisely the life history and the species of the wireworms affecting our corn, breeding experiments were begun this season. From over one hundred larvæ, obtained May 25, and placed in boxes of earth mixed with soaked corn and covered with sod, we obtained a considerable number of imagos, all belonging to the species *Melanotus cribulosus* as determined for me by Dr. Horn, except a single specimen of the better known species, *Melanotus communis*. When the breeding boxes were examined on the 12th of July no pupæ were found, but by August 3 transformations had begun. On the 22d of August pupæ were seen, but no imagos. On the 12th of September fully developed imagos, just transformed, were dug out of the earth. No imagos appeared above ground during fall and winter, although living individuals were removed from the pupal cells in the earth as late as November. It is evident, therefore, that *cribulosus* (and probably *communis* also) completes its larval life during the latter part of summer; that it pupates in cells in the earth; commences to transform to the imago in early autumn; and remains under ground for hibernation.

In fields of sod corn near Peru, Illinois, I found, as late as July 1, 1883, many wireworms devouring the roots of corn and penetrating the stems just above the root, about six per cent. of the stalks in one of the fields having been killed in this way. Sometimes two or three of these larvæ were found boring through a single stem. The wireworms here collected agree in every particular with those described in the Canadian Entomologist, by Dr. Horn, the beetles bred from which were identified by him as *Agriotes mancus*.* This species is readily distinguished from Melanotus by the cylindrical, blunt terminal segment, marked above by a large black circular pore upon each side of the base. In this same field occurred the wireworm doubtfully identified by Dr. Fitch as our common *Melanotus communis*,†—an identification which I am very much inclined to consider correct because, as noticed above, we bred this species, last year, from corn wireworms.

Believing it to be quite within the limits of a reasonable probability that apparatus may be invented for the rapid and economical application of insecticides to hills of growing corn, I instituted, last June, some experiments upon wireworms with a view to determining what insecticides, if any, would be effective against them. Placing individual larvæ in boxes containing fifteen cubic inches of earth, a dram of kerosene emulsion (half kerosene) was poured over the earth without effect upon the larvæ. A repetition of this experiment gave the same result, but a dram of pure kerosene applied in this manner promptly killed the wireworms. Pyrethrum thoroughly applied directly to the wireworms seemingly did them no harm. Sprouting corn treated with water containing suspended Paris green was not attacked by wireworms placed in the earth with it, but neither were the latter themselves injured. Sprouting corn placed in earth with which Paris green had been mixed failed to grow, but was not attacked by the wireworms, these remaining alive and active.

To determine the effect of treating seed corn with arsenic previous to planting, moistened kernels were rolled in powdered arsenic and allowed to dry, others at the same time being dampened with water holding Paris green in suspension. Only three kernels, out of a possible one hundred, grew in the first lot and two in the second, as compared with the check corn planted at the same time. Later a hundred grains of corn moistened with water and rolled in a mixture of Paris green and plaster of Paris—one part to fifty—were planted in comparison with another hundred grains not so treated, both lots of corn being planted in separate boxes and similarly treated. Forty-four kernels grew in the poisoned boxes, and forty-eight in the check, both lots appearing above ground simultaneously and growing for a month together without important difference.

From the foregoing we may infer the practical inefficiency of both pyrethrum and kerosene emulsion as a protection against these insects, and the doubtful efficiency of Paris green. This last deserves, however, further experiment.

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* Canadian Entomologist, Vol. IV, p. 3.

† Trans. N. Y. St. Agricultural Soc., 1876, p. 529.

The occurrence of wireworms in wheat in numbers sufficient to attract the attention of the farmers has been reported from Washington county by Mr. J. J. Nussbaumer. The specimens sent by him from wheat fields are of a different species from that infesting the corn at Champaign,—one of which we have bred none to the imago, and which consequently cannot be specifically determined.

Five or six acres of wheat were completely destroyed in one field, the plant being eaten off just above the root; and Mr. Nussbaumer estimated that throughout that entire neighborhood an average of one acre in forty had been so destroyed.

The very common BLISTER BEETLES (*Meloidæ*) were far more abundant this year than usual,—a fact doubtless to be connected with the extraordinary abundance of grasshoppers, upon the eggs of which their larvæ are well known to feed. The species most frequently mentioned in our notes of injuries to crops are the so-called "old-fashioned potato beetle," or striped blister beetle (*Epicauta vittata*), the margined blister beetle (*Epicauta cinerea*), and the common black blister beetle (*Epicauta pennsylvanica*). The last is yearly abundant, feeding in autumn upon the flowers of the golden rod and other composite plants; but the other two species are more variable in their numbers. The abundance of *Epicauta pennsylvanica* was noticed as early as the 4th of July, at which time we found it feeding upon the leaves of the honey locust. In August, it was very common in corn fields, associated with the two other species, all of which were feeding freely upon the fresh silk of corn, doing thus apparently a very considerable mischief by preventing the fertilization of the kernels, and partially blighting the ear. Rarely, also, we saw the black species eating the kernels at the top of the ear. The striped blister beetle, likewise common in corn, was more abundant upon potatoes and tomatoes, often stripping these plants of their leaves. The margined blister beetle was also noticed in July and August feeding upon potatoes and tomatoes, sometimes more abundant than the striped species. In corn fields it attacks an allied weed, the common ground cherry (*Physalis viscosa*).

The CORN ROOT WORM (*Diabrotica longicornis*) seems certainly no less abundant than heretofore, although farmers who have adopted the practice of frequent rotation are rarely subject to its injuries.

An extension of the injury of this insect to other crops than corn was inferred by me from the abundance of the species in a field of Indian corn, near Champaign, with the following history. After several years in corn and sorghum, alternating at varying intervals, this field had been planted to sorghum in the spring, following a crop of sorghum. The planting failed, however, and the ground was replanted to corn for fodder, which was fed down by stock in the fall. Following this the field was again planted to corn last spring, and in July I found there abundant evidence of the presence of the corn root worm, in numbers sufficient to produce a very considerable injury to the crop.

Early in September, an assistant, Mr. Hunt, visited a broom-corn field near Champaign, which had produced only about half the

usual crop, this field having been in broom corn for 12 or 13 years. The condition of the roots was precisely that produced by the corn root worm, although at that late date none of the larvæ were to be found in the ground. No facts have as yet come to my knowledge which indicate that diversities of season have any appreciable influence upon the numbers or activity of this insect, though during seasons favorable to the growth of the corn, less damage is, of course, perceptible.

I feel bound to do my best to excite the serious apprehension of farmers respecting the future of the corn root worm in regions where it is being neglected. I have no doubt that under such circumstances, multiplying continuously as it is liable to do, it will in time accumulate in such numbers as no longer to confine its chief injuries to fields principally in corn, but that the beetles will be early forced to scatter, in search of food, from the fields in which they emerged, and that the eggs will consequently be freely laid everywhere in the ground instead of being confined, as now, chiefly to corn fields. Indeed, there is already some serious indication of the approach of this calamity. From Mr. B. C. Davis, of French Grove, in Peoria county, I learned this fall that the adult beetle has been seen in his vicinity, flying in swarms, so early in the season that it is not at all likely that the females had yet deposited the principal part of their eggs. In such cases the ground will almost certainly be heavily stocked with the eggs wherever a sufficient food supply occurs, and fields not lately in corn will be liable to show next year evidences of serious injury by this pest. As the beetle lives largely upon the pollen of plants, and congregates upon clover heads and other late blooming flowers, it is in fields of clover, or those containing an unusual amount of fresh young vegetation, that this prevalence of the corn root worm is likely to be noticed.

It is not unlikely that the abundance of grasshoppers in corn fields in some parts of the State this autumn, and the consequent diminution of the ordinary food supply of the corn root worm beetle, may have forced it to leave the corn fields earlier than is its custom. But this consideration serves to enforce the importance of a general and frequent rotation of crops as a safeguard against a pest so liable to take advantage of even slightly favoring circumstances, and to inflict uncontrollable damage upon the principal farm crop of the State.

As a very effective precaution against a possible injury to corn by the root worm on ground not last in corn, I would suggest the early fall plowing of such fields. By thus destroying the food of the adult before the season for the laying of the eggs, all temptation to resort to these fields will be removed. To this end, ground in clover, or that covered with any sort of late blooming vegetation, or with a fresh growth of tender herbage, like volunteer oats, should be plowed before the middle of October, if intended for corn.

The ravages of this insect are, so far, curiously limited to northern and central Illinois. Near Edgewood, in Effingham county, I failed to find any evidence whatever, either in corn fields or upon thistle blossoms, of the presence of this insect as late as September 12, at which time the beetle was superabundant as far south as

Champaign. In Union county, also, most careful search in cornfields and in other proper situations, has failed to give us the slightest evidence of the presence of this species. I think it scarcely likely that this immunity of our southern corn fields is due to any geographical limitation upon the spread of the species, since it was first described from Arkansas, was first reported as a corn insect from St. Louis county, Missouri, and has been frequently mentioned as very abundant in central Kansas. In a note of twenty years ago to Mr. Walsh, Prof. W. S. Robertson, of Kansas, reported the occurrence of this insect in very large numbers upon sorghum, its usual home being a large thistle. In his comments upon this information, printed in the "Practical Entomologist" for October, 1866, Mr. Walsh remarks that he took three specimens of this species many years ago, on flowers in central Illinois. Its rarity at that time, in the experience of so active a collector as Mr. Walsh, is evidence that this species is a somewhat recent enemy of corn in Illinois. It probably invaded the State from the westward, having its original home on the great plains, whence we received also its more notorious ally, the Colorado potato beetle.

From an observation first reported to me by a correspondent of the office, Mr. Benjamin Buckman, of Farmingdale, Ill., we derived an interesting item relating to the life history and habits of *Epicærus imbricatus*,—a snout beetle occurring very commonly in miscellaneous collections and also often encountered in my studies of the food of birds. These specimens, taken May 29, were charged by Mr. Buckman with eating the leaves of young pear trees. "They come up out of the ground," he says, "and may be seen with their heads just sticking out as if the earth had not been broken above them, while others have holes to which they seem to retreat, like a spider." The beetles were sent me in a box with a twig of pear, and when received several of the leaves were found stuck together by their opposed surfaces, with a closely packed layer of slender white eggs between them. To make sure that these were the eggs of the Epicærus, the beetles were removed to another box June 1, and confined with a fresh twig of pear. They were found two or three days afterwards, to have laid eggs upon the leaves and then to have gummed the latter together as above described. The edges of many of the leaves were also eaten. In an attempt to secure the hatching of the eggs, these were unfortunately left until they spoiled.

On page 183 of Mr. Saunders' valuable work on "Insects Injurious to Fruits," occurs one of the very few inaccurate statements which I have noticed in this book. Speaking of the PLUM CURCULIO (*Conotrachelus nenuphar*) he says that it occasionally deposits its eggs in the pear and apple, but that in these fruits *it seldom matures*. Finding, in 1884, that a large orchard of the present Secretary of the State Horticultural Society of Illinois, A. C. Hammond, Esq., at Warsaw, was badly infested by curculios, I collected about half a bushel of apples from which the imagos had not as yet emerged, and, placing them in breeding cages at Normal, I finally obtained a considerable number of adults of the plum curculio,—how many, I find our notes do not clearly state. During experiments made in

the apple orchard this season for the destruction of the codling moth, we found the plum curculio nearly half as prevalent as the other insect. It is, in fact, everywhere in apple orchards, far more common than the apple curculio itself in regions where no peach-tree has been seen for years, and even the plum is very rare. That it has been thoroughly habituated to the apple as its breeding place can no longer be considered as doubtful. Indeed, a statement to this effect was made by Mr. Walsh as early as 1867*.

Similar information is conveyed in a note from Mr. S. T. Maynard, of Massachusetts, published in the Report of the Secretary of the Board of Agriculture of that State for 1884. "It has often been noticed early in the summer," he says, "that apples nearly all fall from the trees when quite small. This was especially the case during the past season, and a careful investigation was made to ascertain the cause. A tree of the variety known as the Westfield Seek-no-further, which blossomed very abundantly and set an unusually large crop of fruit, was selected. When from one-half to one inch in diameter, the fruit began to drop in large numbers, so that not enough was left on the tree for half a crop. A large quantity of them were collected and examined, and out of eight hundred it was found that all but three were punctured by the plum curculio, leaving its peculiar crescent-shaped mark, and in every puncture was found an egg or small larva. The worms commonly found in the apple at this time have generally been supposed to be the larvæ of the codling moth (*Carpocapsa pomonella*), yet in the number examined only four or five of the larvæ of the latter were found."

Digging in an old pasture near Normal, June 12, 1883, I observed some thick footless coleopterous larvæ apparently feeding upon the thick roots of grass. They were not at all abundant, and our attempt to rear these specimens failed. On the 13 h of July, 1885, I received from Mr. J. R. Gaston, of Normal, a number of specimens of what was evidently the same larva, taken by him from the roots of timothy in a field which had been about eight years in grass. The crowns of the grass were here eaten out, from one-half to one per cent. of the stalks being consequently killed. The same species was found in timothy at Champaign, about the middle of July, eating directly into the crown of the grass from beneath, usually throwing out a mealy mass by which the position of the larvæ could be recognized. On the 21st of July the grubs transferred to our breeding cages were still active and feeding upon the grass, but September 24 an examination of the earth discovered a living *Sphenophorus parvulus* associated with a larval skin and an empty pupa case, in a way to indicate beyond all question its connection with the footless larva under observation. October 5 another specimen of the same species emerged.

The larva of this species is a thick fleshy grub, white except the head, which is reddish brown with black mandibles. The body is much wrinkled, both transversely and longitudinally, destitute of feet, provided with a few scattered straight brown hairs, somewhat

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*"I have found its larvæ very abundant in the cherries in Kankakee, and have this year bred it from numbers of the Early Harvest apple taken from Mr. G. H. Baker's orchard." Trans. Ill. St. Hort. Soc. 1867, p. 114. See also American Entomologist, Vol. ii, p. 276.

longest at the tip of the abdomen. The cervical shield or dorsal part of the first segment is concolorous with the rest of the body. The sutures of the front of the head are obscure except the median one, which extends about half way to the epistoma.

An imago of this species was seen June 7, 1881, with its beak inserted in a stalk of wheat, and another was taken May 26, 1885, making an identical attack up n a young corn plant. So intent was it on its employment that it remained attached after the stalk was pulled up, and even then had to be forcibly pulled away. *Sphenophorus pertinax* was also found at the base of a hill of corn, June 16.

Although in our own observation (confined to the northern half of central Illinois) the CHINCH BUG has not anywhere appeared in sufficient abundance to threaten immediate injury, reports of correspondents of the State Department of Agriculture from the region immediately to the southward, give more unfavorable indications, and it seems extremely likely that unless unfavorable weather should interpose a check upon the rapid multiplication of this species, it may overpass the limit of insignificance before another year. In the August Crop Report the chinch bug was reported injurious to corn in Clinton, Jefferson, Macoupin, Madison, Pike, Wayne, White, and Richland counties,—in Pike, especially, the corn having been greatly damaged. As early as July, in fact, notes of injury to corn by the chinch bug were sent from Crawford and Madison counties.

I have already made mention, in a brief note relating to the lesser apple leaf roller, of the simultaneous and similar injuries done to the foliage of the young apple by the GREEN APPLE LEAF HOPPER (*Empoa albopicta*, Forbes.)* This species was described by me as a new apple insect in my Second Report (1883), and it was not until after this had been published that I happened upon a much earlier account of it printed in the "Prairie Farmer," of Chicago, for September, 1853. Dr. Le Baron, subsequently State Entomologist of Illinois, writes of this insect, associated then, as now, with an apple leaf roller, evidently the same as that which he afterward describes as *Teras malivorana*. "Every one," he says, "who has had the care of apple-trees in this section of country, and especially of young trees in the nursery, must have observed that during midsummer the newly formed leaves often become crumpled and rolled downwards, thus checking the growth of the tree for a time. Upon examining the under side of the leaves, the mischief is found to be caused by a number of small green leaping insects which belong to the tribe of Tettigonians, or leaf hoppers. They subsist upon the sap circulating in the leaves, which they obtain by puncturing the veins on the under side, thus causing them to roll downwards. These little insects are not stationary like the Aphides

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* A comparison of my specimens with an analysis of the genera of Jassidæ, given by Fieber, shows that most of the specimens clearly belong to his genus Chloria, although the outer apical cells at the tip of the hemelytra may be either sessile or stalked, partaking consequently of the characters of both his genera Chloria and Kybos. The head and and pronotal characters are, however, those of Chloria. On the other hand, there can be no doubt that the species belongs clearly under the species Empoa, as described by Fitch, or under the genus Empoasca of Walsh. (Proceedings of Boston Society of Natural History, Vol. IX, p. 315.) As both these generic descriptions antedate those of Fieber, his genus Chloria must be considered a synonym.

and Coccides, but move readily by leaping, as their name implies, and, like most other insects, acquire wings and the power of flight in the last or perfect stage of their existence.

"I have never known them to multiply to a sufficient extent to do very serious injury. Besides, they appear to feed but little after their change from the pupa to the winged state, which takes place previous to the second or autumnal growth of the trees."

In another paragraph he gives a recognizable description of the species, and proposes for it the name of *Tettigonia mali*, or apple-tree leaf hopper. Curiously, no subsequent mention was made of this insect, either in his own writings or anywhere in the works of entomologists, previous to that in my own report. Although the specific name *mali* was the first proposed for this species, names based upon descriptions published in agricultural papers are not accepted by entomologists, and consequently, to avoid the perpetuation of a synonym, it is probably best to continue the species under the name given in my Report.

The serious character of the injury to the apple done by this insect, is sufficiently indicated in the note above on the lesser apple-leaf roller.

The life history of the species is not yet fully determined, although our observations amount to highly probable proof that it does not differ from the life history of the common leaf hoppers; that of the grape, for example, (*Erythroneura vitis*). Our earliest specimens were collected May 21, on clover, and repeated collections made thereafter in May and June, were all adults. By the 2d of July, however, both larvæ and pupæ appeared in the specimens collected from the young apple. Later in summer only imagos were found. From these data we may reasonably infer that the species hibernates in the adult condition, lays its eggs in early summer on the leaves of the apple, lives as an immature insect upon that plant, and completes its transformations to the winged stage in the latter part of summer and early autumn.

As an adult it is not by any means confined to the apple for food, but occurs upon a great variety of plants, being in fact a very common object in miscellaneous collections obtained by sweeping and beating. Clearly, the injuries of this species can be met only in spring and early summer, when the eggs and newly hatched young are upon the leaves. Dipping the tops of the trees at that time in an emulsion of kerosene, or possibly thoroughly spraying the nursery stock with this fluid, is, in my opinion, the most promising method of procedure.

This is not one of the nursery insects likely to be spread by shipments of young trees, since these are made in early spring, before it is at all likely that the imagos have laid their eggs.

What the Hessian fly is to wheat, that the CORN PLANT LOUSE (*Aphis maidis*) bids fair to become to corn. This species has been known in a general way for years, since it was first described by Fitch, but its life history (far from complete, it is true,) gives us as yet no clue to a method of combating its injuries. Even the hope which I have hitherto indulged, that it would be found most prevalent upon

ground which had previously been in corn, and that its injuries could consequently be arrested by judicious rotation, seems doubtful in the light of our recent experience.

Early in July, this season, reports reached me from the country surrounding Champaign, of a severe and mysterious injury to corn. This condition of affairs was discovered in eight adjacent fields, the areas affected varying from one third to four fifths of the separate fields. The injury, from all the attendant circumstances, seemed to me to be almost certainly due to plant lice. No great numbers were in the ground at the time, but concurrent testimony to their abundance on the roots a few days previously, was too weighty to be ignored, two intelligent farmers reporting that the plant lice had emerged from the ground in very large numbers, and scattered just before my visit to the fields.

The notorious SOFT MAPLE BARK LOUSE (*Pulvinaria innumerabilis*), which so seriously injured soft maple trees last year, seemed to the casual observer, in spring, to threaten an equal injury this season; but upon close inspection late in June, the cottony egg masses of the female were found, in nearly every instance examined, to harbor a coccinellid larvæ (Hyperaspis), by which the eggs were being rapidly devoured; and before the end of the season the pest was reduced to insignificance throughout the greater part of the area infested by it. In here and there a locality where it had been less abundant than usual last year, it reached its climax this, but the total damage done was slight.

The winter wheat near Champaign was last year very badly damaged by spring frosts, but late in April I learned of injury to a few fields, of such a character that the owners could not attribute it to the weather. In these fields great numbers of a small EARTH-WORM (Lumbriculus) were found collected about the roots of the dead plants, occurring also to some extent among the living wheat, but far less abundantly. To the presence of these worms some of the farmers attributed the damage done, and the question consequently arose whether these worms might not rather have been attracted to the wheat after the death of the plants, finding in the dead and half-decayed vegetation an abundance of food. To determine this matter we planted two small boxes of wheat, stocking one of them with 160 worms and leaving the other free. The wheat grew freely in both boxes and was entirely uninjured by the worms during several weeks, when the experiment was discontinued.

Experiments on the Codling Moth and Curculios.

(*Carpocapsa pomonella*, Linn.; *Anthonomus quadrigibbus*, Say.; *Conotrachelus nenuphar*, Herbst.)

By S. A. Forbes.

No insect has been longer or more unfavorably known to the apple grower than the codling moth. It is a denizen of the whole earth, wherever the apple has found a home, and has probably infested that fruit in the old world at least, from immemorial time. It was first described as a species by the great Linnæus a hundred and thirty years ago, at which time its injuries to the apple seemed well known; and there has doubtless been no year since when it has not deserved and received the heart-felt anathemas of the fruit grower over a large part of the civilized world. It would seem, at the first blush, remarkable that there should be anything further to say concerning an insect that has centered upon itself for so long a time an extraordinary share of the deeply interested attention of the horticultural world; but in this case, as in very many others, our knowledge, gathered by chance, by a great many observers, and systematically and perseveringly studied by none, is fragmentary and indefinite,—our acquaintance with remedial measures especially falling far short of the completeness and accuracy necessary to guide us to a correct practice.

Dismissing for the present all other parts of the subject, it is my purpose here to confine myself wholly to a report of some systematic experiments with remedial measures made by me and my assistants during the summer of 1885,—only incidentally mentioning the life history and habits of the insect, as related to the character and value of the remedies used.

While the investigation to be here reported was originally planned for the codling moth alone, we found ourselves engaged almost as deeply with the plum and apple curculios as with this former insect; and for this reason enlarged the field of our experiment so as to cover all three of these species together.

Until quite recently the standard measures of defense against the codling moth have been but two,—the destruction of the fallen fruit with the larvæ or "worms" within it and the application of bands of rags, or similar material, to the trunks of the trees as a temptation to the larvæ seeking a suitable place for pupation,—the pupæ found under the shelter of these bands being removed and destroyed at short intervals. Both of these remedies have the very

decided disadvantage that they apply only after the insect has done all the damage that it individually can, and that they can consequently only tend to diminish the mischief done by the following generation; hence if these remedies are not generally applied throughout a considerable district, there is always a probability that the best efforts of the most faithful fruit grower will be largely disappointed through the indifference of his neighbors.

Among the older European authors some other remedial measures are frequently mentioned, but they serve us only to illustrate a condition of horticultural enterprise amusingly different from that of Illinois. Thus Köllar speaks of a remedy as chiefly applicable to apples grown in pots; and Boisduval describes a French practice of killing the larvæ inside the apple with an iron needle, afterwards stopping the holes with wax. Of late years, since the advance of the Colorado potato beetle has familiarized fruit growers with the arsenical poisons as insecticides, these have been quite frequently and positively recommended for the codling moth, by high authority, both scientific and practical.

For example: the Hon. J. N. Dixon, of Iowa, in a prize essay submitted to the State Horticultural Society at its meeting in 1882, says that he considers the arsenic solution as complete a remedy for the codling moth as for the canker worm, continuing,—"When the apples are from the size of a bird-shot to the size of a pea, if the orchard is carefully sprinkled with arsenic water, at the rate of one pound of white arsenic to 200 gallons of water, it will not leave a canker worm, codling worm, tent caterpillar, or Bucculatrix in the orchard."

Prof. A. J. Cook, of the State Agricultural College of Michigan, says: "It is now settled beyond question that the arsenites are the cheapest and most efficient specific against the codling moth."*

Mr. H. Shepley, a fruit grower, of Nevada, Missouri, reported in 1884 to the Horticultural Society of that State an account of his experiments in spraying orchards with London purple, and a synopsis of this article as published in the Country Gentleman for June 12, 1884, is cited. He says: "We have never known an instance out of many trials where this treatment [spraying with Paris green] was not entirely successful with the canker worm, or where it did not destroy most of the codling worms, and give much fair fruit which before was nearly ruined with this insect. In rainy weather it should be repeated two or three times, the first applications being washed off."

Attention has also been especially called, from time to time, to the use of lime as an insecticide for the codling moth, these recommendations being apparently based upon statements of the late Dr. E. S. Hull, of Alton, formerly State Horticulturist of Illinois. I do not find any experiments recorded by Dr. Hull himself, but in the "Prairie Farmer" for November 20, 1880, we read:—"But a safer insecticide, and we think equally sure to kill all soft-bodied insects, is air-slaked lime,—lime slaked into fine powder by exposure to the air and freely dusted over the leaves. The late Dr. Hull, of this

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* "Experiments with Insecticides," published in the Proceedings of the First, Second and Third Meetings of the Society for the Promotion of Agricultural Science, p. 112.

State, considered this *the* remedy for the codling moth. To destroy this noxious insect, the lime powder should be plentifully thrown on the apple-tree in the spring, immediately after the petals fall from the blossoms. At this time the eye of the apple in which the moth deposits its egg opens upward, the lime falls in the opening, and a small particle of it is either distasteful to the moth or destroys the egg before it hatches, and it is questionable if the poisons would do this."*

It was my first intention to experiment with all the known methods of attack upon the codling moth not manifestly absurd on their face, for the purpose of making a comparative test of their value and cost, but the general failure of the apple crop in our region made it impossible to find trees enough well loaded with fruit within any practicable distance from the office. The experimental orchards on the University farm were not available, both for the above reason and because they are pastured by stock; but I finally secured from G. F. Beardsley, Esq., of Champaign, the privilege of experimenting in an orchard situated about a mile from the office, in which were found ten bearing trees suitable for my purpose. Under these circumstances I decided to use the opportunities for experiment available, in a way to test as thoroughly as practicable the most popular arsenical poisons and lime. So I appropriated these ten trees to three experiments,—one with Paris green, one with London purple, and one with lime. The Paris green experiment was made on two trees, two others of the same variety, as nearly like them as possible, being selected at the same time as checks on the experimental trees. The London purple experiment was tried on a single tree, and the lime application on two, these also being guarded by check trees not treated at all.

The spraying began on the 9th June, at which time the apples on the trees selected averaged about a quarter of an inch in diameter,—that is, they were about as large as small peas. An earlier beginning would perhaps have been desirable on theoretic grounds, but we shall find evidence that the date was early enough to preclude possible injury to the apples by the codling moth. At any rate, as it happened, I could not complete all the necessary arrangements before this date.

We used at first the Cyclone Nozzle made by the United States Entomological Bureau, our example being furnished me by Dr. Riley; but the assistant in charge of the spraying experiments objected to this as liable to clog with the Paris green, and after much experimenting with a variety of nozzles, I finally selected the Deflector Spray and Solid-Jet-Hose-Nozzle, manufactured by the Lowell Faucet Company, Lowell, Massachusetts. This has the especial advantage of complete and ready adjustment to any requirement, being easily changed while in action by turning a ring, thus throwing, at the will of the operator, anything from a solid stream to the finest spray or an almost imperceptible mist. This nozzle was attached to the end of a strong rubber tube long enough to reach from the ground to the

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* Prof. Beale, of Michigan, is reported by the "Prairie Farmer" for May 26, 1883, to have experimented with slaked lime thrown upon the trees at different times when they were in fruit, but without any effect upon the number of moths or wormy apples.

top of the highest tree in the orchard, into which it was lifted on the end of a long light pole. The fluid was carried in a can and applied by means of a hand force pump. More convenient arrangements for work on a large scale might easily be devised, but the foregoing answered our experimental purpose well.

The spray was applied so thoroughly that we had no doubt, in any case, that every apple was reached and bedewed by it. The finer particles of water were so minute that they floated on the air and were carried by the gentlest breeze, a rainbow forming readily in the mist when thrown towards the sun. In fact, the spray thrown by the adjustable nozzle was so delicate that at the height of the tree-top it was sometimes scarcely visible, except when brought between us and the sun. Notwithstanding this minute subdivision of the fluid, it evidently conveyed the Paris green, as the nozzle very rarely clogged either with that or the London purple. The poisons were kept suspended in the water by frequent stirring, and the spray was thrown until the leaves began to drip. Applied in this way we found about two gallons of fluid sufficient for a large apple-tree. The time occupied averaged about four minutes to a tree.

For the purpose of testing the results of the various applications used, the fallen apples were picked up at short intervals and carefully examined one by one, the number affected by the codling moth and by curculios being separately noted, and also those injured in miscellaneous and undetermined ways. The number which showed no traces of injury, belonging to each tree, was recorded with the others, and these records were kept until the end of the season. The ripened apples were then picked, and these also were handled in the same manner, every apple from all the trees treated, as well as from all the checks, having thus been individually examined, and in most cases cut in two. Something of the amount of work done in this study may be inferred from the fact that the number of apples thus separately scrutinized was 16,529.

From the data thus obtained, calculations have been made, for each collection and each experiment, of the number of apples affected by the codling moth, by the curculios, and by all other causes taken together, and of the ratio of these to the whole number of apples from each tree. The data thus obtained have been carefully worked out, by comparison and cross-comparison, in a manner the details of which I need not give you here, as they will all be exhibited in the tables accompanying this paper.

Before I begin any detailed account of the experiments, or statement of the results, I wish to call especial attention to the exceptional circumstances of the year, and to the consequent peculiar and provisional value of the conclusions based upon the season's work. The crop of the year preceding had been very abundant throughout the entire region around Champaign; and, in fact, the apple orchards had averaged a fair yield at least, for some years in succession, so that apple-feeding insects had had more than a medium opportunity for multiplication. When the spring opened this season, they must, consequently, have been present in more than average numbers. But the extremely short crop of this year necessarily afforded them relatively little food, and hence what apples

there were must have received the concentrated and inordinate attack of a relatively excessive number of codling moths and curculios. The conditions, therefore, were as unfavorable as possible to the success of our experiments,—or, rather, to the effectiveness of the remedies. While this fact renders the results of our work insufficient as a guide to the remedial measures in ordinary years and under ordinary circumstances, it nevertheless gives them a peculiar value as showing what could not have been shown under other circumstances, viz.: the best these remedies can do under the most *unfavorable conditions.*

All the applications made were repeated much more frequently than would be either advisable or economical in practice, and carried later into the season than would be either reasonable or safe, the object being, as already intimated, to determine the greatest possible effect under the circumstances existing. I wish, therefore, especially to emphasize the fact that this paper is not to be taken as conclusive upon the questions raised, but as a contribution to progress on the subject, our experiments requiring to be repeated at least one other year. Indeed, as a basis of a complete estimate of the value of any remedial measure against the codling moth, we should have an account of its effect during one year of excessive relative abundance of the insects, another of average abundance, and still another of unusual scarcity. This paper is a contribution to a knowledge of the value of these remedies under the first circumstances mentioned.

The detailed results of all our experiments and observations I have arranged in the form of tables exhibiting the date of each experiment; the dates when the successive lots of apples were examined, whether fallen fruit or that picked at the end of the season; the total number of apples examined in each lot and its check; the number of apples uninjured in each; and the number of those injured by the codling moth, by the curculio, and by causes indeterminable. Summaries have been added showing the total number, in each case, injured by insects of all sorts, and the total number injured in any way. Under each of these various heads I have also calculated the *ratios* of each injury to the entire number of apples examined.

The remainder of this paper will be devoted to a detailed discussion of the principal facts presented in these tables, followed by a concise summary of the main results.

PARIS GREEN.

The Paris green with which I experimented was bought of E. H. Sargent & Co., of Chicago, having been obtained by them, as I afterwards learned, from some wholesale grocer in the city, whose name they could not give me. As analyzed by my colleague, Prof. McMurtrie, it proved to be considerably adulterated,—or, at any rate, contained a much smaller proportion of arsenic than the current statements concerning the composition of Paris green would lead us to expect. The ratio of arsenic in the specimens submitted for analysis was 15.4 per cent. In our practice three fourths of an

ounce, by weight, of Paris green was stirred up in two and one half gallons of water,—this quantity being sufficient to give the fluid a distinct green tint.

The percentage of Paris green in the fluid was about twice the strength ordinarily recommended for use in orchards by those who claim to have tested the arsenical poisons for the codling moth.

Two trees were treated, both of the same variety, and both having checks likewise of that variety. The first of these trees was first sprayed June 9, and the second June 13, no other difference than this initial one of dates being made throughout the season. Each was sprayed eight times, at intervals ranging from the 9th June to the 3d September. The comparative results as shown by my tables differ so little for these two trees, and for their checks, that both couples may be considered as one.

THE CODLING MOTH.

A careful examination of a large number of apples on the treated trees was made upon the 7th July, one month after the first poisoning. At this time we failed to find an apple on either of these trees giving any evidence of injury by the codling moth, while the check trees adjoining, so close that their branches touched, bore a large number of infested apples.

The first examination of fallen fruit was made July 16, five weeks after the treatment of the first tree, and four and a half weeks after that of the second. Both these trees had now been treated four times in succession; the first on the 9th and the second on the 13th June, and both trees on the 20th and 30th June and on the 15th July. Of the 214 fallen apples from the poisoned trees, examined July 16, only 16, or 7.9 per cent. were affected by the codling moth; while of the 570 apples examined from the check trees, which had not been treated with Paris green, 58 per cent. had been so injured, —more than seven times as large a ratio of these fallen apples having been attacked by the codling moth on the check trees as on the trees sprayed with Paris green.

The fact that in both cases the percentage of injury by the codling moth to the fallen apples was smaller at this time than at any subsequent examination is sufficient evidence that the experiment was begun early enough to meet the insect in the beginning of its career.

To exhibit more exactly the method of our work and the basis of my conclusions, it may be worth while to follow through the history of one of these trees to the end of the season, so far as injuries by the codling moth and curculios are concerned.

To get some idea of the condition of the fruit *upon the tree*, we critically examined, July 21, 100 apples selected at random upon each of the two contrasted trees,—the one poisoned with Paris green and its check. Of the 100 apples upon the poisoned tree, only two were infested by the codling moth, while of those upon the check 33 had already been attacked.

The second examination of *fallen* apples was made July 24, at which time 177 were picked up from under the poisoned tree and

370 from under its check. 23 per cent. of the former now showed injury by the codling moth and 68 per cent. of the latter. Next, July 31, the trees having been sprayed the previous day, 53 apples were collected under the poisoned tree and 120 under its mate, 14 per cent. of the former being wormy and 70 per cent. of the latter. Again, August 7, lots of 93 and 61 apples, respectively, were collected from beneath these two trees. 21 per cent. of those from the tree sprayed with Paris green were found invaded by the pest—as against 56 per cent. of those from the tree not treated. August 27, 34 per cent. of the poisoned apples fallen were infested and 70 per cent. of those not poisoned. September 3, the ratios were respectively 47 and 79 per cent.

The number of fallen apples examined *during the season* amounted to 665 from the poisoned tree and 1,037 from the other. Of the former 22.7 per cent. were injured by the codling moth; of the latter 65 per cent., the injuries to the fallen apples from the experimental tree being thus a trifle over one third of those from the check. On the 10th September the apples were finally picked from both these trees,—846 from the first and 783 from the last.

It will be noted, in passing, that a much greater percentage of apples had fallen from the tree not treated than from its mate, the ratios of fallen apples to the entire number upon the trees in the beginning being 44 per cent. in the first case and 57 per cent. in the second.

Of these ripened apples 178 were damaged by the codling moth on the experimental tree and 591 on its companion, the ratio for the poisoned tree being 21 per cent. and for the other 75 per cent.; or, roughly, one fifth of the ripened apples on the tree sprayed with Paris green had been damaged by the codling moth and three fourths of those on the other. Finally, if we take fallen and ripened apples together, 1,511 from the poisoned tree and 1,820 from its check, we find that the codling moth had damaged 22 per cent. of the former and 70 per cent. of the latter,—something over three times as great a ratio for the tree not treated as for that which had been sprayed. Or, more briefly, two thirds of the apples which would otherwise have been damaged by the codling moth, were saved by the Paris green.

Turning now for a moment to the second tree, similarly treated, I notice that the ratios for the total product of this tree differ so little from those just given, that it is not worth while to detail them here; the ratios, for example, of both picked and fallen apples from the two treated trees being respectively 22 and 20, and for the two checks, 69 and 65. Finally, lumping the results from these four trees, the two poisoned with Paris green and their two checks, the first represented by 2,418 apples and the second by 2,964, we find that the codling moth had left its mark upon 21 per cent. of the former and upon 68 per cent. of the latter; that is, more than three times as many apples were damaged on the trees not treated as upon those which had been sprayed. In a word, crowding the remedy to the utmost, we saved under exceptionally unfavorable circumstances, two thirds of the predestined victims of the apple worm.

THE CURCULIOS.

Since Paris green has been very generally recommended as a protection against the ravages of the curculios, both for plums and apples, we kept as careful a record of curculio injuries as of those by the codling moth. The results will be disappointing to those who have formed their opinions of the efficacy of Paris green as a curculio poison from some of the reports made by fruit growers. Although a single spraying with Paris green has been reported to completely defend the crop against the curculios for an entire season, we found this agent decidedly less effective against these insects than against the codling moth.

Of the 1,975 apples from these two poisoned trees which were examined for the curculio injury, 542, or 27.3 per cent., bore the brand of these insect beaks; while of the 1,172 obtained from the check trees, 602, or 57.3 per cent., had been so injured, the ratio of apples punctured by the curculios on the poisoned trees being nearly half as many as on those trees which had not been sprayed. An inspection of our tables shows that this was a fact apparent throughout the season.

Considering the picked apples only, the result is somewhat more favorable than if the fallen apples also are taken into account; the percentage of those damaged by the curculios on the check tree being 76.5, and upon that sprayed with the Paris green, 34.4 per cent.

The work of both the apple and the plum curculio was abundant upon these trees, the latter being, however, greatly in excess; and these statements apply to both these species. In fact, I may say here, that wherever we kept a complete record of all curculio injuries, we found these to average almost exactly half the number of those by the apple worms,—evidence that the "Little Turk," rarely noticed by the apple grower, is really among his very worst and most dangerous enemies, destined, unless I am much mistaken, greatly to increase in numbers and destructiveness.

If we take the codling moth and curculios together, adding, that is, all recognizable insect injuries to these apples, we shall find that the Paris green diminished the total almost exactly one half, 44 per cent. of the apples on the poisoned trees being damaged, and 86 per cent. of the others.

Occasionally apples were found apparently injured by insects, but not in a way to make it possible to determine to what species the injury was due. These cases I have tabulated as undetermined injuries. They amounted to about 18 per cent. of all the apples examined which were not clearly injured by codling moth or curculio.

It will be a matter of interest to report, while I have the data in hand, the percentage of the fruit whose *falling* was due to injury by the codling moth and curculios. Taking only the two check trees into account, we find that of the 1,859 apples which fell during the season, 1,539, or 82 per cent., had been injured by one or both of these insects, the remaining 18 per cent. having fallen from causes not perceptible.

COST OF THE EXPERIMENT.

So much for the dance; now what must we pay the fiddler? Do apples raised with a force pump and fed on poison, possibly cost more than their market price? Excluding interest on the cost of the apparatus, which is too slight to be taken into account, the expenses of application are covered by the cost of labor and material. The former, in our case, amounted, for the season, to the hire of two men for thirty-two minutes per tree, and the latter reached a sum of 22½ cents per tree, the total amount of Paris green for each tree being six ounces for the season—here reckoned at 50 cents per pound. It is evident that the Paris green was used by us in excessive quantity, and we shall soon find that the trees were sprayed more frequently than was necessary or expedient. Further, if special contrivances were used for the distribution of the fluid in an orchard, the time per tree for a single spraying would doubtless be considerably lessened as the laborers became expert at the work, so that I do not doubt, upon the whole, that 10 cents per tree, for the season, is a fair estimate of the necessary cost of a sufficient use of Paris green to give the full effect of the remedy.

DAMAGE TO THE TREES.

Used with the strength and frequency of our experiments, the Paris green conspicuously burned the leaves. Probably from one third to one half of those upon the experimental trees were more or less scorched and withered at the edges, and a greater part of the leafage fell in autumn somewhat prematurely. In fact, our notes show that the leaves from one of these trees were falling rapidly July 31, the tree treated with London purple being similarly affected. We had some evidence that the fruit itself was injured in our case, a surface discoloration and subsequent local rotting of the apples being most evident on that side of the tree towards the prevailing winds with which the greater part of the spraying was done. Thus the rather nice question is raised, in our experiments, whether our gain in apples was not lost in damage to the tree. We had saved some fragments of the golden egg, but had we not possibly crippled the goose by our heroic surgery? It is not to be presumed, however, from the above, that this damage to fruit and foliage is a necessary consequence of the use of Paris green. It is doubtless to be attributed partly to the purposed excess with which we applied the poison, and partly to our lack of experience in spraying in the beginning of the season.

DANGERS TO STOCK.

It of course goes without saying that no poisonous substance should be applied in an orchard to which stock is admitted.

DANGERS TO HEALTH.

Keeping in mind the fact already repeatedly alluded to, that our use of Paris green in these experiments was excessive, it will be worth while to report the result of a chemical analysis. From one

of the trees last sprayed September 3, apples were picked on the 10th of that month and brought to the office in a sack. From these, sound examples were taken at random and submitted to Prof. William McMurtrie, of the chemical laboratory of the University, for analysis. According to his report* these apples averaged .9 milligram of arsenic each,—an amount such that seventy-four apples would convey a poisonous dose.

During the interval between the last spraying and the harvesting of these apples, a violent storm had occurred, an inch or more of rain falling, and the wind blowing a gale for two days.

These facts clearly indicate that exposure to a week's ordinary weather, with heavy rain and wind, is not sufficient to free the apple from a dangerous amount of Paris green.

Remembering that arsenic is one of those substances likely to have a cumulative effect if taken long in small quantities, remaining in the system and finally producing powerful results from very small doses, it will be seen that it would not do to have the family apple supply dusted, even very lightly, with any arsenical substance. I only mention these matters to indicate the great importance of a careful investigation as to the length of time and the circumstances within which Paris green may be safely used in the orchard. Certainly we may say that it would be quite inexcusable to apply it during the latter part of the season, or, indeed, for some time previous to the ripening of the apples, whether they are early or late.

As the codling moth continues its attack throughout the entire summer, small larvæ appearing in our collections as late as September, it is clear that Paris green, even if completely effective when thoroughly applied, cannot be relied upon wholly to prevent injury by this insect. During the latter part of the season, when its use is inadmissible, the apples will be subject to damage by the later codling moths.

LONDON PURPLE.

The London purple experiment was in all respects similar to that with Paris green, except that a somewhat smaller ratio of the poison was used and that only one tree was carried through the

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*UNIVERSITY OF ILLINOIS, DEPARTMENT OF CHEMISTRY,
CHAMPAIGN, Ill., October 20, 1885.

Prof. S. A. Forbes, State Entomologist:

DEAR SIR: I have the honor to submit the following report upon examination for arsenic upon apples from trees which had received arsenical spray for destruction of insects.

The apples were preserved, as received, in a closed box until needed for examination. First one was taken and submitted to qualitive test for arsenic by the application of the Marsh test. The presence of the poison was detected. To determine the quantity of arsenic present another and large apple was selected, treated to destroy its organic constituents, and the arsenic separated in the metallic state by means of the Marsh apparatus as before. The results are as follows:

Weight of apple taken, 76.025 grammes; weight of arsenic secured, 0.0009 grammes; percentage of arsenic, 0.0013.

Respectfully submitted.

WM. McMURTRIE, E. M. Ph. D.,
Prof. of Chemistry, University of Illinois.

season. A second tree, sprayed in the beginning, was abandoned because the orchard in which it was situated was pastured with cattle.

The London purple used was obtained from the Hemmingway London Purple Company, New York, with the understanding that it was intended for experiment and under a promise to report the results to them. There is consequently every reason to suppose that it was a good sample of the article. By Prof. McMurtrie it was found to contain 22.25 per cent. of metallic arsenic. Comparing this ratio with that given for the Paris green we find that in applications of the latter substance we used the equivalent of 50.5 grains of metallic arsenic to the bucket of water (20 grains to the gallon) and in the London purple applications 37.2 grains of arsenic to the same (nearly 15 grains to the gallon),—the Paris green fluids being thus about one third stronger in arsenic than the London purple. In Paris green the arsenic is combined with copper to form an arseniate of copper, while in London purple it is combined with lime to form the arseniate of lime. Whether this difference in composition is likely to make any perceptible difference in the insecticide activity of the two substances, I am unable to say.

The tree was treated eight times, as in the Paris green experiment, commencing June 13 and ending September 3, and, as usual, a check was selected in its immediate vicinity, not treated at all. The course of events was in all respects similar to that detailed under "Paris Green," except that the differences between the poisoned tree and its check were, all along, less than in the other experiment. For example, 34 per cent. of the fallen apples obtained July 16 from the poisoned tree had been injured by the codling moth as against 52 per cent. from the check, while the corresponding Paris green trees gave us at this date, it will be remembered, 7 per cent. and 53 per cent.

Examining the whole number of fallen apples collected during the season, we found that of 1,048 from the experimental tree, 495, or 47 per cent., had been penetrated by the larva of the codling moth, while of the 1,828 apples gathered under the companion check, 1,040, or 57 per cent., were so injured. Of these fallen apples, consequently, the number injured in the check lot was only about 10 per cent. greater than those injured in the experimental collection. The picked apples at the end of the season gave a similar result, 61 per cent. of those on the experimental tree having been injured by the codling moth and 76 per cent. of those on the check,—a difference, in this case, of only 15 per cent. in favor of the poisoned tree.

Taking all the apples, both fallen and ripened, we find that 49 per cent of those treated with London purple were injured and 59 per cent. of those not so treated; again a difference of only 10 per cent. in favor of the experimental lot. Comparing the general averages of these London purple trees with those of the trees sprayed with Paris green, we see that the latter application was from two to three times as effective as the former—both being used in quantity to burn the foliage.

The showing was very nearly the same for the curculios as for the codling moth,—39 per cent. of the apples injured where the tree had been sprayed with London purple, and 48 per cent. where it had not been so treated.

For the remaining particulars of this experiment, I refer the reader to the tables appended to this paper, adding only the fact that the entire number of apples handled from these two London purple trees was 3,241. Late in the season some scorching of the leaves similar to that attributed to the Paris green was noticed on this London purple tree; less serious, however, than in the other case.

LIME.

Lime has been commonly used as an insecticide, in the form of a powder to be dusted on the plant, but as this mode of distribution is very inconvenient in the orchard, we applied it in the same way as the arsenical poisons, stirring it up in water and throwing it upon the tree with a pump.

No exact measurement was made of the ratio of lime to water, but as large a quantity was used as could be conveniently managed, no degree of injury to the foliage being anticipated.

Fresh air-slaked lime was mixed with water and thrown immediately upon the tree. A quantity was used sufficient to whiten the leaves slightly as the water dried away. The same number of applications was made as in the other experiments, commencing June 13, except that the apples on one of the trees ripened before the date of the last spraying, and consequently this tree received but seven applications. The first two trees selected, the experimental tree and its check, were of the same variety and in all respects similar. The first spraying was extraordinarily profuse on account of the frequent stoppage of the cyclone nozzle with the particles of lime, several buckets of lime water being used to each tree.

On the 7th July a cursory search was made for the codling moth, and one example was found upon each of the two trees sprayed. The lime of the last spraying, done a week before, was still visible on the leaves, notwithstanding several intervening showers. From the examination of the fallen apples collected under this tree and its check, there was no evidence of any effect upon the codling moth, 53 per cent. of the 1,615 apples from the experimental tree having been burrowed by the worms, as compared with 46 per cent. of the 1,609 apples from the check. The same inefficiency of the lime was indicated by an examination of the apples upon the trees, 200 apples upon the treated tree containing, July 21, 18 larvæ of the codling moth, and 200 from the check containing 16 such larvæ. The picked apples gave only a slightly different result; 70 per cent. of those treated with lime contained the codling moth and 78 per cent. of those not so treated. The final ratios for the year, including both fallen and ripened apples, were 54 per cent. of wormy apples for the tree sprayed with lime water and 50 per cent. for

its companion, the first tree bearing, all told, 1,706 apples and the second 1,825. The effect upon the codling moth of treatment with lime was, consequently, absolutely nothing.

With respect to the curculios, however, the case was slightly different, the lime having apparently some perceptible effect on the numbers of these insects. Almost exactly one third more apples had been damaged by the curculios on the trees not treated than on those sprayed with lime water,—the ratios being respectively 29.6 and 38.8 per cent. for the picked apples, and 31 and 40.6 per cent. for all the apples of the season taken together. By a very remarkable coincidence, the two ratios representing all descriptions of injury to the fruit of these two trees were precisely alike,—72.6 per cent. for each. As the final result of this experiment, we must conclude that time spent in treating the apple orchard with lime for the codling moth would be wholly thrown away. So much for the first tree.

When I came, however, to tabulate and inspect the record of the second, I was astonished and puzzled by a totally different exhibit of results. Of the ripened fruit of this second tree sprayed with lime water, only 4.5 per cent. was wormy, while of the check selected for comparison, 71 per cent. had been affected by the codling moth,—an enormous and surprising difference. Taking together the fallen fruit and that harvested at the end of the season, the ratios for the lime-water tree and its mate were, respectively, 25.5 and 67.5 per cent.,—facts which seemed altogether irreconcilable with the conclusions drawn from the preceding table. A closer inspection of the history of this experiment brought out, however, some interesting points, which not only serve to explain this discrepancy, but also give us some unexpected information upon a subject not taken into account in planning these experiments. Owing to the limited number of trees from which the selection was made, it was impossible to find a proper mate for the tree last treated with lime, the check used being of a different variety and containing only a small number of apples, while the tree treated was much the most heavily loaded of any covered by these experiments. From the latter 3,555 apples were taken; from the former only 820, the lime-water tree thus bearing more than four times as many as its fellow. A great quantity of these limed apples, 2,869 in number, fell during the summer, leaving only 686 apples (about two bushels) upon the tree at the end of August, and nearly half of these fallen apples were dropped without apparent injury. Clearly, the other tree, starting with so small a number of apples and dropping only a little more than half of them, was totally unfit for a check upon this. Now, besides the differences between these two trees with respect to the lime-water treatment and the number of apples borne by each, the only other perceptible difference was in the variety of apple. Both were early apples and of similar texture, but evidently not of the same kind. It is not supposable that a mere difference in variety, not involving a difference in season or important difference in quality of fruit, could have any influence on injuries by the codling moth; neither have any observations to this effect been made by either entomologists or fruit growers, so far as I am aware, all varieties of similar quality being equally subject to injury by this insect. (Taschenberg reports, how-

ever, that the finer apples are more liable to attack than the coarser kinds.) We have left, then, only the difference in abundance of apples upon these two trees to account for the extremely different ratios of insect injury. It would seem that each tree in the orchard attracts an approximately equal share of codling moths, and that when a tree bears but few apples, a large percentage of these will be attacked; while if the apples are numerous, the attack will be less concentrated, and the ratio of injury proportionally diminished. These circumstances will perhaps explain some of the extravagant claims set up for the efficiency of arsenical poisons and other remedies as applied to the codling moth and the curculios. If I had ventured to report to you upon the strength of a single instance, and if that instance had happened to be the present, I should have asserted no less positively than others the remarkable value of lime as a remedy against the codling moth or apple worm.

NATURAL HISTORY OF THE CODLING MOTH.

This insect is currently reported to breed twice during the year, one brood of the moths appearing in early spring, and the second in midsummer. The most elaborate observations made upon its life history with which I am acquainted, are those reported by Mr. Charles G. Atkins in the "Agriculture of Maine" for 1883, and as a result of his observations, he concludes that, in the latitude of Maine, at least. only a single brood occurs, distributed in its development over a considerable part of the season. Our collections and observations made this year show, however, that in central Illinois the insect is unquestionably two-brooded, the moths of the second brood occurring in July. On the 24th July, at which date nearly 1,100 apples injured by the codling moth larvæ were examined, not over a dozen of these larvæ were found in the fruit. A single pupa also occurred in an apple. Curculio larvæ, it may be worth while to note, were at this time decidedly abundant. On the 31st July, again, no mature larvæ whatever were found, but a few very small ones were detected at the blossom end of the apple,—evidently young of the second brood. By August 7 the average length of forty examples removed from the apples, was 7.6 mm.—a little more than one fourth of an inch—while, by the 27th August, the average of twenty examples was 10.1 mm., or about two fifths of an inch. On the 31st of this month, three fourths of the apples injured by the apple worm still contained the larvæ, many of them in the blossom end of the apple, and so small as to be difficult of detection. This circumstance is of interest as showing that the second brood is more numerous than the first,—a reason additional to those already mentioned why no complete protection to the fruit can be afforded by spraying only early in the season.

CONCLUSION.

And now, in conclusion, I will give you a summary and brief recapitulation of the whole matter:

(1). The investigation was undertaken to test the efficiency of lime and arsenical poisons as insecticides for the codling moth and apple and plum curculios in the apple orchard.

(2.) Owing to the scarcity of apples and the abundance of apple insects, the season was the most unfavorable possible for the success of these remedies.

(3.) The insecticides were applied suspended in water, the Paris green in the ratio of one and a half ounces to five gallons, the London purple in half that weight, and the lime in indefinite amount.

(4.) The spraying with Paris green began when the apples were about as large as currants; and four days later, with the London purple and lime.

(5.) All the trees were thoroughly sprayed seven and eight times between June 9 and September 3.

(6.) The fallen apples were gathered six times from July 16 onward, and those remainining were picked as they ripened.

(7.) All the apples, both fallen and ripened, 16,529 in number, were examined individually for insect injuries, and those due to the codling moth and curculios were separately noted.

(8.) As a result of the examination of 2,418 apples from trees which had been sprayed with Paris green, and of 2,964 others from check trees which had not been so treated, it appeared at the end of the season that 21 per cent. of the poisoned apples had been infested by the codling moth and 67.8 of those not so treated; while 27.3 per cent. of the poisoned lot had been infested by the curculios and 51.3 per cent of those not sprayed. That is to say, treatment with Paris green had saved something more than two thirds of the apples which would otherwise have been damaged by the codling moth, and something more than half of those which would have been sacrificed to the curculio. It should be remembered in this connection that the Paris green not only serves to protect the apples from attack, but by actually destroying the insects must assist to lessen the amount of insect injury in succeeding years. Analysis of apples one week after treatment with Paris green, a heavy storm intervening, gave abundant evidence that this insecticide could not be safely applied for some weeks preceding the harvesting of the fruit.

(9.) As a result of the comparison of 1,205 apples from a single tree sprayed with London purple, and 2,036 apples from a check tree not so treated, it appeared that 49 per cent. of the former were affected by the codling moth and 58.8 of the latter, and also that 39 per cent. of the first lot of apples had been invaded by curculios and 48 per cent. of the second lot. The London purple thus saved about one sixth of the apples which would otherwise have been sacrificed to the codling moth and about one fifth of those otherwise to be spoiled by the curculios.

In comparing these results with those derived from the Paris green experiment it must be remembered, however, that the spraying with London purple began four days later than that with Paris green, and that the latter, as used, contained about one third more arsenic than the former. It should be further noted that both were applied to the limit of considerable damage to the foliage, conspicuous as early as the last of July.

(10.) 1,706 apples obtained from a tree treated with lime, as compared with 1,825 apples collected from a tree of the same variety used as a check, show that 53.9 per cent. of the former contained the apple worm, and 49.8 per cent. of the latter, thus indicating the uselessness of this substance as against the codling moth. A similar application made to a tree heavily loaded with fruit, bearing in all 3,555 apples, and placed in comparison with a tree of another variety bearing only 820 apples, serves merely to show that the ratio of codling moth injury to the fruit of a single tree depends largely upon the number of apples borne. The lime had no injurious effect whatever upon the foliage. While producing some effect on the curculios, seemingly lessening the damage about one fourth, lime is less efficient in this respect than Paris green.

(11.) As bands for traps serve only to capture the apple worm after it has done its mischief, and hence only interpose a general protection against future attack, and are moreover liable to be rendered ineffectual by the neglect of one's neighbors, the use of Paris green will serve at least as a valuable addition to remedial measures against the codling moth. Since it may be safely applied, however, only for the spring brood, it is best to use both bands and insecticides, each measure supplying the deficiencies of the other.

(12.) Attending only to the picked apples, and condensing our statement of results to the last extreme, we may say that, under the most unfavorable circumstances, Paris green will save, *to ripening*, at a probable expense of ten cents per tree, seven tenths of the apples which must otherwise be conceded to the codling moth; that London purple will apparently save about one-fifth of them; and that lime will save none.

Furthermore, if we must judge from results thus far reached, these various applications are of too slight effect upon the apple and plum curculios to make them worthy of use against these insects, Paris green diminishing curculio blemishes less than one half, London purple about one fifth, and lime not far from one fourth.

(13.) Our observations upon the life history of the codling moth merely confirm the statement of previous observers in this latitude to the effect that the insect is double-brooded. It is apparent, however, that the first attack is not made upon the apple until this has reached the size of a small pea.

For next year I propose, if the conditions are at all favorable, to carry on these experiments on a larger scale, to vary them in such a way as to show the smallest quantity of the poison and the fewest applications that will effect the purpose of protection, and to thoroughly test other remedial measures than those we have studied this year.

Paris Green Experiment 1. Trees 1 (poisoned) and 2 (check).

Trees.	Fruit.	Sprayed.	Examined.	Total No. of apples	Codling moth.		Curculios.		Both	Total Insects.		Undetermined Injuries.		Total Injuries.		Uninjured.	
					No.	Pr.ct	No.	Pr.ct		No.	Pr.ct	No.	Pr.ct	No.	Pr.ct	No.	Pr.ct
1	Fallen	June 9, 20, 30	July 16	141	10	7.1	28	21.3	Not separately reported.	38	27.0	10	9.7	48	34.0	93	66.0
2	"		"	244	130	53 2	12	10.5		142	58.2	35	34.3	177	72.5	67	27.5
1	"	July 15	July 24	177	42	23.1	12	9.5		54	30.4	1	.8	55	30.5	122	68.9
2	"		"	370	253	68.4	66	56.4		319	85.4	4	7.8	323	85.5	47	13.0
1	"	July 30	July 31	56	8	14 3	12	25.0		20	36.3	1	2.7	21	38.1	35	63.6
2	"		"	120	84	70.0	23	63.8		107	89.0	0	0.0	107	89.0	13	10.8
1	"	Aug. 5	August 7	93	20	21.5	27	36 9		47	50.5	4	8.7	51	54.8	42	45 1
2	"		"	61	34	55.7	19	70.3		53	86 8	2	25.0	55	90.1	6	9.8
1	"	Aug. 27	August 27	168	57	33.9	48	43.2		105	62.5	2	3.1	107	63.6	61	36.3
2	"		"	189	133	70.3	42	75.0		175	92.5	4	28.0	179	94.7	10	5.2
1	"	Sept. 3	September 3	30	14	46.6	3	18.9		17	56.6	3	23.0	20	66.6	10	33.3
2	"		"	53	42	79.2	8	72 7		50	94.3	0	0 0	50	94.3	3	5.6
Total 1	"			665	151	22.7	130	25.2		281	42.2	21	5.4	302	45.4	363	54.5
Total 2	"			1,037	676	65 1	170	47.0		846	82.3	45	23.6	891	86.7	146	14.0
1	Picked	Sept. 3	September 10	846	178	21 1	230	34.4		408	49.2	184	42 0	592	69.9	254	30 0
2	"		"	783	591	75.4	147	76.5		738	94.2	19	42.2	757	96 6	26	33.0
Grand total 1				1,511	329	21.7	360	30 4		689	45.6	205	25.2	894	58 0	617	40.8
Grand total 2				1,820	1,267	69 6	317	57.3		1,584	87.0	64	27.1	1,648	90.5	172	9.4

Paris Green Experiment 2. Trees 3 (poisoned) and 4 (check).

3	Fallen	June 13, 20, 30	July 16	73	6	8.2	11	16.4		17	23.2	10	17.8	27	36 9	46	63 0
4	"		"	326	205	62.8	56	46 2		261	80.0	8	12 3	269	82.5	57	17.4
3	"	July 15	July 24	114	31	27.2	15	18.0		46	40.3	0	0.	46	40.3	68	59.6
4	"		"	149	79	53.0	37	52.8		116	77.8	0	0.	116	77.8	33	22.1

3	Fallen	July 30	July 31	74	9	12.1	17	26.1	.....	26	35.1	0	0.0	26	35.1	48	64.8
4	"		"	112	51	45.5	41	67.2	.....	92	82.1	0	0.0	92	82.1	20	17.8
3	"	August 5	August 7	48	7	14.5	8	19.5	.....	15	31.2	1	3.0	16	33.3	32	66.6
4	"		"	56	30	53.5	19	73.0	.....	49	87.5	0	0.0	49	87.5	7	12.6
3	"	August 27	August 27	267	52	19.4	56	26.0	.....	108	40.4	7	4.4	115	43.0	152	56.9
4	"		"	144	129	89.5	13	86.6	.....	142	98.5	0	0.0	142	98.5	2	1.4
3	"	September 3	September 3	31	9	28.9	5	22.7	.....	14	45.1	0	0.0	14	45.1	17	54.8
4	"		"	35	31	88.5	2	50.0	.....	33	94.2	0	0.0	33	94.2	2	5.7
Total 3	"			607	114	18.7	112	22.6	.....	226	37.2	18	4.7	244	40.1	363	59.8
Total 4	"			822	525	63.6	168	56.5	.....	693	84.3	8	6.2	701	85.2	121	14.7
3	Picked	September 3	September 10	301	66	21.9	70	23.2	11	125	41.1	18	10.2	143	47.5	158	52.4
4	"		"	322	220	68.3	117	36.3	56	281	87.3	13	31.9	350	93.8	28	8.7
Grand total 3				908	180	19.8	182	22.9	11	351	39.8	36	6.4	387	42.5	521	57.3
Grand total 4				1,144	745	65.1	285	42.8	56	994	85.1	21	14.0	1,051	86.9	149	13.0
Grand total 1 and 3				2,418	509	21.0	542	27.3	11	1,042	43.9	241	17.6	1,280	52.9	1,138	47.0
Grand total 2 and 4				2,964	2,012	67.8	602	51.3	56	2,558	86.2	85	20.9	2,643	89.2	321	10.8

London Purple Experiment. Trees 5 (poisoned) and 6 (check).

5	Fallen	June 13, 20, 30	July 16	444	151	34.6	104	35.8	.....	258	58.1	11	5.9	269	60.6	175	39.1
6	"		"	927	486	52.4	197	44.6	.....	683	73.5	2	.8	685	73.7	242	26.1
5	"	July 15	July 24	165	82	49.6	34	40.9	.....	116	70.3	2	4.0	118	71.5	47	28.4
6	"		"	366	165	45.0	90	44.7	.....	255	69.6	1	.9	256	69.9	110	30.0
5	"	July 30	July 31	88	35	39.7	36	67.9	.....	71	80.6	0	0.0	71	80.6	17	19.3
6	"		"	146	73	50.0	60	82.1	.....	133	92.5	0	0.0	133	92.5	13	9.0
5	"	August 5	August 7	68	27	39.7	33	80.4	.....	60	88.2	0	0.0	60	88.2	8	11.5
6	"		"	84	47	55.9	35	94.5	.....	82	97.6	0	0.0	82	97.6	2	2.3
5	"	August 27	August 27	243	171	70.3	20	28.0	.....	191	78.6	0	0.0	191	78.6	52	21.4
6	"		"	243	207	85.1	21	58.3	.....	228	93.4	2	13.3	230	94.6	13	5.3
5	"	September 3	September 3	40	26	65.0	3	21.4	.....	29	72.5	1	9.0	30	75.0	10	25.0
6	"		"	62	62	100.0	0	0.0	.....	62	100.0	0	0.0	62	10.0	0	0.0
Total 5	"			1,048	495	47.2	230	41.6	.....	725	69.1	14	4.6	739	70.1	309	29.5
Total 6	"			1,828	1,040	56.8	403	51.1	.....	1,443	78.8	5	1.3	1,448	79.0	380	20.8

London Purple Experiment—Continued.

Trees.	Fruit.	Sprayed.	Examined.	Total No. of apples	Codling moth.		Curcullos.		Both	Total Insects.		Undetermined Injuries.		Total Injuries.		Uninjured.	
					No.	Pr.ct	No.	Pr.ct		No.	Pr.ct	No.	Pr.ct	No.	Pr.ct	No.	Pr.ct
5	Picked	September 3	October 9	157	96	61.1	48	30.5	25	119	75.1	2	5.2	121	76.3	36	22.9
6	"		"	208	158	75.9	79	37.9	54	183	87.9	6	2.4	189	90.8	19	9.1
Grand total 5				1,205	591	49.0	278	39.1	25	844	70.0	16	4.2	860	71.3	345	28.6
Grand total 6				2,036	1,198	58.8	482	48.3	54	1,626	79.7	11	2.9	1,637	80.4	399	19.6

Lime Experiment 1. Trees 7 (treated) and 8 (check).

7	Fallen	June 13, 20, 30	July 16	701	210	29.9	78	15.9		288	41.0	64	15.4	352	50.2	349	49.7
8	"		"	522	209	40.0	10	3.2		219	41.9	14	14.6	233	44.6	289	55.3
7	"	July 15	July 24	279	161	57.7	51	43.2		212	75.9	0	0.0	212	75.9	67	24.0
8	"		"	410	145	35.3	104	39.2		249	60.7	6	3.7	255	62.1	155	37.8
7	"	July 30	July 31	166	100	60.2	47	71.2		147	88.5	0	0.0	147	88.5	19	11.4
8	"		"	173	57	32.9	91	78.4		148	85.5	0	0.0	148	85.5	25	14.4
7	"	August 5	August 7	89	60	67.4	20	68.9		80	89.8	0	0.0	80	89.8	9	10.1
8	"		"	160	61	38.1	89	88.0		150	93.7	3	30.0	153	95.6	7	4.3
7	"	August 27	August 27	360	305	84.7	41	74.5		346	96.1	0	0.0	346	96.1	14	3.9
8	"		"	310	239	77.0	62	87.4		301	97.0	1	11.1	302	97.4	8	2.5
7	"	September 3	September 3	20	20	10.0	0	0.0		20	100.0	0	0.0	20	10.0	0	0.0
8	"		"	34	28	82.3	1	16.7		29	85.2	0	0.0	29	85.2	5	14.7
Total 7	"			1,615	856	53.0	237	31.2		1,093	67.6	64	12.0	1,157	71.6	458	28.3
Total 8	"			1,609	739	45.9	357	41.0		1,096	68.1	24	4.6	1,120	69.6	489	30.3
7	Picked	September 3		91	64	70.3	27	29.6	13	78	85.7	2	15.3	80	87.9	11	12.2
8	"			216	170	78.6	84	38.8	59	195	90.2	7	33.3	202	93.5	14	6.4
Grand total 7				1,706	920	53.9	264	31.06	13	1,171	68.7	66	12.5	1,237	72.6	469	27.4
Grand total 8				1,825	909	49.8	441	40.61	59	1,291	70.7	31	5.8	1,322	72.6	503	27.5

Lime Experiment 2. Trees 9 (treated) and 10 (check).

9	Fallen	June 13, 20, 30	July 16	890	160	17.9	81	11.0	.....	241	27.0	14	2.1	255	28.6	635	71.3
10	"		"	100	49	49.0	7	15.6	.....	56	56.0	0	0.0	56	56.0	44	44.0
9	"	July 15	July 24	420	106	25.2	103	32.7	.....	209	49.7	5	2.4	214	50.9	206	49.0
10	"		"	52	23	53.8	8	33.3	.....	36	69.2	2	12.5	38	73.0	14	26.9
9	"	July 30	July 31	423	88	20.8	168	50.1	.....	256	60.5	5	2.9	261	61.7	162	38.2
10	"		"	51	35	64.8	14	73.6	.....	49	90.7	0	0.0	49	90.7	5	9.2
9	"	August 5	August 7	777	419	53.9	160	44.6	.....	579	74.5	25	12.6	604	77.7	173	22.1
10	"		"	86	49	56.9	28	75.6	.....	77	89.5	2	22.2	79	91.8	7	8.0
9	"	August 27	August 27	359	104	28.8	33	12.9	.....	137	38.1	5	2.2	142	39.6	217	60.4
10	"		"	85	77	90.5	7	87.5	.....	84	98.8	0	0.0	84	98.8	1	1.1
Total 9	"			2,869	877	30.5	545	27.3	.....	1,422	49.5	54	7.7	1,476	51.4	1,393	48.5
Total 10	"			377	238	63.1	64	46.0	.....	302	80.1	4	5.3	306	81.1	71	18.8
9	Picked	September 3	August 31	686	31	4.5	38	5.8	.....	69	10.0	8	1.3	77	11.2	609	88.7
10	"		"	443	315	71.1	10	7.8	.....	325	73.3	10	8.4	335	75.6	108	24.3
Grand total 9				3,555	908	25.5	583	22.0	.....	1,491	41.9	62	3.0	1,553	43.6	2,002	56.3
Grand total 10				820	553	67.5	74	27.7	.....	627	76.4	14	7.2	641	78.1	179	21.6
Grand total 7 and 9				5,261	1,828	34.7	847	19.2	13	2,662	50.6	128	4.9	2,798	53.0	2,471	46.9
Grand total 8 and 10				2,645	1,462	55.2	515	27.0	59	1,918	72.4	45	6.1	1,963	74.2	682	25.7

A SECOND CONTRIBUTION TO THE LIFE HISTORY OF THE CORN PLANT LOUSE (*Aphis maidis*, Fitch.)

By H. GARMAN.

In continuing the study of the life history of the corn plant louse, at the beginning of the summer of 1885 a large frame was erected out of doors and so enclosed as to exclude insects from without and to prevent those within from escaping. In this enclosed frame three hills of field corn were planted and on their appearance above ground one of them was stocked with a colony of *Lasius alienus*, Forst.,* the small ant which habitually attends the root form of this plant louse. The ants made themselves quarters about the roots of the corn, and on the 19th of July a number of wingless viviparous female lice, with their young and one pupa, were placed within reach of the ants and were at once carried to the roots of the corn by the latter. On the 22d of July other root lice, wingless and winged, were placed near the stocked plants and were also carried to the roots.

With a view to learning whether or not root lice would of themselves make their way to the roots of corn, on July 22d and subsequently many specimens were placed at the base of one of the hills not colonized with ants. They always disappeared, but could not be found afterwards on the roots. The plants with which they were placed continued to grow as well as the third hill under cover, which from the first had not been disturbed, and at the close of the summer careful search did not disclose lice on the roots.

The injurious effect of the lice on the infested plants was soon noticeable in their smaller size and less vigorous growth. At various times during the summer the burrows of the ants along the roots were uncovered, revealing each time the presence of lice. From July 23d until the first of August winged lice came from these burrows and were sometimes found on the blades of corn, but more frequently on the inside of the enclosing cloth of the frame. These winged individuals showed no disposition to establish colonies on the blades of corn, but on the contrary seemed desirous of leaving the plants as soon as possible. All were viviparous females and in

*This species has been heretofore mentioned in these reports as *Lasius flavus*, on the strength of a determination made for us in 1882 by a distinguished student of American Formicidæ. Doubts arising as to the correctness of this specific name, especially as the habits of our species were very different from those of *L. flavus* as reported in the old world, specimens were sent, in 1885, to Dr. Aug. Forel, of Geneva, Switzerland, and the name here given rests on his authority.—S. A. F.]

several cases where confined upon the plants, although sometimes inserting the beak and feeding, they died with the ovaries filled with young. The migration of winged lice from the ground was observed at the same time in neighboring fields where, on the 27th of July, many of these winged lice, chiefly dead, were found on the blades. A careful search of the roots, made at the same time, showed that the root form was now rare in situations in which it had done most injury in the spring.

Root lice were observed on the enclosed corn until the latter part of August, but were not again uncovered until October 7, the ants in the meantime being constantly observed running in and out. On the morning of October 7, the infested plants were dug up carefully and carried in doors for careful examination, and upon one of the roots which had several times during the season been found to support plant lice was found a small colony of oviparous females, the only egg-laying examples of the species which up to the time had been seen. They bear a close resemblance to the more common viviparous female of the root form, as the following description will show:—

The Oviparous Female Aphis maidis [root form].—General color, dull green; body covered with a glaucous bloom. Above, head dusky, prothorax chiefly dusky, the three succeeding segments each with a median transverse dusky blotch, all the segments behind the prothorax with a marginal and submarginal series of dusky specks on each side. Below, head and prothorax dusky, two dark spots outside the coxa of the middle leg, a dusky line before the coxa of the hind leg, abdominal segments with two series of dusky specks on each side and a pair of dark spots before the cauda. Antennæ, two basal articles, third and fourth at tips, and fifth and sixth chiefly, dusky. Eye brownish red. Rostrum dusky. Anterior and middle legs with the coxæ, femora except at bases, tibiæ at tips, and tarsi except bases, dusky. Posterior leg, excepting the extreme base of the femur, black. Cornicles black. Cauda with black border. Body stout, its greatest width at about the middle. Outline of the front seen from above incurved medially. Antenna with first and second articles equal in length, the first stoutest; third article about equal in length to the fourth and fifth together, the latter nearly equal in length and similar in form; basal part of sixth article shorter than the distal part, about equal to the fifth in length. Cornicles short, not at all swollen at the middle. The limbs and cauda have the usual slight pubescence of members of the genus Aphis.

Length of body	2.27 mm.
Width of body	1.20 mm.
Antenna	.80 mm.
Cornicle	.20 mm.

Perfectly developed eggs taken from the ovaries are oval in shape, pale yellow in color, and measure about .73 mm.

In addition to the discovery of the oviparous female of the root form another interesting fact in the life history was observed during the season. A careful lookout was kept for any tendency of the plant lice, both within and outside the enclosed frame, to breed on

plants other than corn, and on the 30th of August indubitable *Aphis maidis* of the ærial form were found to be not uncommon in places on young grasses which later were found to be Panicum. After this date they were repeatedly found on this grass. All those examined from the grasses were apterous viviparous females and young.

On the Injurious Locusts of Central Illinois.

BY CLARENCE M. WEED.

One of the most notable entomological events of the year 1885, in Illinois, was the destructive outbreak of two common and widely distributed species of locusts, or grasshoppers as they are more familiarly known, the red-legged locust (*Pezotettix femur rubrum*) and the olive locust (*Pezotettix differentialis*), which resulted in much serious injury to various farm and garden crops, and caused no little apprehension concerning future attack in many farming communities. The region infested may be broadly indicated as the area between the fortieth and forty-second parallels of latitude, or included within a parallelogram having the eastern and western boundaries of the State for two of its sides, and horizontal lines passing through the central portion of Champaign county on the south and the northern boundary of DuPage county on the north for the other two. But the region of greatest injury was much more limited than this, being, as stated by Prof. Forbes in an article "On Some Illinois Locusts," published in the Crop Report of the Illinois Department of Agriculture, for August, 1885 "nearly circumscribed by a line running from the mouth of Rock River to LaSalle, thence down the Illinois Central Railroad to Bloomington, and from there to Quincy," nearly all the accounts of serious mischief coming from the vicinity of Galesburg and Peoria, in the triangular region between those points and the Illinois river to the southward of the former place. In the report just cited, correspondents record that the grasshoppers were so abundant as to cover the pastures in Bureau, DuPage, and Fulton counties; that oats were "injured to a considerable extent just before harvesting" in Grundy county; that "grasshoppers are in greater numbers than for twenty-five years" in Henry county; that oats are poor in Iroquois county, "the grasshoppers having cut off the heads of fully one third of the crop;" that the pests "have injured the oat crop some" in Kankakee county, as is the case in Livingston county, where, also, "the condition of pastures is not good, owing to the drouth and grasshoppers." From McDonough county the correspondent writes that grasshoppers are very numerous and are "injuring the corn to some extent;" while in McLean county "the pastures were doing well until the grasshoppers began to work on them." In Peoria county, according to the report, "the prospect for an average yield of corn is not encouraging, owing to the vast amount of replanting and the injury done by grasshoppers," while "oats have been injured in Rock Island county; and there was

"some complaint of grasshoppers damaging corn" in Stark county. Correspondents also state that the pests had injured oats "very much" in Tazewell county; that "oats were injured by grasshoppers" in Warren county, and, finally, that "the grasshoppers were very numerous and did some damage to meadows and oats in Woodford county."

HABITS AND LIFE HISTORY.

Prof. Forbes has summarized, in the article mentioned above, the life history of these species as follows:

"These locusts are single-brooded as far as observed; they hibernate in the egg, hatching in midsummer; pass through five successive moults, gaining their full size, and with this their wings, in August, and commence to lay their eggs in September. The females deposit these in the earth, boring cylindrical holes for the purpose with the abdomen, and laying the eggs in a symmetrical mass within the burrow thus formed. With the egg mass is extruded a quantity of mucus, which soon hardens and forms a sort of case or matrix, in which the eggs are imbedded. The upper part of the hole is also filled with this mucus. The female is commonly busied from two to four or five hours in the deposit of a single egg mass, and lays, ordinarily, from two to four such masses in different holes, upon different days, commencing this process of oviposition, as a rule, about a month after she has acquired her wings. After this process is completed, the exhausted females soon perish. They select by preference, for oviposition, hard and dry ground, roadsides and pastures being especially favorite localities. Meadows and pastures are commonly resorted to by the mature females, especially the latter, as the eggs seem not to be laid ordinarily on ground covered by luxuriant vegetation. I have never known them deposited in cultivated earth.

"The food habits of these locusts are extremely simple, and consist in eating nearly everything that comes in their way. They are quiet by night, and indeed, as they mature, they select elevated positions as roosts, climbing to the tops of stems of grass in meadows, to the tassels of the stalks in corn fields, and even deserting fields of low herbage if they can find more elevated roosting points near by. When very abundant, and when the weather continues dry, they occasionally swarm like the Rocky Mountain locust, but rarely flying continuously to any great distance, or indeed taking any definite course."

In many respects the outbreak of these locusts the past season is similar to that recorded as having taken place at varying intervals since the settlement of Illinois; the destruction thus caused in 1868–69 being especially noteworthy. It was probably due to the combination of a variety of local and meteorological causes favoring the undue development of these locusts, which are ordinarily kept below the danger line by their insect and other enemies. Even in the region indicated as infested, the destruction was largely local, the farmers of one county suffering serious loss, while the lands of their neighbors in the county adjoining were free from attack.

INJURIES.

In the article above cited, Prof. Forbes states:

"The first decided injuries reported this year were to oats, which the grasshoppers commonly invaded when driven out of the meadows by the harvesting of the hay. This crop being already headed, the insects attacked it by climbing the stems and eating off the pedicels of the oats so that the grain dropped to the ground, many fields being thus almost entirely destroyed, and others reduced in yield from five, to ten or fifteen bushels per acre. In some cases the entire head was eaten off, and dropped to the ground. Considerable annoyance was occasioned in harvest fields by the grasshoppers eating the twine bands, so that the bundles fell apart. After the oats were harvested the pests frequently took refuge in adjacent corn fields, working at first around the borders of the fields, but later, in some situations, scattered almost uniformly through the entire area. Here a very serious damage was done, especially if the corn was a little late, by their eating off the silk at the tip of the young ear as fast as it fruited, and likewise eating out the stamens from the tassels, the necessary consequence being to prevent the fertilization of the grain and consequently to occasion the blasting of the ear. Some farmers in the regions worst infested have reported to me that their fields were entirely ruined, but commonly the principal mischief was confined to the ten or twenty outer rows. In gardens, potatoes, cabbages, raspberries, and strawberries have suffered materially, and in nurseries, the foliage upon the young stock had in many cases been completely eaten away."

In general little need be added to this account, but the following notes of a visit I made, under Prof. Forbes's direction, to a farm on which the grasshoppers were very numerous and caused serious injury, may be of interest as fairly representing the conditions on many other farms where the locusts were destructive. On November 25 I visited the farm of Mr. B. C. Davis, of French Grove, Peoria county, and found the destructive results of the grasshoppers' presence very apparent even at that time. The farm, consisting of 160 acres, had been cropped the past season about as follows: corn, 63 acres; oats, 20 acres; clover pasture, 40 acres; clover and timothy meadow, 30 acres; the remaining portion being utilized for gardens, yards, etc. Mr. Davis, who kindly did all in his power to aid the investigation, stated that the injury to corn was very great, as the locusts attacked it and began eating the silk before the pollen had fertilized the kernels, so that the latter did not "fill." Sixteen acres of the sixty-six yielded fifty bushels to the acre; the rest only twenty bushels per acre. There was no difference in the time of planting or methods of cultivation, the increased yield of the former portion of the field being due to the fact that the locusts did not reach it sufficiently early to cause serious injury. On many of the cobs to be found upon the injured acres there was not a single well developed kernel, and a large proportion of the ears consisted of stunted cobs bearing only a few dozen partially developed kernels. The injury to oats was equally serious, Mr. Davis stating that he lost 400 bushels from twenty acres because of the grasshoppers, which attacked half the field before it was cut; the yield on the

untouched portion being double that of the rest. Of the injury to clover Mr. Davis said that he had seventy acres in meadow and pasture, largely clover, and the loss occasioned by the locusts amounted to at least five dollars per acre. A forty-acre pasture on which the insects were driven from the oat field when the oats were cut was eaten close, and in many cases the growth was entirely killed, the attack necessitating feeding with other forage the stock pasturing upon it. The clover of the thirty-acre meadow was in the greater portion killed, and the timothy was badly injured.

The above statements of the damage caused by grasshoppers on Mr. Davis's farm in all probability fairly represent the then existing condition of many other farms in Peoria county. From a number of gentlemen who were at Mr. Davis's home at the time of my visit, I learned that in the whole region around French Grove serious depredations had taken place. Mr. M. P. Reed, an intelligent farmer residing in the vicinity, stated that he had forty acres of oats damaged to an extent equal to seven bushels per acre: a loss of 280 bushels. A separate piece of four acres, also belonging to Mr. R., bordered by pasture on one side and meadow on the other, was totally destroyed. Mr. Reed also mentioned a twenty acre field of oats belonging to Mr. Homer Tucker, that was so damaged that no attempt was made to harvest it. He added that the grasshoppers in the oats at the time of threshing, made such a horrible stench that it was sickening to measure; the oats that were threshed earliest being worst in this respect. Mr. Samuel Reed stated that some of his oats were more injured after they were in the shock than before. Another instance was reported, where, from twenty-five acres of oats, only one hundred and sixty bushels were harvested, the small yield being attributed to a visit from the locusts. Clover was also seriously injured on many farms. Mr. M. P. Reed, whose statements concerning injuries to oats have just been quoted, reported that a splendid stand of clover and timothy in a forty-acre field, which had been in oats, was destroyed, and a stand of clover belonging to Mr. Samuel Reed, which was as high as the stubble when the oats were cut, was so devastated that at the time of threshing not a green leaf could be seen.

ENEMIES.

Fortunately there are a considerable number of species of animals that depend, to a greater or less extent, upon grasshoppers for subsistence. Some of these are predaceous, others parasitic, but all combine in keeping the pests in check. Prominent among those efficient in this work are the species that live within or upon the eggs of the locusts, as the latter exist in that state for the longest period of their lives, and are also then the most helpless and susceptible to injury. The common blister beetles (*Epicauta*) live, so far as known, in their larval state, exclusively upon the eggs of locusts, and are thus of immense benefit to man. The adults of two species of these beetles, the margined blister beetle, (*Epicauta cinerea*) and the striped blister beetle (*E. vittata*) were found very abundantly by Prof. Forbes in Peoria and Knox counties late in September, and,

as indicated below, the larvæ were taken quite abundantly, destroying the locust eggs later in the season. Small red mites, which are frequently seen attached to the bodies of the mature locusts, are also of benefit, in that while young they suck the life-juices of the locusts, and, later, puncture their eggs and extract the contents. These were rather numerous in the infested regions. The larvæ of the common black ground beetles (*Carabidæ*) which are, to a great extent, carnivorous, also feed upon the eggs, and, as they are everywhere abundant, contribute not a little to lessening their numbers. Certain species of two-winged flies (*Diptera*) are also known to be parasitic upon the eggs as well as the adults, and there were indications that some of them, at least, were at work in Peoria and Knox counties the past season. The white hair-worms (*Mermis*), which also infest grasshoppers, were found by Prof. Forbes, in the summer, "unusually numerous in the sod," though he had not "seen any evidence that they appreciably diminished the number of grasshoppers."

The following account, as given in my notes, of the investigation of the situations in which the eggs were laid and the extent to which they had been destroyed during the autumn of 1885, on Mr. Davis's farm, may be of interest as indicating the positions from which the young locusts will emerge the coming season, and the condition in which the eggs were at the beginning of winter.

The first field examined was the pasture on which the locusts had been so numerous that a considerable portion of clover had been killed, root and branch. In searching for the eggs, which are deposited about an inch below the surface of the soil in masses or pods, each of which contains a number of eggs varying from a dozen to fifty or sixty or even a hundred, a short strip was plowed to a depth of about one inch and the sod thus inverted was broken up bit by bit, a careful record of the number of egg-masses found being kept, and the eggs themselves, together with any predaceous, parasitic, or other insects that were discovered, were bottled in alcohol. All facts that could have any bearing on the subject, such as situation in the field, the number and species of insect enemies, or the proportion of eggs destroyed, were also recorded. The first plowing on the highest portion of the pasture turned up about 27 square feet of sod, in which nine egg pods were found, a portion of them having been destroyed by insect enemies. In one of the pods was a living larva of one of the blister beetles (*Meloidæ*), which had already devoured about half of the eggs, and was rapidly making way with the rest. Several red mites, which are supposed to prey upon locust eggs, were found, as were a few of the predaceous larvæ of the *Carabidæ* or ground beetles. At the second plowing, 20 square feet were inverted, revealing four egg masses, two meloid coarctate larvæ, and two carabid beetles. Next, 15 square feet were overturned, seven egg pods being found, four of which had been destroyed; and one meloid coarctate larva was taken. Another strip of the same size as the last, midway between the highest and lowest part of the pasture, yielded six egg masses (one of which was destroyed) two red mites, and one meloid larva. The rest of the plowing was in the lowest portion of the field, which was well underdrained and perfectly dry. The soil here was black and loamy.

Eggs were quite abundant, and a smaller proportion had been destroyed than on the higher ground. One pod contained a living devouring carabid larva, with fragments of eaten eggs and other eggs as yet untouched. Three other larvæ of Carabidæ were here found, as also one meloid larva.

We next visited the upland meadow, consisting of about thirty acres of clover and timothy mixed. The grasshoppers had killed the first crop of clover and the roots were mostly dead, but the timothy was still alive. The egg masses were much less numerous in this field than in the pasture, and a greater proportion had been destroyed. Probably oviposition would here be more difficult than in the pasture, because the ground near the surface was more penetrated with the coarse roots and stalks of the timothy and clover; but the principal reason for the greater scarcity of the eggs is, as suggested by Professor Forbes, in all probability to be found in the fact that the insects would naturally have left this field on account of the cutting of the hay before the time of oviposition. A considerable surface of the meadow was plowed and only fifteen or twenty egg masses were found, all but four of which had been more or less destroyed. Several larval and imago Carabidæ were collected, as also one coarctate larva of Epicauta, and red mites were common. A number of dipterous larvæ, which may prey upon the eggs, were also found. The reasons for the comparatively greater destruction in this field are probably that the surface above the egg masses was more porous, allowing enemies easier access, and that the scarcity of the eggs necessitated the concentration of the destructive forces.

SITUATION OF THE EGGS.

In order to determine whether the eggs were ever laid in corn fields, a point of considerable importance in considering methods of destruction, a thorough search was made in various parts of the corn fields where the locusts had been destructive, resulting in the discovery of a single egg mass which had been destroyed by enemies. Mr. Davis stated that he had seen an instance where a grasshopper was depositing eggs in the corn field, but he believed it to be a rare occurrence. Hence it seems safe to conclude that practically the number of eggs deposited in corn fields is not sufficient to be of any account. An oat field on which the locusts had been very numerous, though leaving it soon after the crop was harvested, was also examined, but no eggs were found.

IN KNOX COUNTY.

On November 26, acting under Prof. Forbes's directions, I visited the farm of Mr. Sisson, at Galesburg. The farm consists of 320 acres of slightly rolling land, mainly devoted to pastures, meadow, corn, and oats. The grasshoppers were very numerous during the summer, injuring oats to an amount estimated at 20 bushels per acre. The stand of clover in the oat stubble was also considerably damaged, and in spots entirely killed. Corn was injured somewhat, especially along the edges, but the damage was much less serious

than at French Grove. The corn field was examined for eggs, but none were found. On the upland meadow twenty-four egg masses were taken during a search of about one hour, in which Mr. Sisson kindly rendered efficient aid, twenty of which were parasitized and completely destroyed. In the earth about the parasitized masses, considerable numbers of dipterous pupæ were found, probably from the locust eggs. Some of these were put in a breeding cage and it is hoped that the adult flies may be obtained the coming season. A few dipterous larvæ similar to those of *Anthomyia* were also taken, and red mites were rather common.

DESTROYING YOUNG GRASSHOPPERS.

In the first report of the United States Entomological Commission, a Commission appointed to investigate the life history and methods of preventing the ravages of the Rocky Mountain locust, Dr. Riley, in considering the destruction of the young or unfledged locusts, writes that experience has firmly established the fact "that with proper means, efforts, and co-operation, the farmer in the more settled portions of the country liable to their injury, may successfully cope with them; that, in short, he can protect his crops against them with about as little labor and expense as he must annually employ to protect most of these same crops from weeds." As the life histories of the two species at present threatening to become seriously destructive in certain portions of Illinois are not essentially different from that of the one just mentioned, and as they succumb to the same destructive agencies as have been successfully employed with little expense in the West, it becomes the duty of every farmer in the infested regions to watch closely such situations on his farm as are likely to be stocked with locust eggs for the hatching of the young, and to immediately apply such remedial measures as seem best adapted to each case. Negligence in this respect would be almost criminal, and hearty individual and united efforts are earnestly advised.

In the report above cited the methods of destroying young locusts are classified thus: 1. Burning. 2. Crushing. 3. Trapping. 4. Catching. 5. Use of destructive agents. By the first method old hay or straw is scattered "over or around the field in heaps and windrows, into which the locusts for some time after they hatch may be driven and burned." When the weather is cold and damp the locusts will seek the shelter of the hay or straw, and may easily be burned before escaping. This method is well adapted to upland pastures, where the eggs have been deposited in greatest numbers.

For the successful application of the second method mentioned above, it is necessary that the surface of the fields on which it is applied be smooth and hard. Here, again, the upland pastures present unusually favorable opportunities for successful work. Dr. Riley states that "Where the surface of the ground presents this character, heavy rolling can be successfully employed, especially in the mornings and evenings of the first eight or ten days after the newly hatched young have made their appearance, as they are generally sluggish during these times and huddle together until after sunrise.

It it also advantageously employed during cold weather at any time of the day, since the young, when the temperature is low, seek shelter under clods, etc."

Under the third head given above, that of trapping, Dr. Riley includes ditching, trenching, and the use of pans covered with coal oil, or coal tar. In the first two processes ditches or trenches are dug in favorable situations, into which the young insects are driven. Probably the use of pans covered with coal oil will be as simple and advisable a method, unless we except that of rolling, as can be employed in the district under consideration. Dr. Riley has described a small pan well adapted for the purpose, as follows: "A good and cheap pan is made of ordinary sheet iron, eight feet long, eleven inches wide at the bottom, and turned up a foot high at the back and an inch high at the front. A runner at each end, extending some distance behind, and a cord extending to each front corner, completes the pan, at a cost of about $2.50.

"We have known from seven to ten bushels of young locusts caught with one such pan in an afternoon. It is easily pulled by two boys, and by running several together in a row, one boy to each outer rope, and one to each contiguous pair, the best work is performed with least labor. Longer pans, to be drawn by horses, should have transverse partitions to avoid spilling the liquid; also more runners. The oil may be used alone, so as to just cover the bottom, or on the surface of water; and the insects strained through a wire ladle. When the insects are very small, one may economize in kerosene by lining the pan with saturated cloth, but this becomes less efficient afterwards, and frames of cloth saturated with oil do not equal the pans."

The use of destructive agents, such as London purple, Paris green, and the like, has not been attended with any very great success when applied on a large scale. But for limited areas, doubtless a great many of the locusts may thus be easily destroyed. Dr. Riley has recently published a description of a mixture which was successfully employed last year in California. The mixture consists of "arsenic, sugar, bran, and water, the proportions being one part, by weight, of arsenic, one of sugar, and five of bran, to which is added a certain quantity of water. The arsenic and bran are first mixed together, then the sugar is dissolved in water and added to the bran and arsenic, after which a sufficient quantity of water is added to thoroughly wet the mixture. About a teaspoonful of this mixture is thrown upon the ground at the base of each tree or vine (in gardens and orchards) and left to do its work. The poison works slowly, seldom killing its victim within eight or ten hours after it has been eaten."

In some situations it might be advisable to harrow the surface thoroughly as early in spring as possible, to expose the eggs to the air and to their numerous insect and other enemies.

CONCLUSION.

From the data now (Feb. 23) at hand, it does not seem safe to attempt to foretell to what extent the locusts may prove injurious

the coming season. We know that their enemies are now present in the devastated fields, that the long, warm autumn and open winter have been favorable for the destruction of the eggs, and that at the beginning of winter a considerable percentage had been destroyed. But as an immense number of eggs have doubtless been deposited, even should only a small proportion hatch, the locusts would be sufficiently numerous to stock the infested regions to an extent equal to, or greater than that of last year. The percentage escaping will probably depend somewhat upon the weather during the present spring and early summer. We do know, however, the situations in which the eggs have been deposited, and consequently the places where the young locusts will first appear; viz., upland pastures and meadows, and along roadsides and hedges, but probably never to any practical extent in fields cultivated the previous season, and then planted to corn, oats, and similar crops; unless perhaps there should have been a growth of young grass or clover to attract the egg-laden females late in autumn. Hence if a careful watch for the hatching of the young locusts is kept on these situations, and remedial measures, such as the use of the flat kerosene pans, rolling, etc., be at once applied, the insects may be destroyed at comparatively little expense before they migrate to the neighboring cropped fields.

PARTIAL ECONOMIC BIBLIOGRAPHY OF INDIAN CORN INSECTS.

By Thomas F. Hunt.

[The following bibliographical notes and list were intended as a basis for a discussion of the insects injurious to Indian Corn in Illinois; but circumstances explained on another page having prevented the publication of this monograph, this paper is printed as the best available present substitute.

A complete bibliography of the subject was unnecessary for the purpose intended; but it is believed that so much as is here given, includes all the published facts of economic importance relating to the corn insects. S. A. F.]

The following books, periodicals, and newspapers, were scanned in preparing the list of references to the insects affecting Indian Corn:

Harris's Insects Injurious to Vegetation, 3d ed.

Fitch's Reports on the Insects of New York, Vols. I–XIV.

Reports of the U. S. Commissioner of Agriculture for the years 1862–1884.

Riley's Reports on the Insects of Missouri, Vols. I–IX.

Reports on the Injurious Insects of Illinois, I–XIV.

Packard's Guide to the Study of Insects.

Packard's Reports on the Insects of Mass., I–III.

Lintner's Reports on the Insects of N. Y., I–II.

Reports U. S. Ent. Commission, I–III.

Reports of Ent. Soc. of Ontario, I–XV.

Practical Entomologist, I–II.

American Entomologist, I–III.

Canadian Entomologist, I–XVII.

Report Kansas State Board Agric., 1872–1882.

Report Maine State Board Agric., 1872–1878.

Report Michigan State Board Agric., 1872–1884.

The Prairie Farmer, Chicago, 1843–1852 and 1862–1867.

The Cultivator, 1844–1863.

The Cultivator and Country Gentleman, 1865–1883, except 1881.

Miscellaneous articles in the Proceedings of the American Philosophical Society, in the Proceedings of the Philadelphia Academy of Natural Sciences, in the Proceedings of the Entomological Society of Philadelphia, in the Transactions of the American Entomological Society, in Hayden's Geological and Geographical Survey of the Territories, in Comstock's Report on Cotton Insects, in office newspaper scrap-books, and in other books not enumerated, were also freely drawn upon for data.

Order HYMENOPTERA.

Family Formicidæ.

1. The Small Yellow Ant.

(*Solenopsis fugax*, Latr.)

1798. Latreille, P. A.—*Formica fugax*. Ess. sur l'Histe des Fourm. de la France, p. 46. Original description.

1802. Latreille, P. A.—Idem. Hist. Nat. des Fourm. p. 265. Description male and female.

1884. Forbes, S. A.—*Solenopsis fugax*. 13th Rep. St. Ent. Ill., pp. 112, 113. Description of imago. Injuries to young Indian Corn—feeding upon the kernel and thereby stunting the growth of the plant.

2. Solenopsis molesta, Say.

1835. Say, Thomas.—*Myrmica molesta*. Bost. Jour. Nat. Hist. I., 294. Complete writings, II., 737. (Description of new North American Hymenoptera and observations on some already described.) Original description. Sometimes eats vegetable food.

1865. Fitch, Asa.—Idem. Trans. N. Y. St. Agr. Soc., 1865, p. 133. Injuring young Indian Corn by gnawing blades.

Order LEPIDOPTERA.

Family Bombycidæ.

3. The Arge Tiger-Moth.

(*Arctia arge*, Drury.)

1770. Drury, Drew.—*Bombyx arge*. Illustr. Nat. Hist. I., 35, pl. XVIII., fig. 2. Original description.

1797. Smith, J. E.—*Phalæna dione*. Nat. Hist. Lep. Ins. Ga. p. 125, tab. 63.

1842. Harris, T. W.—*Arctia arge.* Rep. Mass. Insects. General description of moth and larva. Moth taken from May 20 till middle of July. Caterpillars appear sometimes in great numbers in October. Eat leaves of plantain and other herbaceous plants. Sometimes very destructive to Indian corn in Southern States.

1861. Clemens, B.—*Arctia dione.* Proc. Acad. Nat. Sci. Phila. 1860, p. 528. Description of moth. N. Y., Mass., Ga., Ill.

1862. Harris, T. W.—*Arctia arge.* Insects injurious to vegetation, 3d ed. p. 346. (See under 1842.)

1862. Morris, J. G.—*Arctia dione.* Synop. Lep. N. A., Appendix, p. 340. Description of moth and larva. U. S.

1863. Saunders, W.—Idem. Synop. Can. Arctiidæ p. 7.

1864. Packard, A. S., Jr.—*Arctia arge.* Proc. Ent. Soc. Phila. III., p. 118. (Synopsis of the Bombycidæ of the U. S.) Synonymy and bibliography. In Massachusetts this species is not infrequent, and becomes more abundant southward.

1873. Lintner, J. A.—Idem. Rep. N. Y. St. Cab. N. H. XXIII., p. 193. Larva collected Feb. 23, in N. Y.

1874. Lintner, J. A.—Idem. Rep. N. Y. St. Cab. N. H. XXVI., p. 179. Imago taken July 28, 1872.

1875. Snow, F. H.—Idem. Trans. Kan. Acad. Sci. IV., p. 38. Not common in Kansas. Feeds upon plantain.

1878. French, G. H.—Idem. 7th Rep. St. Ent. of Ill. p. 182. General description of moth and larva. Food plants, plantain and Indian corn.

1881. Marten, John.—Idem. 10th Rep. St. Ent. of Ill. p. 115. General description of larva. Feeds on plantain and Indian corn.

Coquillet, D. W.—Idem. 10th Rep. St. Ent. Ill. p. 170. Specific description of larva. Feeds on evening primrose. Sept. to May.

4. The Salt Marsh Moth.

(*Leucarctia acræa*, Drury.)

1797. Smith, J. E.—*Phalæna acria.* Nat. Hist. Lep. Ins. Ga. p. 133, tab. 67.

1816. Hubner, Jacob.—*Estigmene acria.* Samml. Exot. Schm Bd. 2, pl. 191, no loc.

1823. Harris, T. W.—*Arctia pseuderminea.* Mass. Agr. Rep. and Journ. p. 322, pl. I. Description of larva and moth. Life history and habits. Very destructive to grasses in salt marshes about Boston. Eggs laid in middle of June. Hatch in seven or eight days. Larvæ attain full size in

seven weeks; then become very voracious and "begin to run," devouring everything in their progress—INDIAN CORN, garden vegetables, etc. Soon change to chrysalids and winter thus.

Remedies:—Cut grass early in July and burn meadows in March.

1860. MORRIS, JOHN G.—*Spilosoma acria.* Synopsis Lep. N. A., Appendix, p. 342. Description of moth and larva.

1861. CLEMENS, B.—*Spilosoma acrea.* Proc. Acad. Nat. Sci. Phila. 1860, p. 531. Description of moth.

1862. HARRIS, T. W.—*Arctia acræa.* Insects injurious to vegetation, p. 351, fig. 169. Destructive to grasses in salt marshes about Boston, July and August. Feed in corn fields and gardens. Change to chrysalids in August and emerge June following. Middle and Southern States two broods annually. Destructive at irregular periods. Description of moth and larva. Mow marshes early and burn stubble following March.

1864. PACKARD, A. S., Jr.—*Spilosoma acræa.* Proc. Ent. Soc. Phila., III., 125. (Synopsis of the Bombycidæ of the United States.) Synonymy and bibliography.

1869. PACKARD, A. S., Jr.—*Leucarctia acræa.* Guide to the Study of Insects, p. 286. Caterpillar very injurious at times by its great numbers.

1875. SNOW, F. H.—Idem. Trans. Kan. Acad. Sci., IV., 38. Common in Kansas. Found feeding upon beet leaves.

1878. FRENCH, G. H.—Idem. 7th Rep. St. Ent. Ill., p. 79, 183. P. 79, widely distributed. Eats freely tender leaves of garden vegetables, field grains, etc. Description of larva and moth. Natural history. Remedy; burn stubble. P. 183, specific description of moth and larva. Food plants; cultivated plants, weeds, and grasses. Two broods. Checked by parasites. Hand-picking when numerous.

1881. COQUILLET, D. W.—Idem. 10th Rep. St. Ent. Ill., p. 170. Specific description of larva. Feeds on rag-weed, June to October.

5. THE YELLOW BEAR.

(*Spilosoma virginica*, Fab.)

1852. HARRIS, T. W.—*Arctica virginica.* Insects Injurious to Vegetation, p. 349. Feeds on leaves of INDIAN CORN, grasses, and herbaceous plants generally. Description of moth and larva. Larva—June to October. Moth emerges May and June. Hand-picking suggested.

1857. FITCH, ASA.—*Spilosoma virginica.* Third Rep. Ins. N. Y., p. 82, No. 125. Brief description of moth, larva, and pupa. Food plants.

1861. Clemens, B.—Idem. Proc. Acad. Nat. Sci. Phila. 1860, p. 531. Description of moth.

Morris, John G.—Idem. Synop. Lep. N. A., Appendix, p. 342. Description of moth and larva.

1863. Saunders, W.—Idem. Synop. Can. Lep., p. 14.

1864. Packard, A. S., Jr.—Idem. Proc. Ent. Soc. Phila., III., 125. (Synopsis of the Bombycidæ of the United States.) Synonymy and bibliography.

1869. Packard, A. S., Jr.—Idem. Guide to the Study of Insects, p. 287. Brief description of imago.

1870. Riley, C. V.—Idem. Amer. Ent., II., 272. General description of moth and larva. Habits and life history. Moths appear May 1. Larva from June to October. Two-brooded. Winter in chrysalis state. Feeds on Indian corn and almost any plant with tender leaves. Checked by five distinct parasites.

1871. Riley, C. V.—Idem. 3d Annual Rep. St. Ent. of Mo., p. 68. (See under 1870.)

1873. Lintner, J. A.—Idem. 23d Rep. N. Y. St. Cab. N. H., p. 193. Moth collected May 7 and June 19 in N. Y.

1874. Lintner, J. A.—Idem. 26th Rep., N. Y. St. Cab. N. H. p. 179. Moth collected May 30 to June 29, 1873.

1875. Snow, F. H.—Idem. Trans. Kan. Acad. Sci. IV., p. 38. Common in Kansas. Feeds upon leaves of Indian Corn, peas, beans, plantain, grasses, and sometimes grape, currant, and gooseberry.

1878. French, G. H.—Idem. 7th Rep. St. Ent. of Ill., p. 183. Specific description of larva and moth. Found from June to October on peas, beans, cabbages, Indian corn, grapes, etc. Hand-picking suggested.

1881. Saunders, W.—Idem. Ann. Rep. Ent. Soc. Ont. for 1880, p. 21. General description of moth and larva. Habits and life history. Two-brooded. Winters in pupa state. Moths appear in May. Checked by several parasites.

Marten, John.—Idem. 10th Rep. State Ent. Ill., p. 116. Specific description of larva. Two-brooded. Food plants; butternut, lilac, peas, beans, gooseberry, sorrel, convolvus, Indian Corn, currant, sunflower, smartweed, plantain, verbena, geranium, etc.

Coquillet, D. W.—Idem. 10th Rep. St. Ent. of Ill., p. 169. Specific description of larva. June to November.

6. Saddle-Back Caterpillar.

(*Empretia stimulea*, Clemens.)

1861. Clemens, B.—*Empretia stimulea.* Proc. Acad. Nat. Sci. Phila., 1860, p. 159. Original description of moth and larva. Spines produce painful sensation. On a great variety of plants: fruit-trees, rose, Indian corn.

1862. Morris, J. G.—Idem. Synop. Lep. N. A., p. 130. Description of moth and larva. Spines of horns produce painful sensation. On a great variety of plants: fruit-trees, the rose, Indian corn, etc.

1864. Packard, A. S., Jr.—Idem. Proc. Ent. Soc. Phila. III., 340. (Synopsis of the Bombycidæ of the United States.) Bibliography. Conn. N. Y.

1868. Walsh and Riley.—Idem. Amer. Ent. I., 40. Stinging sensation produced by spines of larva.
Walsh and Riley.—Idem. Amer. Ent. II., 32, 59. P. 32, derivation of name. P. 59, figured.

1869. Packard, A. S., Jr.—Idem. Guide to the Study of Insects, p. 289, pl. vii, fig. 1; 1a, larva. Brief description of moth and larva. Moth appeared June 18. Larva feeds on raspberry.

1875. Snow, F. H.—Idem. Trans. Kan. Acad. Sci. IV., 39. Seen only as a larva. Rare. Feeds upon the pear.

1878. French, G. H.—Idem. 7th Rep. St. Ent. Ill., p. 187. Description of moth and larva. Spines on its horns are poisonous. Feeds on great variety of plants, including fruit-trees, rose, and Indian corn.

1881. Marten, John.—Idem. 10th Rep. St. Ent. Ill., p. 117. Specific description of larva. Food plants: fruit-trees, rose, and Indian corn.

7. The Io Moth.

(*Hyperchiria io*, Fab.)

1797. Smith, J. E.—*Phalena io.* Nat. Hist. Lep. Ins. Ga., p. 97, tab. 49.

1835. Harris, T. W.—*Saturnia io.* Cat. Ins. Mass.

1842. Harris, T. W.—Idem. Rep. Ins. Mass., p. 284. General description of moth, larva, and cocoon. Larva, June to September. Furnished with spines. Winters in chrysalis state. Moths emerge during June and July. Feeds on leaves of Indian corn, clover, sassafras, dogwood, elm, and balsam poplar.

1856. Fitch, Asa.—Idem. Third Rep. Nox. Ins. N. Y., p. 61. Description of larva. Moths appear in June. Wild black cherry and thorn. Eat leaves from end of limbs.

1862. Harris, T. W.—Idem. Insects Injurious to Vegetation, pp. 393-397. 3d ed. figs. 188, 191, 192, larva; 190, pupa; 189, cocoon. (See under 1842.)

Morris, John G.—Idem. Synopsis Lep. N. A., p. 220. Description of moth and larva. Cocoon spun between several dry leaves. Feeds on sassafras, dogwood, and poplar. United States.

1864. Packard, A. S., Jr.—*Hyperchiria varia.* Proc. Ent. Soc. Phila. III., 384. (Synopsis of the Bombycidæ of the United States.) Synonymy and bibliography. Reason for using *varia* instead of *io.*

1869. Packard, A. S., Jr.—Idem. Guide to the Study of Insects, p. 299. Brief description of imago, larva, and pupa. Very harmful to Indian corn and cotton southward.

1873. Lintner, J. A.—*Hyperchiria io.* 23d Rep. N. Y. St. N. H., pp. 189, 193. Moths collected July 9 and September 23. Larvæ collected July 15 and September 16 in N. Y.

1874. Lintner, J. A.—Idem. 26th Rep. N. Y. St. Cab. N. H., p. 180. Moth collected June 12, 1872.

Reed, E. B.—*Saturnia io.* Canadian Entomologist, Vol. VI., 227. Description of moth and larva. Difference of sexes. Life history and habits. Caterpillars gregarious. June to September. Food plants numerous: Indian corn, clover, choke cherry, etc.

1875. Reed, E. B.—Idem. Rep. Ent. Soc. Ont. 1874. pp. 11–13. Figs. 1, 2, 3, and 4. (See under 1874.)

Snow, F. H.—*Hyperchiria varia.* Trans. Kan. Acad. Sci. IV., 41. Not common in Kansas. Feeds upon false indigo, wild cherry, willow, poplar, hop-vine, and Indian corn.

1878. French, G. H.—*Hyperchiria io.* 7th Ann. Rep. St. Ent. Ill., p. 195. Description of moth. Food plants: Indian corn, sassafras, locust, willow, etc.

1880. Saunders, W.—*Saturnia io.* Rep. Ent. Soc. Ont., 1879, p. 75, figs. 46, 47, and 48. Description of moth and larva. Caterpillars gregarious. Pupate on ground among loose leaves and rubbish. Common in many quarters.

1881. Marten, John.—*Hyperchiria io.* 10th Rep. St. Ent. Ill., p. 127, fig. 40. Description of larva. Feeds on Indian corn, clover, currant, apple, and foliage of many trees.

Coquillet, D. W.—Idem. 10th Rep. St. Ent. Ill., p. 169, fig. 64. Description of larva. June to September.

Family Noctuidæ.

8. The Smeared Dagger.

(*Apatela oblinita* Sm. and Abb.)

1797. Abbot?, John.—*Acronycta oblinita.* The Nat. Hist. of the Rarer Lep. Ins. of Ga., p. 187, pl. 94. Original description.

1852. Guenee, A.—Idem. Nat. Hist. of Insects I., 49. Specific characters of imago and larva. Moths appear in April. Common in N. A.

1870. Riley, C. V.—Idem. Amer. Ent., II., 275. Food plants: grape, smartweed, and a number of other plants.

Riley, C. V.—Idem. 3d Rep. St. Ent. Mo., p. 70. Descriptions and figures of imago, larva, and pupa. Life history. Description of three parasites. Feeds on cotton, asparagus, peach, apple, and willow.

1873. Lintner, J. A.—Idem. 23d Rep. N. Y. St. Cab. N. H., p. 194. Larva on Polygonum. September 12 in N. Y.

Saunders, W.—Idem. Rep. Ent. Soc. Ont. 1872, p. 23, fig. 13. Description of imago and larva. Pupates in September. Moths emerge in June. Feeds on strawberry, raspberry, Lombardy poplar, smartweed, peach, apple, and willow. Three parasites mentioned. Remedy, hand-picking.

1874. Lintner, J. A.—Idem. 26th Rep. N. Y. St. Cab. N. H., p. 180. Larva on Polygonum September 1, 1872.

1875. Gentry, Thomas G.—Idem. Proc. Phila. Acad. Nat. Sci., 1875, p. 24. Certain larvæ did not spin cocoons. Supposed to be due to deficient nutrition. Feed upon smartweed (*Polygonum pennsylvanicum.*) October.

Snow, F. H.—Idem. Trans. Kan. Acad. Sci. IV., 43. Common in Kansas. Food plants.

1878. French, G. H.—Idem. 7th Rep. St. Ent. Ill., p. 201. Description of imago and larva. Larva occurs frequently during June and August or September. Feeds on smartweed, apple, and grape.

1881. Marten, John.—*Apatela oblinita.* 10th Rep. St. Ent. Ill., p. 131, fig. 43. Description of larva. Found in June, August, and September on smartweed, apple, grape, and willow.

Coquillet, D. W.—*Acronycta oblinita.* 10th Rep. St. Ent. Ill., p. 170, fig. 66. Description of larva. Feeds on smartweed, hazel, and Indian corn. June to October.

1884. Forbes, S. A.—*Apatela oblinita.* 13th Rep. St. Ent. Ill., p. 82, pl. vi, fig. 3. Summary of published facts.

Cutworms.

1842. Harris, T. W.—Cutworms. Rep. Mass. Ins. Habits, injuries, and natural history of cutworms. Five species described. Various remedies proposed: collecting given as the only effectual one.

1845. Drummond, Za.—Idem. The Cultivator, 1845, p. 122. Writes from Virginia that his Indian corn has never suffered from any kind of worms when the land has been thoroughly plowed in winter; but that it has always suffered on rich ground not plowed in winter.

1852. Prairie Farmer, XII., 59.—Fall Plowing for Insects. Suggests that fall plowing destroys cutworms by destroying the food necessary for their development in early spring.

1856. Risley, Wm.—Cutworms and their Destruction. The Cultivator, 3d series, IV., 145.

Fitch, Asa.—Cutworms. Rep. N. Y. Insects, II., 310–318. Severing the young stalks of Indian corn, by night, at or near the surface of the ground. A thick, cylindrical, pale dull-colored worm, an inch or more in length. Popular ignorance respecting cutworms. Their life history and habits. Different kinds. Five larvæ described and three imagos, but their relations not stated. Natural enemies: crows, predaceous insects. Abundant seed recommended. Supposes cutworms to come from surrounding fields to the places where they are noticed, and hence advocates making a deep furrow around field or garden.

Fitch, Asa.—Idem. The Cultivator, 3d series, IV., 115. (Same as above.)

1862. Harris, T. W.—Idem. Insects Injurious to Vegetation, 3d ed., pp. 441–451. (See under 1842.)

1863. Fitch, Asa.—Idem. 9th Rep. N. Y. Insects, pp. 804–817. Early notices and records of their injuries. Ill success in rearing them. Young worms in autumn. Plowing to destroy them. Their habit of severing young plants; habits of different species. Their destruction by larvæ of *Calosoma calidum.*

1864. Warder, J. A.—Idem. (Paper read before Cincinnati Hort. Soc.) Prairie Farmer, new series, XIII., 341. Remedial agencies.

Riley, C. V.—The Cutworm. Prairie Farmer, new series, XIII., 169. Gives briefly their general life history. Does not believe plowing useful in destroying them.

1865. Riley, C. V.—Idem. (From Rep. U. S. Dept. Agriculture, April and May, 1865.) Prairie Farmer, new series, XV., 483. Instance of efficacious use of salt by the Commissioner of Agriculture. Said to be fatal to cutworms on account of its effect upon their skin.

1866. Walsh, B. D.—Cutworms. Prac. Ent., I., 85–86. Defines the use of the term cutworm. Plants attacked. Seven species mentioned, and an account of injuries done by cutworms, especially to fruit trees, and remedies for the same.

1867. Townley, John.—Idem. Prac. Ent., II., 64–66. Injuries done to buds and foliage of trees by cutworms. Remedies proposed. Sugaring with poisoned molasses suggested by Walsh.

Riley, C. V.—A Chapter on Cutworms. Prairie Farmer, XIX., 413–414. Gives an account of their injuries to fruit trees and gives specific characters of one moth and three larvæ.

1869. Riley, C. V.—Cutworms. 1st Rep. St. Ent. Mo., pp. 67–91. Gives natural history and descriptions of twelve distinct species. Natural enemies; parasites and predaceous insects. Collecting recommended. Fall plowing, to be efficacious,

must be done late. Remedies: ashes, lime, salt, etc. Experimenters generally forget that there is a period in the life of these worms when they disappear in the earth, and anything applied just before this happens, is sure to be heralded as a perfect remedy.

1872. Coles, Isaac.—Cutworms in Corn. Country Gent., XXXVII., 339. Sends specimens of cutworms to the editor with statement that they had almost entirely destroyed a field of Indian corn, from one to five or six being in proximity to a hill, and enveloped in a web. Editor supposes them to *Hadena arctica*, Boisd.

1874. L. B.—Treatment of Cutworms. The Country Gent. XXXIX., 275. Writes from Maryland that he seldom finds cutworms destructive on fall or early spring plowing. Whenever they are destructive, he waits till they pupate and then replants.

1877. Fernald, C. H.—Cutworms. Rep. Me. St. Board of Agriculture, 1877, pp. 62–65. Gives a brief account of habits, and an extended one of an attack upon a cutworm by a wasp (Sphex). States that for those which attack Indian corn, digging up and killing is the best remedy.

1880. Bowles, G. J.—Canadian Cutworms. Rep. Ent. Soc., Ont., 1879, pp. 38–46. Description and natural history of twelve species given, mostly after Fitch, Harris, and Riley. Abundance in Canada. Natural enemies, predaceous insects.

1885. Riley, C. V.—Cabbage Cutworms. Rep. Com. Agr., 1884, pp. 289–300. Plates II and III. Eight species described and life history and habits given. Remedies for cutworms as cabbage pests.

9. Spotted Cutworm.

(*Agrotis c-nigrum*, Linn.)

1767. Linne, Carl von.—*Noctua c-nigrum. Systema Naturæ.* 12th ed., Tome I., Part II., 852, No. 162. Original description.

1796. Hubner Jacob.—Samml. Europ. Schmett, p. III. Original description of larva.

1852. Guenee, A.—*Noctua c-nigrum.* Spec. Gén. Lép. V.—Noct. I., 328. Bibliography. Brief description of imago. North America.

1873. Lintner, J. A.—*Agrotis c-nigrum.* 23d Rep. N. Y. St. Cab. N. H., p. 194. Imago collected in N. Y. June 23.

1875. Snow, F. H.—Idem. Trans. Kan. Acad. Sci. IV., 43. Not common in Kansas.

1878. French, G. H.—Idem. 7th Rep. St. Ent. Ill., pp. 89, 202. Specific characters of imago and general character of larva. Southern part of State. Larvæ change to chrysalids May 1. Observations on life history. Two-brooded or more.

1881. Marten, John.—Idem. 10th Rep. St. Ent. Ill., p. 132. Description of larva. Feeds on grass, vegetables, pear-and maple-trees in March and April.

Coquillet, D. W.—Idem. 10th Rep. St. Ent. Ill., p. 184. Description of larva. Feeds on grass. Found throughout the year.

1882. Coquillet, D. W.—Idem. 11th Rep. St. Ent. Ill., p. 51. Abundance compared with army worms, as one to eight. Description of larva. Life history. Two-brooded. Moths June and September.

1883. Riley, C. V.—Idem. 3d Rep. U. S. Ent. Com., p. 135. Large numbers of larvæ among army worms, in the evident proproportion of about one cutworm to five army worms.

1885. Lintner, J. A.—Idem. Cutworms, p. 6. Destructive to Indian corn.

10. The Dingy Cutworm.

(*Agrotis subgothica*. Haw.)

1810. Haworth, A. H.—*Agrotis subgothica*. Lep. Britain. (*Teste* Lintner.) Original description.

1852. Guenee, A.—*Agrotis jaculipera*. Sp. Gen. Lep. V., Noct. I., 262. Description of imago. North America, Canada. Seems very common.

1869. Riley, C. V.—Idem. Rep. St. Ent. Mo. I., 82. Specific characters of imago, chrysalis, and larva. Injuries in Northern Illinois. Moths, September.

1873. Grote, A. R.—*Agrotis subgothica*. Bul. Buf. Soc. Nat. Sci. I., 100. (*Teste* French.) Synonymy.

1874. Lintner, J. A.—Idem. 26th Rep. N. Y. St. Cab. N. H., p. 180. Imago collected in N. Y. July 21 and 30.

1875. Snow, F. H.—Idem. Trans. Kan. Acad. Sci. IV., 43. Very abundant and very destructive in Kansas.

1878. French, G. H.—Idem. 7th Rep. St. Ent. Ill. pp. 89, 204. P. 89, distinguishing marks of imago and larva. P. 204, description of imago and larva. Atlantic district to Colorado. Larva September to July. Reported destructive to gardens in the vicinity of Rockford.

1880. Bowles, G. J.—*Agrotis jaculifera*. Rep. Ent. Soc. Ont., 1879, p. 41. Compared to *A. subgothica*.

1881. Marten, John.—*Agrotis subgothica*. 10th Rep. St. Ent. Ill., p, 132, fig. 44. Description of larva. Larvæ destructive in June. Chrysalids, July. Moths, September.

1885. Lintner, J. A.—Idem. Cutworms, p. 6, fig. 10. Destructive to Indian corn.

11. Western Striped Cutworm.

(*Agrotis herilis*, Grote.)

1852. Guenee, A.—*Agrotis jaculifera*, var. b. Sp. Gén. Lép. V., Noct. I., 262. Original description.

1856. Fitch, Asa.—*Agrotis subgothica*. Rep. N. Y. Insects II., 314. General description of moth. July to September. Illinois. Common. Severs the young stalks by night at or near the surface of the ground. Natural enemies: Crows and predaceous beetles. Remedies: abundance of seed and collecting the larvæ.

1867. Riley, C. V.—Idem. Prairie Farmer, XIX., 214. Specific characters of larva. Called Western striped cutworm.

1869. Riley, C. V.—Idem. Rep. St. Ent. Mo. I., 81. Specific characters of larva with general description of imago. Moths, August, and September. Common.

Packard, A. S., Jr.—Idem. Guide to the Study of Insects, p. 306, fig. 233. Moths often seen flying over blossoms of the golden-rod in autumn.

1873. Grote, A. R.—*Agrotis herilis*. Bul. Buf. Soc. Nat. Sci. I., 99. Names species and clears up synonymy.

1874. Lintner, J. A.—Idem. 26th Rep. N. Y. St. Cab. N. H. p. 180. Collected in N. Y. August 14, 1872.

1875. Cook, A. J.—*Agrotis subgothica*. Rep. Mich. St. Bd. Agriculture, 1874, p. 111, fig. 2. Injurious to Indian corn in Michigan.

1878. French, G. H.—*Agrotis herilis*. 7th Rep. St. Ent. Ill. pp. 90, 205. Specific characters of imago and larva. Pupates May and June. Moths emerge September. Synonymy explained.

1880. Bowles, G. J.—*Agrotis subgothica*. Rep. Ent. Soc. Ont. 1879, p. 40. General description of imago and larva. Moths, August and September. Common in Canada.

1881. Marten, John.—*Agrotis herilis*. 10th Rep. St. Ent. Ill. p. 133. Description of larva.

1885. Lintner, J. A.—Idem. Cutworms, p. 7. Destructive to Indian corn.

12. W-marked Cutworms.

(*Agrotis clandestina*, Harris.)

1842. Harris, T. W.—*Noctua clandestina*. Rep. Mass. Ins. Original description of imago. Abundant in New England. Moths, June to August. Larvæ pass winter half grown. Prefer young Indian corn plants. Early sown buckwheat, young pumpkin plants, young beans, cabbage plants, and many other field and garden vegetables. Remedies: fall plowing and killing by hand.

1856. Fitch, Asa.—Idem. Rep. N. Y. Insects, II., 315, Plate 3, fig. 6. Very common. Larva severs the young stalks by night at or near the surface of the ground. Natural enemies: crows and predaceous beetles. Remedies: abundance of seed and collecting the larvæ.

1862. Harris, T. W.—Idem. Insects Injurious to Vegetation, 3d ed., p. 446. (See under 1842.)

1867. Riley, C. V.—Idem. Prairie Farmer, XIX., 413. Larva described. Injurious to apple buds, young cabbages, and Indian Corn. Moths appear in latter part of June.

1869. Packard, A. S., Jr.—Idem. Guide to the Study of Insects, p. 309. Specific characters of larva.

1873. Lintner, J. A.—Idem. 23d Rep. N. Y. St. Cab. N. H., p. 194. Collected in N. Y. July 1.

1874. Lintner, J. A.—Idem. 26th Rep. N. Y. St. Cab. N. H., p. 180. Collected July 4, 14, and September 23, 1872.

1875. Snow, F. H.—Idem. Trans. Kan. Acad. Sci., IV., 43. Not common in Kansas.

1878. French, G. H.—Idem. 7th Rep. St. Ent. Ill., pp. 95, 213. Specific characters of imago and larva. Most abundant species of this group in Middle and New England States. Climbing habit. Food Plants.

1880. Bowles, G. J.—Idem. Rep. Ent. Soc. Ont., 1879, p. 44, fig. 6. General description of imago and larva. Food plants: Indian Corn, wheat, buckwheat, young pumpkins, beans, cabbages, and many other garden plants. Common in Canada and in northern and western United States.

1881. Marten, John.—Idem. 10th Rep. St. Ent. Ill., p. 135. Larva described. Climbing habit.

1884. Riley, C. V.—Idem. Rep. Com. Agriculture, 1884, p. 293, pl. II, fig. 4. Distinguishing features of larva. Moths, June to August. Larvæ hibernate. Pupæ, May and June. Food plants: Indian Corn, buckwheat, pumpkin-vines, beans, cabbage, apple buds, and wild endive.

1885. Lintner, J. A.—Idem. Cutworms, pp. 6, 8. Destructive to Indian Corn, cabbage, and beans.

13. Dark-sided Cutworm.

(*Agrotis messoria*, Harris.)

1842. Harris, T. W.—*Agrotis messoria*. Rep. Mass. Insects. Original description.

1862. Harris, T. W.—Idem. Insects Injurious to Vegetation, 3d ed., p. 444. (See under 1842.)

1867. Riley, C. V.—*Agrotis cochranis*. Prairie Farmer, XIX., 413. Described as new species. Injuries to fruit trees in Wisconsin and Illinois.

1868. Grote and Robinson.—*Agrotis repentis.* Trans. Am. Ent. Soc. I., 350, pl. 5, fig. 58, ♂. Described as a new species. Atlantic district.

1873. Lintner, J. A.—*Agrotis cochranii.* 23d Rep. N. Y. St. Cab. N. H., p. 194. Collected in N. Y. September 20th.

1875. Cook, A. J.—Idem. Rep. Mich. St. Bd. Agriculture, 1874, p. 144. Very destructive to fruit trees in eastern and western part of Michigan. Natural history. Remedies: collecting larvæ; entrapping with fresh clover; catching by use of sheet and mallet; preventing their ascent of the trees.

1875. Snow, F. H.—Idem. Trans. Kan. Acad. Sci., IV., 43. Common in Kansas.

Snow, F. H.—*Agrotis messoria.* Trans. Kan. Acad. Sci., IV., 44. Common in Kansas.

1878. French, G. H.—Idem. 7th Rep, St. Ent. Ill., pp. 92, 209. Specific characters of imago and larva. Moths, July and August. Climbing habit of larva. Found among cabbages, potato-hills, and in Indian Corn fields and in flower gardens.

1880. Bowles, G. J.—Idem. Rep. Ent. Soc. Ont., 1879, p. 42, fig. 5. General description of imago and larva. Injuries to fruit trees. Michigan, Illinois, and Canada.

1881. Marten, John.—Idem. 10th Rep. St. Ent. Ill., p. 134. Larva described.

1884. Riley, C. V.—Idem. Rep. Com. Agriculture, 1884, p. 290, pl. ii, fig. 6. Single-brooded. Larvæ hibernate. Moth, July and August. Injuries to fruit trees. Wide spread in United States.

1885. Lintner, J. A.—Idem. Cutworms, p. 7. Destructive to Indian corn.

14. Striped or Corn Cutworm.

(*Agrotis tessellata*, Harris.)

1842. Harris, T. W.—*Agrotis tessellata.* Rep. Mass. Insects. Original description.

1856. Fitch, Asa.—The Striped Cutworm. Rep. N. Y. Insects, II., 313. Original description of larva. Common in corn fields, cutting off plants half an inch above ground. Buries itself but slightly.

1862. Harris, T. W.—*Agrotis tessellata.* Insects Injurious to Vegetation, 3d ed. p. 445, fig. 221. (See under 1842.)

1863. Fitch, Asa.—*Agrotis nigricans*, var. *maizi.* Rep. N. Y. Insects, IX., 804. Specific characters of imago and larva. Existing knowledge of cutworms. Habits and natural history. Habits compared with those of yellow-headed cut-

worm. Food plants: INDIAN CORN, grass, flax, weeds, and garden plants. Moth appeared July 6. *Calosoma calidum* predaceous upon it. Fall plowing.

1869. PACKARD, A. S., JR.—*Agrotis tessellata*. Guide to the Study of Insects, p. 306, fig. 237. Brief description.

1875. COOK, A. J.—*Agrotis nigricans*. Rep. Mich. St. Bd. Agriculture, 1874, p. 111. Injurious to INDIAN CORN in Michigan.

1878. FRENCH, G. H.—*Agrotis tessellata*. 7th Rep. St. Ent. Ill., pp. 91, 206. Specific characters of larva and imago. Common in southern Illinois. Natural history and habits.

1880. BOWLES, G. J.—Idem. Rep. Ent. Soc. Ont. 1879, p. 39. General description of larva and imago. Very destructive to INDIAN CORN. Common in Canada and the United States.

1881. MARTEN, JOHN.—Idem. 10th Rep. St. Ent. Ill., p. 133. Description of larva.

1885. LINTNER, J. A.—Idem. Cutworms, p. 7. Destructive to INDIAN CORN.

15. GREASY OR BLACK CUTWORM.

(*Agrotis ypsilon*, Rott.)

1842. HARRIS, T. W.—*Agrotis telifera*. Rep. Mass. Insects. Description of imago.

1852. GUENEE, A.—*Agrotis suffusa* var. *idonea*. Hist. Nat. des Insectes, I., 269. Common in Europe, East Indies, and in greater part of America in June and September.

1862. HARRIS, T. W.—*Agrotis telifera*. Insects Injurious to Vegetation, 3d ed. p. 443. (See under 1842.)

1867. RILEY, C. V.—Idem. Prairie Farmer, XIX., 414. Original description of larva.

1869. RILEY, C. V.—Idem. 1st Rep. St. Ent. Mo., p. 80. Specific characters of larva, chrysalis, and imago. Moths, July. Larva destructive to tomato and INDIAN CORN in Missouri.

PACKARD, A. S., Jr.—*Agrotis suffusa*. Guide to the Study of Insects, p. 306, fig. 239. Description of larva. Chrysalids at roots of INDIAN CORN in Maryland.

1875. SNOW, F. H.—Idem. Trans. Kan. Acad. Sci., IV., 44. Common in Kansas.

1878. FRENCH, G. H.—*Agrotis ypsilon*. 7th Rep. St. Ent. Ill. pp. 93, 210. Specific characters of imago and larva. Abundant throughout United States. Very destructive in INDIAN CORN fields and gardens in Illinois.

1880. BOWLES, G. J.—*Agrotis telifera*. Rep. Ent. Soc. Ont. 1879, p. 40, fig. 3. General description of imago and larva. Food plants. Very common in Canada from June until October. First specimen taken at sugar, October 1.

1881. MARTEN, JOHN.—*Agrotis ypsilon.* 10th Rep. St. Ent. Ill. p. 134, fig. 46. Description of larva. Pupates in June; emerges in July. Food plants: INDIAN CORN, tobacco, tomato plants and cypress vines.

1884. RILEY, C. V.—Idem. Rep. Com. Agriculture 1884, p. 294, pl. II, fig. 2. Original description of egg. General description of imago and larva. Natural history and habits. Probably both one- and two-brooded. Pernicious cutting habit. World-wide.

1885. LINTNER, J. A.—Idem. Cutworms, p. 7. Destructive to INDIAN CORN.

16. VARIEGATED CUTWORM.

(*Agrotis saucia*, Hübn.)

1796. HUBNER, JACOB.—*Agrotis saucia.* Samml. Europ. Schmett, p. 378. (*Teste* Guenée.) Original description.

1823. FREYER, C. F.—Beitr. zur Schmett. (*Teste* Guenée.) Description of larva.

1842. HARRIS, T. W.—*Agrotis inermis.* Rep. Mass. Ins. Description of imago.

1852. GUENEE, A.—*Agrotis saucia.* Sp. Gén. Lép. V.—Noct. I., 271. Europe and America in June and September. Not rare.

1862. HARRIS, T. W.—*Agrotis inermis.* Insects injurious to vegetation. 3d. ed., p. 444. (See under 1842.)

1869. RILEY, C. V.—Idem. 1st Rep. St. Ent. Mo., p. 72. Specific characters of imago, larva, and chrysalis. Damage to grape vines. Eggs on twigs of trees. Mode of walking when young. Two-brooded. Moth hibernates. Voracious feeders.

1878. FRENCH, G. H.—*Agrotis saucia.* 7th Rep. St. Ent. Ill., pp. 94, 211. Specific characters of imago and larva. Natural history and habits. Probably two-brooded. Not so injurious to INDIAN CORN as some other species. Bores into cabbage heads. Widely distributed.

1880. BOWLES, G. J.—*Agrotis inermis.* Rep. Ent. Soc. Ont. 1879, p. 41. General description of imago and larva. Moth taken August 14. Common in Canada and in Northern and Western States.

1881. MARTEN, JOHN.—*Agrotis saucia.* 10th Rep. St. Ent. Ill., p. 134. Description of larva. Complete transformation in thirty-five days.

1884. RILEY, C. V.—Idem. Rep. Com. Agriculture, 1884, p. 297. General description of imago, larva, and egg. Eggs on apple twigs. General feeder. Damage to young grape vines and lettuce. Extracts from breeding notes. Common throughout North America and Europe.

1885. LINTNER, J. A.—Idem. Cutworms, pp. 7, 8, 9. Destructive to INDIAN CORN, cabbage, and Smilax.

17. Glassy Cutworm.

(*Hadena devastator*, Brace.)

1819. Brace, John P.—*Phalæna devastator*. Silliman's Amer. Journ. of Science I., 154. Original description. Prefers beans. Feeds on cabbage and Indian corn. Pupa state four weeks; emerges about July 13. Eggs laid in autumn and hatch in May. Chrysalids exposed to the sun, died; hence plowing in July suggested.

1842. Harris, T. W.—*Agrotis devastator*. Rep. Mass. Ins. Description of imago. Moths common July 13 to August 15. Believes the eggs hatch in autumn.

1856. Fitch, Asa.—Idem. 2d Rep. N. Y. Insects, p. 315. Description of imago.

1862. Harris, T. W.—Idem. Insects Injurious to Vegetation, p. 445. (See under 1842.)

1869. Riley, C. V.—Idem. 1st Rep. St. Ent. Mo., p. 83, fig. 30, larva. Specific characters of larva and chrysalis. Food plants: grass and cabbage.

Packard, A. S., Jr.—Idem. Guide to Study of Insects, p. 306. Mention.

1873. Lintner, J. A.—*Mamestra devastator*. 23d Rep. N. Y. St. Cab. N. H., p. 194. Collected in N. Y. August 15.

1874. Lintner, J. A.—Idem. 26th Rep. N. Y. St. Cab. N. H., p. 180. Collected July 7 to August 14.

1875. Cook, A. J.—*Agrotis devastator*. Rep. Mich. St. Bd. Agriculture, 1874, p. 111. Injurious to Indian corn in Michigan.

1878. French, G. H.—*Hadena devastatrix*. 7th Rep. St. Ent. Ill., pp. 96, 216. Specific characters of imago and larva. Food plants: Indian corn, grass, and cabbage.

1880. Bowles, G. J.—*Agrotis devastator*. Rep. Ent. Soc. Ont. 1879, p. 38, fig. 2. General description of imago and larva. Common in Canada, Northern and Western United States.

1881. Marten, John.—*Hadena devastatrix*. 10th Rep. St. Ent. Ill., p. 137. Description of larva. Found underground near cabbage plants in May.

1884. Riley, C. V.—Idem. Rep. Com. Agriculture, 1884, p. 296, pl. III, figs. 3, 4. Transformations. About half-grown May 1; pupated June 19; emerged July 7.

1885. Lintner, J. A.—Idem. Cutworms, pp. 7, 8. Destructive to Indian corn and cabbage.

18. The Yellow-headed Cutworm.

(*Hadena arctica*, Boisd.)

1859. Fitch, Asa.—*Hadena amputatrix.* 3d Rep. N. Y. Insects, p. 107. Description of imago. Severing stalks of currants, roses, etc. Common night-flying moth.

1863. Fitch, Asa.—Idem. 9th Rep. N. Y. Insects, pp. 811, 816. Very destructive to Indian corn. Habits compared with those of striped cutworm. Severs Indian corn below surface of ground. Pupates in July.

1874. Lintner, J. A.—*Hadena arctica.* 26th Rep, N. Y. St. Cab. N. H., p. 180. Imago collected in N. Y. June 27 to July 28, 1872.

1875. Cook, A. J.—*Hadena amputatrix.* Rep. Mich. St. Bd. Agriculture, 1874, p. 111. Destructive to Indian corn in Michigan.

1878. French, G. H.—*Hadena arctica.* 7th Rep. St. Ent. Ill., pp. 96, 217. Specific characters of larva and imago. Northern United States and Europe.

1880. Bowles, G. J.—Idem. Rep. Ent. Soc. Ont., 1879, p. 39. General characters of larva and imago. Moths appear July and August. Common in Canada and Northern United States.

1881, Marten, John.—Idem. 10th Rep. St. Ent. Ill., p. 137. Description of larva.

1884. Saunders, W.—Idem. Can. Ent. XVI., 205. Very destructive to Indian corn and other crops in Canada.

1885. Lintner, J. A.—Idem. Cutworms, p. 7. Destructive to Indian corn.

19. The Fall Army Worm.

(*Laphygma frugiperda*, Guen.)

1797. Smith and Abbott.—Insects of Georgia, II., p. 96. (*Testc* Guen.)

1852. Guenee, A.—*Laphygma frugiperda.* Sp. Gén. Lép. V.—Noct. I., 159. Description of imago and larva. North and South America in July. Also reported from Tasmania.

1869. Riley, C. V.—The Wheat Cutworm. 1st Rep. St. Ent. Mo., p. 89. Description of larva. Known to attack wheat for many years in Mo. Appeared only on wheat sown on oat stubble. Early plowing suggested.

1870. Riley, C. V.—*Prodenia daggyi.* Amer. Ent. II., 43, 328. P. 43, injurious to Indian corn. P. 328, Missouri and Illinois. Feeds upon wheat, oats, Indian corn, barley, grasses, purslane, and turnips.

Riley, C. V.—*Prodenia antumnalis.* Amer. Ent. II., 363, fig. 221. Specific characters of imago, larva, and pupa. Kansas. Variable. Larvæ appeared in multitudes August and September. Moths abundant September and October. Several-brooded. Feeds also on apple and peach leaves. Feeds extensively on wheat sown on oat stubble. Tachina parasite.

1872. Glover, Townend.—Idem. Rep. Com. Agriculture, 1872, p. 118. Destructive to Indian corn, grass and pea crops, in Georgia and Florida.

1878. French, G. H.—*Laphygma frugiperda.* 7th Rep. St. Ent. Ill., pp. 97, 219. General character of imago and larva. Very destructive to young Indian corn in central Illinois in 1868. Also, sometimes, to wheat, rye, and grass. Two-to four-brooded.

1881. Marten, John.—Idem. 10th Rep. St. Ent. Ill., p. 138, fig. 48. Description of larva. Appears in the fall, and feeds on both wheat and Indian corn.

1884. Forbes, S. A.—Idem. 14th Rep. State Entomologist of Illinois, pp. 55-67. Pl. v, figs. 1 and 2. General article under heads of Literature, Nomenclature, Description, Distribution, Life History, Injuries to Vegetation, Natural Enemies, and Methods of Prevention and Remedy. Describes extensive injuries to wheat in central Illinois, fall of 1884. New species of parasite, *Exorista infesta,* Williston.

20. The Bronze-colored Cutworm.

(*Nephelodes violans,* Guen.)

1852. Guenee, A.—*Nephelodes, violans.* Sp. Gén. Lép. V.—Noct. I., 130. Original description. New York and Illinois.

1873. Lintner, J. A.—Idem. 23d Rep. N. Y. St. Cab. N. H., p. 194. Imagos collected August 27, in N. Y.

1874. Lintner, J. A.—Idem. 26th Rep. N. Y. St. Cab. N. H., p. 180. Collected September 6, 1872.

1875. Snow, F. H.—Idem. Trans. Kan. Acad. Sci. IV., 45. Common in Kansas.

Norman, Geo.—Idem. Can. Ent. VII., 6. Common in Ontario. Collected September 1.

1876. Norman, Geo.—Idem. Can. Ent. VII., 69. Collected August 21. Very frequent.

1878. French, G. H.—Prairie Farmer, April 6, 1878. Original description of larva.

French, G. H.—*Nephelodes violans.* 7th Rep. St. Ent. Ill., pp. 99, 220. Specific characters of larva and imago. Habits. Pupated in June, emerged in September. Feeds on Indian corn and grass.

French, G. H.—Idem. Can. Ent. X., 61. Specific characters of larva. Transformation and food habits. Feeds mostly at night.

1880. Forbes, S. A.—Idem. Amer. Ent. III., 231. Larva from stomach of blackbird.

1880. Riley, C. V.—Idem. Amer. Ent. III., 205. Common in northern Illinois and Missouri in early spring on blue-grass sod. Full-grown larva hibernates. Widely distributed.

1881. Riley, C. V.—Idem. Amer. Nat. XV., 575. Specific characters of larva. Habits and distribution. Pupates in June and emerges in autumn.

Marten, John.—Idem. 10th Rep. St. Ent. Ill., p. 139. Specific characters of larva. Food plants and transformation.

Osborn, Herbert.—Idem. Iowa Homestead, June 17, 1881. (*Teste* Lintner.) Diseased larvæ.

1882. Lintner, J. A.—Idem. 1st Rep. Injurious and other Insects St. N. Y., p. 99. Specific characters of moth and larva. Injuries in St. Lawrence county, New York. Difficulty of rearing larvæ. Dates of collection of larvæ, April 24 to June 29. Literature and bibliography. Natural history. Food plants: grass, clover, and Polygonum. Widely distributed. United States and Canada. Parasites. Preventives and remedies: deep plowing, burning, rolling, and attracting by sweetened substances.

21. The Stalk Borer.

(*Gortyna nitela*, Guen.)

1842. Harris, T. W.—Rep. Mass. Ins. Larva described but not identified. Common in potato stalks.

1852. Guenee, A.—*Gortyna nitela*. Sp. Gén. Lép. V.—Noct. I., 124. Original description. Illinois.

1862. Harris, T. W.—Insects Injurious to Vegetation, 3d ed., p. 440, fig. 219. (See under 1842.)

1867. Walsh, B. D.—*Gortyna nitela*. Prac. Ent. II., 115. Description of pupa. Difference between habits of *Gortyna nitela* and those of *Achatodes zeæ*. Destruction of hibernating moths a check on its undue increase.

Riley, C. V.—Idem. Prairie Farmer, XIX., 116. Specific characters of imago, chrysalis, and larva. Imago and larva figured. Bores into dahlia and astor. Life history. Larvæ July; pupæ August; moths emerge September.

1868. Walsh and Riley.—Idem. Amer. Ent. I., 22, fig. 11; p. 206, fig. 140; p. 258. P. 22, abundant in parts of Missouri and Illinois. Boring through cob of growing Indian corn. Life history and food plants. Pupates in ground, latter part of July. Emerges September and is supposed to hibernate as an imago. P. 206, fig. 140, in peach twigs. P. 258, much damage to Indian corn in Connecticut.

1860. Walsh and Riley.—Idem. Amer. Ent. II., 42, 43. Often bores into stem of Indian corn plant.

Riley, C. V.—Idem. 1st Rep. St. Ent. Mo. p. 92, figs. 35. 36. Food plants: Potato, tomato, dahlia, astor, cocklebur (*Xanthium strumarium*). Natural history. Single-brooded moths probably hibernate. Prevention, careful inspection of wilting stalks.

Harris, T. W.—Entomological Correspondence, p. 135. Specific characters of larva. Found in potato and pigweed stalks.

Packard, A. S., Jr.—*Gortyna nitela*. Guide to the Study of Insects, p. 310, fig. 241. Brief description of larva and imago. Habits and life history.

1871. LeBaron, Wm.—Idem. 3d Rep. St. Ent. Ill., p. 141. Figured. Destructive to wheat in Wisconsin. Two acres of very early wheat entirely destroyed. Question of possible rate of multiplication important.

1876. Riley, C. V.—Idem. 8th Rep. St. Ent. Mo. p. 37. Shape and character of ovipositor.

1877. Prairie Farmer, July 21.—Idem. In late planted sweet corn. Remedies: lights, Paris green, and close inspection.

Packard, A. S., Jr.—Idem. 9th Rep. G. G. Surv. Terr. for 1875, p. 719, pl. 65, fig. 6. (*Teste* Lintner.) Brief notice.

1878. Smith, Emma A.—Idem. 7th Rep. St. Ent. Ill. p. 112. Description larva, pupa, and imago. Various complaints of injury to Indian corn. Life history. Does not always leave stalk to pupate. Food plants, nineteen species. Freedom from them in some gardens due probably to presence of fowls. Preyed upon by a parasite.

French, G. H.—Idem. 7th Rep. St. Ent. Ill., p. 221. Description of larva and moth. Very destructive to Indian corn in localities. Most injurious to Indian corn following oats. Preventive, clean culture.

1879. Lintner, J. A.—Idem. Country Gent. XLIV., 503. Description of moth and larva. Reported injurious to potatoes. Caterpillar active. Arches its back in walking. Food plants. Life history.

1880. Lintner, J. A.—Idem. Country Gent. XLV., 472. Reported in potato stalk. Depredations seem to be on the increase.

Lintner, J. A.—Idem. 39th Rep. N. Y. St. Agric. Soc., 1879, pp. 48, 52, fig. 1, 2. (*Teste* Lintner.)

p. 56. Identifies the species with *G. nebris*. Normally pupates in stalk.

1881. Riley, C. V.—Idem. Gen. Ind. Mo. Reports, Supplement,

1882. Lintner, J. A.—Idem. 1st Rep., Injurious and Other Insects, St. N. Y. p. 110. Description moth and larva. A pest to potatoes, Indian corn, wheat, etc., at intervals in certain localities. Larvæ failed to mature. Food plants, twenty species. Recorded depredations. Illinois, Missouri, Wisconsin, Connecticut. Habits and number species of family. Allied species. Natural history. In case of injury to potatoes, stalks may be burned.

1883. Forbes, S. A.—Idem. 12th Rep. St. Ent. Ill., p. 103, fig. 23. Found slightly injurious to oats throughout central and northern Illinois in July and August. One larva doubtless destroys many stalks. Remedy,—clean culture.

22. The Spindle Worm.

(*Achatodes zeæ*, Harr.)

1842. Harris, T. W.—*Achatodes zeæ*. Rep. Mass. Insects. Original description; imago, chrysalis, and larva. Destructive to Indian corn, boring into the young stalks. Pupates in stalk. Moth emerged in August. Feeds also in elder and dahlia. Larva should be sought for and killed.

1852. Guenee, A.—*Achatodes sandix*. Sp. Gén. Lép. V.—Noct. I., 132. Description imago. New York.

1862. Harris, T. W.—*Achatodes zeæ*. Insects Injurious to Vegetation, 3d ed., p. 438, pl. vii, fig 9. (See under 1842.)

1867. Walsh, B. D.—Idem. Pract. Ent. II., 115. Habits of larva contrasted with those of *G. nitela*. Attacks younger Indian corn.

1869. Packard, A. S., Jr.—Idem. Guide to the Study of Insects, p. 311. Description of imago and larva. Food plants.

1875. Snow, F. H.—Idem. Trans. Kan. Acad. Sci. IV., 46. Not common as yet in Kansas. Bores into the stalks of Indian corn and is very destructive in the New England States.

1878. French, G. H.—Idem. 7th Rep. St. Ent. Ill., pp. 100, 222. Specific characters of imago with description of larva. Found throughout northern Illinois.

23. The Army Worm.

(*Heliophila unipuncta*, Haw.)

1810. Haworth, A. H.—*Noctua unipuncta*. Lepidoptera Britannica iv., 177. (*Teste* Riley.) The original description of imago from one specimen found in the collection of Mr. Francillon.

1852. Guenee, A.—*Leucanea extranea*. Sp. Gén. Lép. V.—Noct. I., 77. Description of imago. Very common in North America, Brazil, Columbia, etc.

1861. Fitch, Asa.—*Leucania unipuncta*. 6th Rep. N. Y. Insects, pp. 855, 866. Specific characters of imago. Injuries to Indian corn and grass. Past history and bibliography. Habits and reasons for sudden appearance. Effects of dry and wet seasons. Remedies and preventives: reclaiming swamps, burning grass lands in fall. Parasite,—*Ichneumon leucaniæ*, n. s.

FITCH, ASA.—Idem. The Cultivator IX., 278. Received specimens from Illinois, Iowa, and Maryland. Sketch of recorded history.

FITCH, ASA.—The Army Worm Moth. Illinois Farmer VI., 243. Country Gent. and Cultivator, July, 1861. Description and identification of species.

WALSH, B. D.—*Leucania unipuncta.* Insects Injurious to the Vegetation of Illinois, pp. 17-40. Specific characters of imago and larva. Habits and life history. Breed in timothy and other grass meadows, and migrate to other fields. Almost invariably destroy INDIAN CORN. Food plants: wheat, rye, INDIAN CORN, sorghum, Hungarian grass. Supposes them to be single-brooded, for which opinion he gives several reasons. Recommends burning tame grass meadows annually in the dead of the year. Four parasites known. Irregularity due to this cause. Parasites: *Exorista leucaniæ* (*Senometopia militaris*), *Mesochorus vitreus, Microgaster militaris, Chalcis albifrons.* Original descriptions of last three.
Also in Trans. Ill. St. Bd. Agr. IV., 349-372; and Prairie Farmer, July, 1861.

THOMAS, CYRUS.—Idem. Prairie Farmer, October, 1861. Controversial article upon the stage in which the insect hibernates. Believes they do not hibernate in egg state, and that they are not double-brooded.

THOMAS, CYRUS.—Further from the Army Worm. Prairie Farmer, 1861. Cited instances of benefit by burning stubble. First appearance in Jackson county, April 29; final disappearance about June 10. Dates of transformation.

WALSH, B. D.—The Army Worm. Prairie Farmer, December, 1861. Reply to Cyrus Thomas on the subject of hibernation, with breeding notes from Dr. Bartlett, Champaign county, Illinois.

THOMAS, CYRUS.—The Army Worm. Prairie Farmer, 1861. Description of larva. Dates of appearance and transformation. Speculations on its life history. Remedies. Arguments in favor of pupal hibernation.

THOMAS, CYRUS.—Idem. Illinois Farmer, 1861, pp. 269-273. Describes larva, pupa, and imago. Extended account of life history. Recommends plowing grass under when worms are small.

1862. FLINT, C. C.—*Leucania unipuncta.* Harris's Insects Injurious to Vegetation, 3d ed., appendix, pp. 627-630. Description of imago, larva, and pupa. Best method of arresting their ravages; that commonly practiced is plowing a double furrow around the field. Worms thus trapped may be destroyed by fire or hogs. Rolling recommended, also hogs, sheep, and fowls.

1865. WALSH, B. D.—The Army Worm. Trans. Ill. St. Agr. Soc. V., 1861-64, pp. 470-483. Figures army worm in its three states, and its primary and secondary parasite: *Senometopia militaris, Pezomachus minimus, Chalcis albifrons, Mesochorus vitreus,*

Microgaster militaris, Glyphe viridescens. Arguments in favor of egg hibernation.

GLOVER, TOWNEND.—Army Worm. Rep. Com. Agriculture, 1864, p. 552. Rate of movement. Remedies proposed.

EMERY, H. D.—*Leucania unipuncta.* Prairie Farmer, XVI., 3. Appeared in great numbers in Missouri. Examples of benefit derived from burning meadows.

1867. WALSH, B. D.—Idem. Prac. Ent. II., p. 112. Only one-brooded. Moths usually emerge same year, although some do not transform till following year.

1869. WALSH AND RILEY.—Idem. Amer. Ent. I., 214. Numerous in parts of Illinois and Missouri. Habits and natural history. Single-brooded. Burning, fall plowing, and ditching suggested. Parasites numerous. May sometimes be beneficial by devouring chess or by stripping off blades affected with rust.

PACKARD, A. S., Jr.—Idem. Guide to the Study of Insects, p. 305, pl. VIII, fig. 2. Brief description and habits.

1870. RILEY, C. V.—Idem. 2d Rep. St. Ent. Mo., pp. 37, 56, figs. 14, 15, 16. Specific characters of larva and imago. Compared with *Clisiocampa sylvatica*, Harr; *Anomis xylina*, Say; *Laphygma frugiperda*, Guen. Past history. Appearance and disappearance due to climatic influences and attack of eight parasites. Natural history. Supposed to be mostly single-brooded, and to hibernate mostly in chrysalis state. Parasites described: *Exorista leucaniæ*, Kirk; *Exorista flavicauda*, Riley; *Mesochorus vitreus*, Walsh; *Pezomachus minimus*, Walsh; *Microgaster militaris*, Walsh; *Ophion purgatus*, Say. Also mentions *Chalcis albifrons*, Walsh, *Ichneumon lucaniæ*, Fitch, and two undescribed species. Remedies and preventives suggested.

1871. GLOVER, TOWNEND.—Army worm. Rep. Com. Agr. 1870, p. 83. Brief life history. Generally one-brooded. Northern States.

1875. SNOW, F. H.—*Leucania unipuncta.* Trans. Kan. Acad. Sci. IV., 47. Abundant, especially in wet seasons following very dry ones. Probably the most destructive species among all Lepidoptera, often attacking and destroying entire fields of INDIAN CORN, wheat, oats, grass, and other staple crops.

187 . RILEY, C. V.—Idem. 8th Rep. St. Ent. Mo. pp. 22–56 and 182–185. The term "army worm" applied to various insects. Past history of the army worm. Known in Missouri since 1854. Unusual abundance in vicinity of Peshtigo, Wisconsin, in 1872,—the season following the memorable fires of 1871. History in 1875—very general all over the country. Sexual differences—several organs figured. Natural history of species; occurs in Europe, Asia, New Zealand, and Australia. Original account of oviposition, with description of egg. Hibernates as imago and pupa; perhaps also as larva and egg. Habits of worm. Why it escapes destruction

when young. Why it travels in armies. Appears in April and May. Only one annual brood. Plants preferred. Climatic influences; natural enemies, and remedies. Summary of leading facts.

Cook, A. J.—Idem. Rep. Mich. Bd. Agriculture 1875, pp. 278–282. An account of appearance in southern portion of State, with natural history, dates of capture, disposition of eggs, and effect of parasites.

1877. Riley, C. V.—Idem. 8th Rep. St. Ent. Mo., pp. 47–50. Further notes and experiments. Eggs are thrust in between the sheath and stalk of well-grown grasses whether cut or standing; also in other places. Laid in single row of from five to twenty. Proves them to be double-brooded in latitude of St. Louis. Summary of natural history.

Thomas, Cyrus.—Idem. 6th Rep. St. Ent. Ill., p. 56. Considerable damage done in 1875, especially to young Indian corn. Acts in two roles: first as a true cutworm; and second as a social and migratory race. Climatic conditions chief cause of disposition to migrate. Larvæ destroyed by chickens, birds, and heat. Best preventive, burning meadows in spring.

1878. French, G. H.—Idem. 7th Rep. St. Ent. Ill., pp. 101, 224. Specific characters of imago. Indian corn subject to attack by migratory broods, and by those acting as cutworms. Preventives: ditching, and burning meadows. Two- or three-brooded. Fresh specimens captured in April.

1879. Lintner, J. A.—Idem. Country Gentlemen XLIV., 422. Reply to inquiry from Maryland. Brief description and natural history. Destruction by parasites. Two-brooded in Southern States; single-brooded in Northern States.

Smith, Emily A.—*Heliophila unipuncta*. Prairie Farmer, Aug. 16, 1879. Paper read before a meeting of the Wisconsin Horticultural Society, at Green Bay. A *resumé* of known habits, natural history, natural enemies and remedies.

1880.—Riley, C. V.—*Leucania unipuncta*. Amer. Ent. III., 170, 134, 214. P. 170, marked irruption in many parts of Maryland, Delaware, and New York. Characters of moth, larva, and pupa. Natural history and remedies. P. 184, appearance in the Atlantic States has added new facts. Number of annual generations. How insect hibernates in larval state. The destructive brood probably not the first of the season. P. 214, burning is a preventive, destroying appropriate nidus for the laying of the eggs by the moth in spring. Connection of wet and dry seasons with rate of increase.

Comstock, J. Henry.—*Heliophila unipuncta*. Rep. Com. Agriculture 1879, p. 187, pl. 1, figs. 1 and 3. Known in this country since 1743, and found in almost every part of the world. Natural history studied since 1831. Description of egg, larva, pupa, and imago. Two- to many-brooded. Arguments in favor of hibernation as egg, larva, pupa

and moth. Probably hibernates in all except the egg state. Swamp land and wet-and-dry-season theory discussed. Best methods of destroying actual depredators are rolling, or poisoning with arsenic, etc. Ditching and pitting recommended. Twelve species of insect enemies enumerated.

SCIENTIFIC AMERICAN, June 26.—The Army Worm. An account of its occurrence in Long Island. INDIAN CORN was eaten off close to the ground. Also a compiled account of habits, life history, descriptions, and remedies.

RURAL NEW YORKER, June 12, 1880.—Idem. Its appearance in Long Island in vast numbers. Wheat, rye, and INDIAN CORN fields destroyed. The entire crops of the Island threatened.

COMSTOCK, J. HENRY.—Idem. Farmers' Review, July 8, 1880. Discusses the theory that the natural habitat of the army worm is in the wild grass of wet spots, in swamps, and on the borders of marshes, and expresses doubts of the correctness of the theory. Remedial agencies: rolling, poisoning with arsenic, and trapping by ditches and pits.

THOMAS, CYRUS.—Idem. 10th Rep. St. Ent. Ill., pp. 5, 44, figs. 1, 2 and 3. Its past history. Natural history, and description of egg, larva, pupa, and moth. Terms of life; dates of capture of the moth; notices of the larva; number of broods; and hibernation. Proper home of the species and character of seasons favorable to its development. Natural enemies: ten parasites described and ten predaceous beetles mentioned. Remedies: ditching, burning meadows, poisons.

1881. THOMAS, CYRUS.—Idem. Can. Ent. XIII., 191. Stated at a meeting of the A. A. A. S. that the army worm existed as a caterpillar, chrysalis, and moth seventy-seven days; from which B. P. Mann and C. V. Riley dissented.

FORBES, S. A.—Idem. Bloomington Pantagraph, July 28, 1881. Account of ravages in McLean and adjacent counties. Natural history, injuries, and remedies.

THOMAS, CYRUS.—Idem. Prairie Farmer, August 6, 1881. Beheading oats in Hancock county. Brief sketch of habits, natural history, descriptions, and remedies. Instances of early variety of oats escaping injury.

THOMAS, CYRUS.—Idem. Rural New Yorker, Jan. 29, 1881. Number of annual generations. Cited proofs of second brood. Proper home of the species and character of the seasons favorable to its development discussed with reference to the views of Riley and Comstock.

COOK, A. J.—*Leucania unipuncta*. Can. Ent. XIII., 215. In 1881, observed, for the first time, injuring INDIAN CORN in Michigan. This was a dry season following a wet one.

SAUNDERS, WM.—Idem. Can. Ent. XIII., 198, 215. Much damage in Canada. Double-brooded; probably hibernate in larval state; destructive brood not being the first one.

1882. Riley, C. V.—Idem. Rep. Com. Agriculture, 1881, pp. 89–106, pl. II and pl. VI, figs. 1–3. Chiefly from 3d Rep. U. S. Ent. Com., p. 89–156.

Coquillet, D. W.—Idem. 11th Rep. St. Ent. Ill., pp. 49–64. Description of larva. Habits and life history. Dates moths emerge. Seasons most favorable to its rapid increase. Migratory habit. Finds two distinct races of army worm. Sedentary race rears three broods in one season, and hibernates in larval state. Migratory worms are the progeny of moths which were bred in some remote locality and migrated to the locality in which the worms appeared. Natural enemies: *Exorista leucaniæ*, Kirk, *Microgaster militaris*, Walsh; doubtless also larvæ of *Galerita janus*, Fab., and occasionally the common striped gopher.

1883. Riley, C. V.—Idem. 3d Rep. U. S. Ent. Com., pp. 89–156. Gives names of insects with which it is sometimes confounded; history of its synonymy; geographical distribution; capacit injury; past history; specific characters of the egg, larva, pupa, and imago; sexual differences; habits and natural history; time and place of laying eggs; mode of oviposition; fertility; duration of egg state; habits when young; duration of larval life; traveling habits; time of appearance; sudden appearance and disappearance. Food plants; duration of the pupa state; habits of the moth; flight; position when at rest. Number of annual generations normally three, and possibly or exceptionally four, for all points between the Ohio River and the Great Lakes and north to central New York. In the latitude of Washington there are at least five annual generations, and possibly a sixth. Hibernation. Natural enemies: some twenty-five species enumerated. Remedies proposed: burning old grass, ditching coal tar, poisoning, rolling, fencing, and roping. Accounts from correspondents. Extended bibliography.

Forbes, S. A.—Idem. 12th Rep. St. Ent. Ill., p. 102, fig. 22. Dates of appearance. Evidence of three distinct broods in central and southern Illinois. Abundance and disappearance due to parasites. Of seventy-six pupæ, but one reached maturity.

24. The Corn Worm.

(*Heliothis armiger*, Hübn.)

1793. Hubner, Jacob.—Eur. Schmett, p. 370 (*Teste* Guenée.) Original description.

1842. Freyer, C. F.—Beitr. zur Schmett, III., pl. 203. First figure of larva.

1844. Duponchel, P. A. J.—Hist. Nat. Lép. France, IV., 316, pl. 119, figs. 5, 6. Description of larva.

1852. GUENEE, A.—*Heliothis armigera*. Gén. Lép. VI.—Noct. II., 181. Southern Europe, North and South America, East Indies, and probably in other parts of the globe, in July and August. Common.

1855. GLOVER, TOWNEND.—Corn Worm. Rep. Com. Patents, 1854, pp. 62–71. [Not seen.]

1856. GLOVER, TOWNEND.—The Boll Worm (*Heliothis ?*). Rep. Com. Patents 1855, pp. 98–103. Pl. IX, fig. 4. Treats it as a fall army worm, and states that it will probably prove identical with corn worm treated in preceding report. Gives description of egg and moth; life history, habits, injuries, and remedies.

1862. GROTE, A. R.—*Heliothis umbrosus*. Proc. Ent. Soc. Phila. I., 219. Description of moth. Stated to be specifically distinct from *H. armigera*.

1865. GLOVER, TOWNEND.—Corn worm. Rep. Com. Agriculture, 1864, p. 554. States that he has bred worms from both INDIAN CORN and cotton-balls, and the moths produced were identical.

1866. GLOVER, TOWNEND.—*Heliothis amigera*. Rep. Com. Agriculture 1865, p. 43. An instance reported from South Carolina where crows that were supposed to be injuring corn proved to be feeding upon this worm.

1869. WALSH AND RILEY.—Idem. Amer. Ent. I., 212, 214, figs. 150, 151. Very destructive to INDIAN CORN in southern Illinois, sometimes destroying whole fields. First eats off the silk, and then, sheltered by the husk, feeds upon the soft kernels. Is two-brooded and consequently most destructive to very late corn. Life history, habits, and description of the insect in its various stages. Hand-picking suggested.

WALSH AND RILEY.—Idem. Amer. Ent. II., 42–44, fig. 29. Quote Mrs. Treat's statement that the larvæ feeding upon tassels of INDIAN CORN and upon green peas differ in color from those feeding upon soft ears of corn, and state that this is not without parallel among two-brooded insects. Mention injuries in southern Illinois, Kentucky, and Kansas. Suggest topping corn to destroy first brood.

TREAT, MARY.—Idem. Vineland [N. J.] Weekly, Aug. 21, 1869. Feeds upon the undeveloped tassels of INDIAN CORN.

1870. RILEY, C. V.—Idem. Amer. Ent. II., 329. Often found in company with fall army worm (*Laphygma frugiperda*, Guen.) on ears of late INDIAN CORN. Characters which distinguish it from fall army worm.

1871. RILEY, C. V.—Idem. 3d Rep. St. Ent. Mo. pp. 104–109, figs. 42, 43. States that former belief that corn worms were unable to feed on fully ripened corn is incorrect. Other points chiefly compiled from Amer. Ent. I., 212 and II., 42.

GLOVER, TOWNEND.—Idem. Rep. Com. Agriculture, 1870, p. 84. Very injurious not only to cotton and INDIAN CORN, but to green peas, pumpkins, and tomatoes.

1872. Riley, C. V.—Idem. 4th Rep. St. Ent. Mo., p. 129. *Tachina anonyma* bred from this species and from several others.

Glover, Townend.—Idem. Rep. Com. Agriculture, 1871, p. 84. Reported injurious from Florida, Georgia, Louisiana, and Arkansas.

1878. Lintner, J. A.—Idem. Entomological Contributions, IV., 52, 53. Occurence and habits in Patagonia.

French, G. H.—Idem. 7th Rep. St. Ent. Ill. pp. 102–106, 231–233. Damaged ears of growing Indian corn in southern Illinois. The author confirms Prof. Riley's statements of injury. Proposes early planting, topping corn, and fall plowing as remedies. Gives specific characters of larva, chrysalis, and moth.

1879. Comstock, J. Henry.—Idem. Rep. on Cotton Insects, pp. 287–315. The most complete article that has been written on this insect, giving extent of injuries; nomenclature; georaphical distribution; food plants; description of egg, larva, chrysalis, and moth; number of broods; influence of weather; parasites, and artificial remedies.

1880. Claypole, E. W.—Idem. Amer. Ent. III., 278. An account of this worm's feeding upon ripened kernels of Indian corn in Ohio.

1881. Coquillet, D. W.—Idem. 10th Rep. St. Ent. Ill., p. 150. Figures and larval description. Feeds on Indian corn, living within the husks August to November.

1882. Moffat, J. Allston.—Idem. Rep. Ent. Soc. Ont., 1881, p. 30. Occurrence in Ontario. Habits and distribution.

Johnson, Lawrence.—Idem. Rep. Com. Agriculture, 1881, pp. 150–152. 97 per cent. Indian corn affected in roasting-ear stage in Mississippi. Solitary habits; dates of occurrence; identity with boll worm; artificial remedies and natural enemies.

Lintner, J. A.—Idem. 1st Rep. Ins. N. Y., pp. 116, 126, figs. 27, 28. First appearance as an injurious insect in New York. Description of caterpillar and moth. Carnivorous. Habits of caterpillar. Food plants. Distribution. Operation as a corn worm; method of attacking corn. Occurrence in New York. Remedies. Benefits from destroying first brood.

French, G. H.—Idem. 11th Rep. St. Ent. Ill., pp. 82–104. Treated as a boll worm, as a corn worm, and as a tomato worm. Minute descriptions of egg, larva, chrysalis, and moth. Parasites. Climatic influence. Remedies: early planting, topping Indian corn, tall varieties of corn, fall planting, poisoning, hand-picking, rotation of crops, and destroying the moth.

Riley, C. V.—Idem. Rep. Com. Agriculture, 1881, pp. 145–149, pl. I, and pl. XII, fig. 1. States this insect to be one of the most wide-spread and injurious of the farmers' pests, doing extensive injury to Indian corn in the more northern States in 1881. Treats it with reference to its food plants other than cotton.

Family Pyralidæ.

25. Meal Snout Moth.

(*Asopia farinalis*, Linn.)

1767. Linne, Carl von.—*Pyralis farinalis.* Systema Naturæ, Tome I, Part II, ed. 12, p. 881. Original description.

1791. Brahm, N. J.—Insekten-kalendar fur Sammler & Œkonomen Mainz, p. 521 (*Teste* Guenée.) Mention of larva.

1842. Harris, T. W.—*Pyralis farinalis.* Rep. Mass. Ins. Briefly describes moth. States that the larvæ are found in old flour barrels.

1852. Guenee, A.—Idem. Sp. Gén. Lép. VIII.—Deltoides et Pyralites, p. 119. Description of moth. Bibliography. Very common in Europe in June, July, and August. Also inhabits North America and other countries.

1862. Harris, T. W.—Idem. Insects Injurious to Vegetation, 3d ed., p. 475, pl. VII, fig. 8. (See under 1842.)

1869. Packard, A. S., Jr.—Idem. Guide to Study of Insects, p. 328. Brief description and food plants.

1873. Lintner, J. A.—Idem. 23d Rep. N. Y. St. Cab. N. H., p. 197. Moth collected July 12.

1874. Lintner, J. A.—*Asopia farinalis.* 26th Rep. N. Y. St. Cab. N. H., p. 184. Moths collected July 7 and 28.

1875. Snow, F. H.—*Pyralis farinalis.* Trans. Kan. Acad. Sci. IV., 56. Common in Kansas. Found in old flour boxes and in barns.

1878. French, G. H.—Idem.—7th Rep. St. Ent. Ill., p. 247. Briefly describes moth and larva. Feeds on Indian corn, straw, and clover.

26. The Smaller Corn Stalk Borer.

(*Pempelia lignosella*, Zeller.)

1848. Zeller, P. C.—*Pempelia lignosella.* Isis, 1848, p. 883. Original description.

1882. Riley, C. V.—Idem. Rep. Com. Agr. 1881, p. 142. Pl. VII, fig. 3. A new Indian corn pest, very destructive in North and South Carolina and Georgia. Habits. Natural History. Preventives. Description of moth; original description of larva and pupa.

27. The Root Web Worm.

(*Crambus zeëllus*, Fernald.)

1885. Fernald, C. H.—*Crambus zeëllus*. Can. Ent. XVII., 55. Original description Habitat: Maine, Pennsylvania, West Virginia, Illinois, Missouri. Bred from Indian corn by Prof. S. A. Forbes.

Forbes, S. A.—The Root Web Worm. Illinois Crop Rep., May, 1885, p. 38. This is a new insect pest seriously injuring young corn in May and June. Larva and moth described. Manner of affecting plant. Dates and places of taking worms. Larva figured.

Forbes, S. A.—Further notes on the Root Web Worm. Statistical Rep. Ill. St. Bd. Agriculture, June, 1885, p. 48, figs. 1, 2, 3. Injurious to corn in Champaign county. Expresses doubt as to eggs being laid in spring. Describes nest and character of injury, recommends collecting by hand and advises leaving old hills of Indian corn undisturbed when replanting.

Farmers' Review, June 11, 1885.—The Corn Root Worm. Extract from article by Prof. Forbes in Ill. Crop Rep. for May, 1885.

Prairie Farmer, July 11, 1885.—*Crambus zeëllus*. Figure of imago, larva, silken tube, and affected Indian corn. Natural history and remedies. Compiled from article by Prof. Forbes in Ill. Crop. Rep., May, 1885.

Forbes, S. A.—*Crambus zeëllus*. 14th Rep. St. Ent. Ill., p. 12, pl. I, figs. 1–3. Reported injuries. Original description of larva and pupa. Description of imago. Distribution; life history; natural enemies; and artificial remedies.

29. The Corn Stalk Borer.

(*Diatræa saccharalis*, Fab.)

1793. Fabricius, J. C.—*Phalæna saccharalis*. Ent. Syst. III., ii, p. 238. Original description.

1881. Comstock, J. Henry.—*Diatræa saccharalis*. Rep. Com. Agr. 1880, pp. 240, 243. P. 240, treated as a sugar cane insect. Gives history, habits, life history, amount of damage, and remedies. P. 243, first published account of its injuries to Indian corn. Description of egg, larva, pupa, and moth. Three or more generations; hibernates as larva; injuries five to twenty-five per cent. Remedy, feeding and burning stalks before February. Identity of the insect is not positive.

Family Tortricidæ.

29. The Red-banded Leaf Roller.

(*Lophoderua triferanua*, Walk.)

1863. Walker, Francis.—*Cacœcia triferanus*. Cat. Lep. Het. XXVIII., 314. Original description.

1865. Clemens, B.—*Tortrix incertana* ♀. Proc. Ent. Soc. Phila. V., 138. Description of imago.

1868-69. Robinson, C. T.—Idem. Trans. Am. Ent. Soc. II., 278, pl. vi, fig. 57 ♂, 58 ♀. Description of imago. Habitat. Massachusetts, New York, Pennsylvania, Ohio.

1870. Packard, A. S., Jr.—Idem. Mass. Agr. Rep., p. 240. Injurious to cranberry.

1876. Packard, A. S., Jr.—Idem. Hayden's Surv. X., 523. Larva called cranberry worm. Description of imago and pupa.

1879. Walsingham, Lord.—*Lophoderus triferanus*. Illustr. Lep. Het. in Brit. Mus., Part IV., 15, Pl. lxii, fig. 9. Description of imago; synonymy; habitat.

1880. Murtfeldt, Mary E.—*Tortrix incertana*. Amer. Ent. III, 14. Mentioned as a rose insect.

Lintner, J. A.—Idem. The Insects of the Clover Plants, p. 5. Mentioned as a clover insect.

1882-83. Fernald, C. H.—*Lophoderus triferanua*. Trans. Am. Ent. Soc. X., 15. Synonymical catalogue.

1885. Forbes, S. A.—Idem. 14th Rep. St. Ent. Ill., p. 20. Bred from pale green leaf rollers in Indian corn. Heretofore known to be seriously injurious only to the cranberry. History; habits; description of imago; distribution; food plants. Collected May 29; emerged June 30.

30. The Sulphur Leaf Roller.

(*Dichelia sulphureana*, Clemens.)

1861. Clemens, B.—*Cræcia ? sulphureana*. Proc. Phila. Acad. Sci., 1860, p. 253. Original description.

1868-69. Robinson, C. T.—*Tortrix sulphureana*. Trans. Am. Ent. Soc. II., 273. Description; synonymy; and habitat.

1881. Comstock, J. Henry.—Idem. Rep. Com. Agriculture, 1880, p. 255. Injuries to clover. Original description of larva and pupa. Distribution; food plants; natural enemies.

1882. Packard, A. S., Jr.—*Dichelia sulphureana*. Papilio II., 182. Larva redescribed. Occurrence in Maine. Food plants; dates of transformations.

Fernald, C. H.—Idem. Trans. Am. Ent. Soc., X., 21. Synonymical list. Habitat; food plants.

1885. FORBES, S. A.—Idem. 14th Rep. St. Ent. Ill., p. 17, pl. I, fig. 4. Affects to some extent the INDIAN CORN crop. Description of imago, larva, and pupa. Life history; injuries to vegetation; natural enemies; literature.

Family TINEIDÆ.

ANGOUMIS GRAIN MOTH.

(*Sitotroga cerealella*, Oliv.)

1789. OLIVIER, A. G.—*Alucita cerealella*. Encyc. Method. Hist. Nat. Ins. IV., 121. Original description.

1846. OWEN, RICHARD.—Remarks on the Grain Moth. Flying Weevil. The Cultivator, New Series, III, 208, 344. P. 208, specific characters of egg, larva, pupa, and moth. Food plants; distribution; life history; nature of injury done. Remedies: scalding; kiln drying; salt; sprinkling with lime; friction. Parasite. P, 344, Flying Weevil. Additional notes. Fanning the grain.

1847. FITCH, ASA.—*Anacampsis ? cerealella*. The Cultivator N. S. IV., 13. Generic discussion. Specific marks pertaining to the moth.

1852. HARRIS, T. W.—*Anacampsis* (*Butalis*) *cerealella*. Ins. Inj. Veg. 2d ed., p. 392. Gives synonymy; injuries in Europe and America; description of imago; life history; habits. Two principal broods in a year. Moths raised from INDIAN CORN contrasted with those from wheat. Remedies: heating, fumigating, fanning.

1860. CLEMENS, B.—*Gelechia cerealella*. Proc. Phila. Acad. Nat. Sci., p. 162. Description of imago. Believes it to be introduced from Europe. Received samples in seed wheat from Patent Office at Washington.

1861. FITCH, ASA.—*Butalis cerealella*. 6th Rep. N. Y. Insects, pl. I, fig. 2.

1862. FITCH, ASA.—Idem. 7th Rep. N. Y. Insects, p. 813. In the bins of granaries and store-houses in particular kernels of the grain, a smooth, white worm which consumes all the flour, coming abroad in May and again in November. A tawny, dull yellowish gray moth, having its fore wings commonly sprinkled with a few black dots, its width half an inch across its spread wings. Introduction from Europe. Habits; two-brooded. Description of larva and moth. Parasite mentioned. Remedial agencies.

HARRIS, T. W.—*Anacampsis* (*Butalis*) *cerealella*. Ins. Inj. Veg. 3d ed., pp. 499-510. (See under 1852.)

1865. GLOVER, TOWNEND.—Angoumis Grain Moth. Rep. Com. Agr. 1864, p. 556. Injuries and remedies. Says a moderate application of heat for a considerable time is more efficacious in destroying this insect than intense heat for a short time.

1869. Packard, A. S., Jr.—*Gelechia cerealella.* Guide to the Study of Insects, p. 350, figs. 265, 266, imago and larva. Remarkable habit of the larva.

1872. Bethune, C. J. S.—*Butalis cerealella.* Rep. Ent. Soc. Ont., 1871, p. 61. Brief account of injuries and remedies.

1878. Chambers, V. T.—*Gelechia cerealella.* (Index to Tineina, U. S. Geol. Surv. IV., 142.) Synonymy and bibliography.

French, G. H.—Idem. 7th Rep. St. Ent. Ill., p. 266. One of the most destructive insects known to wheat, barley, oats, and Indian corn. Brief description of larva and moth. Remedies.

1882. Saunders, Wm.—*Butalis cerealella.* Rep. Ent. Soc. Ont., 1881, p. 5. President's Annual Address. Injuries. Southwestern States. Brief description.

1883. Webster, F. M.—*Gelechia cerealella.* 12th Rep. St. Ent. Ill., p. 144. Extent of injuries. History. Description of moth, larva, and pupa. Habits; life history. Natural checks. Hymenopterous parasite (*Pteromalus gelechiæ* n. s.) described. Heating as remedy. Mite parasite described (*Heteropus ventricosus*, Newp.) with notes on life history.

1884. Riley, C. V.—Idem. Rep. Com. Agriculture, 1884, p. 345, pl. vi, figs. 2, 3. Past history and distribution. Natural history. Method and results of its work. Two annual generations in more northern States; perhaps five in Southern States. Parasites. Preventives: cribbing corn with husks on, and storing it shelled. Description of egg.

1885. Lintner, J. A.—*Sitotroga cerealella.* 2d Rep. N. Y. St. Ent. pp. 102–110. Bibliography. Injuries; history. Description of moth. Food plants; life history; distribution; remedies; natural enemies.

32. The Grain Moth.

(*Tinea granella*, Linn.)

1847. Fitch, Asa.—*Tinea granella.* The Cultivator N. S. IV., 13. Description of moth and larva. Two-brooded; life history; remedies. Difference in habits of American and European species. Feeds on outside of kernels of Indian corn which it attaches by means of a web.

1860. Clemens, B.—*Tinea variatella.* Proc. Phila. Acad. Nat. Sci. 1859, pp. 257, 259. Description of imago. On wing in September.

1862. Harris, T. W.—*Tinea granella.* Ins. Inj. Veg. 3d ed., pp. 496–499, pl. vii, figs. 6 and 7. Description of moth and larva. Habits. States that he has seen oats and shelled Indian corn injured by this insect.

1865. Glover, Townend.—Grain moth. Rep. Com. Agriculture, 1864, p. 556. Habits and remedies. Salt recommended.

1869. PACKARD, A. S., Jr.—*Tinea granella.* Guide to the Study of Insects, p. 347, fig. 264. Habits, preventives, and remedies.

1875. CHAMBERS, V. T.—Idem. Can. Ent. VII., 125. Remarks on synonymy.

1878. CHAMBERS, V. T.—*Tinea variatella* and *Tinea granella.* (Index to Tineina, U. S. Geol. Surv. IV., 164.) Synonymy and bibliography.

FRENCH, G. H.—*Tinea granella.* 7th Rep. St. Ent. Ill., p. 265. Feeds on stored grain. Brief description of imago. Remedies.

1880. RILLIET, CHARLES.—Idem. Rural New Yorker, May 1, 1880. Reports it in wheat in northern Illinois.

33. THE INDIAN MEAL MOTH.

(*Ephestia zeæ*, Fitch.)

1856. FITCH, ASA.—*Tinea zeæ.* 2d Rep. N. Y. Insects, p. 320 pl. IV, fig. 1. Original description: larva, pupa, imago. Habits. "In stale INDIAN MEAL and emptying cake made thereof; a soft white worm half an inch long, with a brownish yellow head and polished yellowish white spot above on the neck and on the last segment."

1880. RILEY, C. V.—*Ephestia zeæ.* Amer. Ent. III., 229. Reported from Massachusetts. Habits; description of larva.

ORDER DIPTERA.

Family MYCETOPHILIDÆ.

34. THE BLACK-HEADED GRASS MAGGOT.

(*Sciara*, sp. ?)

1884. FORBES, S. A.—The Black-headed Grass Maggot (Sciara sp. ?). 13th Rep. St. Ent. Ill., pp. 57–59, pl. IV, figs. 5–9. Injuries to sprouting INDIAN CORN. Specimens received from various parts of northern Illinois. Classification, and description of imago.

Family ANTHOMYIDÆ.

35. THE SEED-CORN MAGGOT.

(*Anthomyia zeæ*, Riley.)

1869. RILEY, C. V.—*Anthomyia zeæ.* 1st Rep. St. Ent. Mo., pp. 154–156, figs. 86, 87. Original description. Reported from New Jersey as injurious to sprouting INDIAN CORN. Suggests soaking seed corn in gas-tar or copperas.

Walsh & Riley.—Idem. Amer. Ent. I., 224, figs. 158, 159. Injuring seed corn planted on new ground in Missouri.

1878. Thomas, Cyrus.—Idem. Prairie Farmer, July 28, 1878. Reported injuring Indian corn in Boone county, Illinois.

1881. Riley, C. V.—Idem. Gen. Ind. and Supp. Rep. Ins. Mo., p. 89. Description of imago.

1882. Lintner, J. A.—Idem. 1st Rep. Ins. N. Y., pp. 199–201, figs. 55, 56. Description of larva and imago. Preventives.

Family Geomyzidæ.

36. The Corn Leaf Miner.

(*Diastata ?*)

1881. Comstock, J. Henry.—Diastata ? n. sp. Rep. Com. Agr. 1880, pp. 245, 246. Mining the leaves of garden corn, making a linear mine five or six inches in length, a small, footless, greenish white maggot, which transforms under ground and eventually becomes a small, active black fly. Original description by L. O. Howard.

Order COLEOPTERA.

Family Carabidæ.

37. Omophron labiatum, Fab.

1801. Fabricius, J. C.—*Scolytus labiatus.* Syst. Eleut. I., 248. Original description.

1823. Say, Thomas.—*Omophron labiatum.* Trans. Am. Phil. Soc., New Series, II., 80. Complete writings, p. 495. Description of imago.

1869 Glover, Townend.—Idem. Rep. Com. Agr. 1868, p. 79. Mentioned as very destructive to young Indian corn in Southern States.

1874. LeBaron, Wm.—Idem. 5th Rep. St. Ent. Ill., p. 42. Common at the South. Larvæ feed upon grains of growing Indian corn.

Family Coccinellidæ.

38. The Common Lady Bug.

(*Megilla maculata,* De G.)

1775. De Geer, Carl.—*Megilla maculata.* Mém. Ins. V., 392, 1, t. 16, fig. 22. (*Teste* Crotch.) Orignal description.

1873. Crotch, G. R.—Idem. Trans. Am. Ent. Soc. IV., 364. (Revision of the Coccinellidæ of the U. S.) Description of imago. Habitat, U. S., Central and South America.

1880. Forbes, S. A.—Idem. Bul. Ill. St. Lab. Nat. Hist. No. 3, 159. Specimens examined found to contain chiefly pollen grains and fungus spores.

1881. Riley, C. V.—Idem. Amer. Nat. XV., 326. Reported from Maryland as injurious to Indian corn, eating holes in the blades.

1883. Riley, C. V.—Idem. Amer. Nat. XVII., 323. Food habits—larva and imago eating soft kernels of Indian corn.

Lintner, J. A.—Idem. Country Gent. XLVIII., 941. Reported from Connecticut as injuring Indian corn in the ear. Nature of injury described.

1885. Forbes, S. A.—Idem. 14th Rep. St. Ent. Ill., p. 21. Found eating the exposed kernels of Indian corn at the tips of ears.

Family Cucujidæ.

39. Silvanus surinamensis, Linn.

1767. Linne, Carl von.—*Dermestes surinamensis.* Systema Naturæ, II., 565. Original description. Habitat. Surinam.

1885. Le Conte, J. L.—*Silvanus surinamensis.* Proc. Acad. Nat. Sci. 1854, p. 77. (Synopsis of the Cucuiides of the U. S.) Synonymy and bibliography. Diffused over the whole globe in articles of commerce.

1869. Packard, A, S., Jr.—Idem. Guide to the Study of Insects, p. 446. Brief description of imago and larva. Breeds in bran, rice, and wheat.

Glover, Townend.—Idem. Rep. Com. Agr., 1868, p. 84, fig. 39. Found in wheat and Indian corn.

1871. Glover, Townend.—Idem. Rep. Com. Agr., 1870, p. 66. Food plants: wheat, oats, Indian corn, rye, etc.

1882. Lintner, J. A.—Idem. 1st Rep. N. Y. Ins., p. 40. Pyrethrum as a remedy.

40. Silvanus cassiæ, Reich.

1855. Le Conte, J. L.—*Silvanus quadricollis.* Proc. Acad. Nat. Sci. Phila., 1854, p. 78. (Synopsis of the Cucuiides of the United States.) Description of imago. Habitat, Georgia.

1869. Glover, Townend.—Idem. Rep. Com. Agr., 1868, p. 84, fig. 41. The egg is deposited in Indian corn near the ground. The larvæ feed upon the substance of the grain.

41. Silvanus advena, Waltl.

1836. Waltl, Joseph.—*Cryptophagus advena.* Silberm. Rev. Ent. II., 256 (*Teste* Le Conte.) Original description.

1854. Le Conte, J. L.—*Silvanus advena.* Proc. Acad. Nat. Soc. Phila., 1854, p. 78. (Synopsis of the Cucuiides of the United States.) Description of imago. Abundant throughout U. S. in articles of commerce.

1882. Riley, C. V.—Idem. Rep. Com. Agr., 1881, p. 65. Reported from Washington Co., Mo., as eating grains of Indian corn in the stack.

Family Mycetophagidæ.

42. Typhœa fumata, Linn.

1767. Linne, Carl von.—*Dermestes fumatus.* Syst. Nat. Tome I., Pars. II., 564. Original description.

1857. Le Conte, J. L.—*Typhœa fumata.* Proc. Acad. Nat. Sci. Phila., 1856, p. 15. Description of imago; synonymy; and bibliography.

1882. Riley, C. V.—Idem. Rep. Com. Agr., 1881, p. 65. Reported from Missouri as working upon Indian corn in stack, eating the grain.

Family Nitidulidæ.

43. Ips fasciatus, Oliv.

1789. Olivier, A. G.—*Nitidula fasciata.* Ent. II., 12, p. 7, pl. 2, fig. 13. Original description.

1835. Say, Thomas.—*Ips 4-signata.* Boston Journ. Nat. Hist. I., 169. Complete writings, p. 644. Description of imago.

1861. Walsh, B. D.—Idem. Insects Injurious to Vegetation in Illinois, p. 14. Specimens from St. Paul, Minnesota, reported to have destroyed a great deal of sweet corn in that vicinity.

1867. Walsh, B. D.—Idem. Pract. Ent. II., 56. (See under 1861.)

1879. Horn, Geo. H.—*Ips fasciatus.* Trans. Am. Ent. Soc. VII., 323. Description of imago. Habitat; everywhere in the eastern United States, extending to Oregon and Vancouver.

Family Trogositidæ.

44. Tenebrioides dubia, Melsh.

1844. Melsheimer, F. E.—*Trogosita dubia.* (Description of New Species of Coleoptera of the United States.) Proc. Acad. Nat. Sci. Phila., 1844, p. 110. Original description. Habitat, Pennsylvania.

1863. Horn, Geo. H.—Idem. Proc. Acad. Nat. Sci. Phila., 1862, p. 85. (Monograph of the species of Trogosita inhabiting the United States.) Description of imago. Habitat, Pennsylvania; common.

1869. Glover, Townend.—Idem. Rep. Com. Agr. 1868, p. 83. Destroys wheat, Indian corn and other grains in Maryland.

1871. Glover, Townend—Idem. Rep. Com. Agr., 1870, p. 66. (See under 1869.)

Family Elateridæ.

Wireworms.

1842. Harris, T. W.—Spring Beetles. Rep. Mass. Ins. Characters of family; food plants; future injuries; remedies used in England. Description of six species.

1845. Drummond, Za.—Wireworms. The Cultivator, New Series, II., 122. (See under Cutworms, 1845.)

1859. The Cultivator, 3d series, VII., 107.—The Wireworm. Most injurious on moist, loamy soils of a mucky nature. Remedies: fall plowing; plowing grass land just before planting corn; sowing buckwheat.

1861. F.—Wireworms. The Cultivator, 3d series, IX., 284. Failure of remedies. Regular and frequent rotation of crops a preventive.

1862. Percy, A. G.—Idem. The Cultivator, 3d series, X., 192. (From Rural New Yorker.) Reason given for buckwheat's seeming a remedy.

Harris, T. W.—Spring Beetles. Ins. Inj. to Veg., 3d ed., pp. 51-57. (See under 1842.)

1864. Glover, Townend.—Wireworms. Rep. Com. Agr, 1863, p. 566. Remedies: alkaline substances, potatoes, turnips, rape cake, etc. Natural enemies: moles, crows, etc.

L. [Lintner?]—Once more the Wireworm. Country Gent. XXIV., 57. Proper rotation of crops. Crops which are not attacked by wireworms. Rolling, draining.

1865. Charnock, John H.—Wireworms. Country Gent. XXV., 105. Rape cake as a remedy. Its introduction and quantity per acre.

1866. Walsh, B. D.—Idem. Pract. Ent. I., 100. Effect of salt on Indian corn. Thorough culture a remedy for wireworms.

1867. Walsh, B. D.—Idem. Pract. Ent. II., 61, 62. Compared to myriapod.

Fitch, Asa.—Idem. 11th Rep. N. Y. Ins., pp. 519-543. Extensive depredators. Many kinds. Differences in structure of the last segment of the body. Probably two years in attaining maturity. Worm described. Food plants. Low lands preferred. Grass lands their residence. Indian corn crop oftenest destroyed by them. Habits. Remedies: trapping by potatoes, etc; hand picking; growing a crop that will repel them, as white mustard; fall plowing; draining;

rape cake; manure; guano. Natural enemies: crows and rooks. Description of two species.

1868. F.—The Wireworm. Country Gent. XXXII., 121, 122. Regular rotation of crops.

1869. Packard, A. S., Jr.—Elateridæ. Guide to the Study of Insects, pp. 459–462, Character, and habits of family with a brief mention of several species.

1874. LeBaron, Wm.—Idem. 5th Rep. St. Ent. Ill. pp. 96–100. Generic synopsis of family.

1875. Cook, A. J.—Wireworm. Rep. Mich. St. Bd. Agr. 1874, p. 113. Reported quite destructive to Indian corn and potatoes in Michigan. Natural history and remedies.

1876. Thomas, Cyrus.—Elateridæ. 6th Rep, St. Ent. Ill., pp. 115–120. Characters of the family. Description of eight species. Natural enemies. Remedial agencies.

Jones, S. D.—The Wireworm. Prairie Farmer, March, 1876. Remedies: copperas, kerosene. Effect of fall plowing.

Thomas, Cyrus.—Wireworms. 6th Rep. St. Ent. Ill., pp. 21–32. Injuries; characters of the family; general life history; period of a generation, two or three years. Food plants; character of injury. Remedies: hand-picking; salt; lime; soot; hard rolling; guano; hog manure; rotating crops with vegetables that are obnoxious to the worms; burning grass; starving out; coating seed corn in coal tar, or soaking in sulphate of copper solution.

1877. Fernald, C. H.—Idem. Agric. of Maine, 1877, pp. 65–69. Preferred situations; food plants. Under-draining. Description of *Agriotes mancus*.

1878. Thomas, Cyrus.—Idem. 7th Rep. St. Ent. Ill., pp. 19–32. Injuries and remedies, with a description of seventeen species.

1880. Harrington, W. Hague.—On the Elateridæ. Rep. Ent. Soc. Ont., pp. 77–84. Characters of the family; classified as to habits. Food plants. Conflicting opinion in regard to injury to potatoes. Two years probable period of a generation. Remedial agencies; natural enemies. Classification and description of several species.

Dwinelle, C. H.—Wireworms. Pacific Rural Press, March 13, 1880. Reported injuries to wheat in California.

45. Agriotes mancus, Say.

1823. Say, Thomas.—*Elater mancus*. Jour. Acad. Nat. Sci., Phila., III., 171. Complete writings, p. 111. Original description.

1852. Harris, T. W.—*Elater* (*Agriotes*) *obesus*. Treatise N. E. In-Insects, 2d ed. Brief description.

1853. Le Conte, J. L.—*Dolopius mancus*. Trans. Am. Philos. Soc., New Series, X., 455. Description, bibliography, and synonymy. Distribution.

1862. Harris, T. W.—*Elater (Agriotes) obesus.* Treat. N. E. Insects, 3d ed., p. 56. (See under 1852.)

1866. Fitch, Asa.—*Agriotes truncatus.* 11th Rep. N. Y. Insects, p. 527, figs. 11 and 12—12 larva. Description of larva and imago.

1872. Pettit, J.—*Agriotes mancus.* Can. Ent. IV., 3. Larvæ feed upon wheat. Bred to adult. An exhaustive description of larva and pupa by Dr. Horn.

1886. Forbes, S. A.—Idem. Bred from wireworms in Indian corn.

46. Melanotus communis, Gyll.

1817. Gyllenhal, L.—*Elater communis.* Schönh. Syn. Ins. III., 138. (*Teste* LeConte.) Original description.

1842. Harris, T. W.—*Elater (Melanotus) communis.* Rep. Mass. Ins. Brief description.

1853. Le Conte, J. L.—*Cratonychus communis.* Trans. Am. Phil. Soc., New Series, X., 477. Description; bibliography; synonymy.

1862. Harris, T. W.—*Elater (Melanotus) communis.* Ins. Inj. Veg. 3d ed., p. 55. (See under 1842.)

1867. Fitch, Asa.—*Cratonychus communis.* 11th Rep. N. Y. Ins. pp. 528–530, figs. 13 and 14. Description of imago and larva, in connection with an extended article on wireworms.

1878. Thomas, Cyrus.—*Melanotus communis.* 7th Rep. St. Ent. Ill., p. 30. Compared to *Melanotis fissilis.* Common in Illinois.

1880. Harrington, W. Hague.—Idem. Rep. Ent. Soc. Ont., 1879, p. 83. Common in Canada. Larvæ feed in wood.

1886. Forbes, S. A.—*Melanotus communis.* Bred from Indian corn.

47. Melanotus cribulosus, Lec.

1853. LeConte, J. L.—*Gratonychus cribulosus.* Trans. Amer. Phil. Soc., X., 478. Original description.

1886. Forbes, S. A.—*Melanotus cribulosus.* Bred from Indian corn.

Family Ptinidæ.

48. Sitodrepa panicea, Linn.

1767. Linne, Carl von.—*Dermestes paniceus.* Syst. Nat. Tome. I., Pars. II., ed. 12, p. 561. Original description.

1865. LeConte, J. L.—*Sitodrepa panicea.* Proc. Acad. Nat. Sci. Phila., 1865, p. 229. (Prodromus of a Monograph of the

Tribe Anobiini, of the Family Ptinidæ, inhabiting North America.) Common throughout the United States and Canada. Synonymy.

1869. PACKARD, A. S., Jr.—Idem. Guide to the Study of Insects, p. 470, fig. 440, pupa. Brief description of imago and larva.

1871. GLOVER, TOWNEND.—Idem. Rep. Com. Agr. 1870, p. 66. Recorded as feeding on kernels of INDIAN CORN.

1881. COMSTOCK, J. HENRY.—Idem. Rep. Com. Agr., 1880, p. 273. The parasite, *Pteromalus calandræ*, Howard, bred from this species.

Family SCARABÆIDÆ.

49. APHODIUS LUTULENTUS, Hald.

1843. HALDEMAN, S. S.—*Aphodius lutulentus.* (Description of North American species of Coleoptera presumed to be undescribed.) Proc. Acad. Nat. Sci. Phila. I., 304. Original description.

1871. HORN, GEO. H.—Idem. Trans. Am. Ent. Soc. III., 124. (Description of the species of Aphodius and Dialytes of the United States.) Description of imago. Occurs in middle and upper Southern States.

1882. RILEY, C. V.—Idem. Rep. Com. Agr., 1881, p. 65. Reported from Missouri as feeding on grains of INDIAN CORN in droppings of cattle.

50. THE ROSE BEETLE.

(*Macrodactylus subspinosus*, Fab.)

1775. FABRICIUS, J. C.—*Melolontha subspinosus.* Syst. Ent., p. 39. (*Teste* Lintner.) Original description.

1826. LOWELL, J.—The Rose Bug. Mass. Agr. Rep. Jour. IX., 143–147. Some remarks on the destructive powers of the rose bug. Occurred on INDIAN CORN.

1851. PRAIRIE FARMER, XI., 335, 386.—Idem. P. 335, statement that this beetle is becoming the worst of all our insect foes. Remedies. P. 386, the appearance and depredations of this insect reported from all directions. Brief account of its life history.

1852. HARRIS, T. W.—*Macrodactylus subspinosus.* Treat. Ins. N. E., p. 30. Brief description of imago. Life history; habits; food plants. Collecting recommended.

1856. FITCH, ASA.—Idem. 21 Rep. N. Y. Ins., pp. 245–252. Quotes Lowell as authority that the beetles were injurious to INDIAN

CORN. Gives an account of food plants and injuries, more especially in relation to fruit-trees. Description of imago. Life history and habits. Natural and artificial remedies.

1862. HARRIS, T. W.—Idem. Insects Injurious to Vegetation, p. 35, fig. 16. (See under 1852.)

1864. GLOVER, TOWNEND.—Idem. Rep. Com. Agr. 1863, pp. 567, 568. Food plants and remedies.

1866. GLOVER, TOWNEND.—Idem. Rep. Com. Agr. 1865, p. 89. Reported from Maryland to be killed in great numbers by the blossoms of the ailanthus tree.

1868. GLOVER, TOWNEND.—Idem. Rep. Com. Agr. 1868, p. 87, fig. 65. Brief history and food plants.

1868. WALSH, B. D. Idem. 1st Rep. St. Ent. Ill., p. 24. Swarms upon grape vines, but prefers the Clinton to all other varieties; a fact which may be taken advantage of to draw the bugs from other vines. Only known remedy practically available, jarring off and destroying.

1869. PACKARD, A. S., Jr.—Idem. Guide to the Study of Insects, p. 454. Brief account of habits and life history.

1873. RILEY, C. V.—Idem. 5th Rep. St. Ent. Mo., pp. 108–110, fig. 39. Injurious to fruit-trees in Kansas. Life history after Harris.

SAUNDERS, W.—Idem. Rep. Ent. Soc. Ont. 1872, pp. 10, 11. Preference for Clinton grape vine a means of lessening their injuries. Walsh quoted on this point. Life history taken from Harris.

1875. COOK, A. J.—The Rose Chafer. Rep. Mich. St. Bd. Agr. 1874, p. 740, fig. 41. Life history and habits briefly given. White hellebore, Paris green, and carbolic acid recommended as remedies.

1876. THOMAS, CYRUS.—Idem. 6th Rep. St. Ent. Ill., p. 103. Specific characters of imago. Habits, life history, and injuries, from Harris.

HORN, Geo. H.—Idem. Trans. Am. Ent. Soc. V., 184. Difference in sexes. Occurs especially in the Northern States northward of a line from Va. to Col.

1878. THOMAS, CYRUS.—The Rose Bug. 7th Rep. St. Ent. Ill., p. 34. When very abundant they occasionally extend their operations to INDIAN CORN. No complaint in this respect has ever been made against them in Illinois.

1880. LINTNER, J. A.—Idem. Country Gent. XLV., 407. Past history; first recorded injuries; food plants and which preferred; life history; bibilography.

1882. LINTNER, J. A.—Idem. 1st. Rep. N. Y. Insects, pp. 227–232. Food plants; injuries; natural history; remedies and preventives. Bibliography.

51. The White Grub.

(*Lachnosterna* sp.)

1842. Harris, T. W.—*Phyllophaga quercina*. Rep. Mass. Ins. Description of imago. Recommends shaking beetles from trees in the morning. May be collected on a cloth and destroyed by throwing into boiling water.

1862. Harris, T. W.—Idem. Insects Injurious to Vegetation, 3d ed, pp. 30, 31, fig. 10. (See under 1842.)

1864. Glover, Townend.—May Beetle.—Rep. Com. Agr. 1863, p. 567. Habits; remedies; natural enemies, etc. Early spring plowing. Use infested land for a hog pasture.

1866. Glover, Tonwend.—May Bug. Rep. Com. Agr., 1865, p. 38. Found in stomach of woodpecker.

Walsh, B. D.—*Lachnosterna fusca*. Pract. Ent. I., 60. Three instances cited of injuries to Indian corn. White grub compared to "muck worm". Considers increase of white grub due to the introduction of the improved hog.

1867. Walsh, B. D.—*Lachnosterna quercina*. Prac. Ent. II., 116. Receives specimen of white grub "with a root over an inch long and also a short sprout growing out of the two corners of the mouth," which he supposes to be due to the sprouting of a poisonous seed within the grub. [This is a parasitic fungus.]

Country Gentleman, XXX., 336.—The White Grub. Correspondent states that he has succeeded in repelling grubs by the use of superphosphate of lime.

1869. Packard, A. S., Jr.—*Lachnosterna fusca*. Guide to the Study of Insects, p. 454, figs. 410, 411, larva; 412, side view of pupa. Brief account of habits and injuries.

Riley, C. V.—*Lachnosterna quercina*. 1st Rep. St. Ent. Mo., p. 156, fig. 88. Food plants; remedies; parasitic fungus figured and described; also a very curious fungus reported from Virginia as being parasitic upon the white grub.

1872. Wier, D. B.—Idem. Prairie Farmer, March 9, 1872. Has known it to utterly destroy large fields of corn. Noxious in beetle state, once in three years only. Remedies.

Le Baron, Wm.—Idem. Prairie Farmer, May 12, 1872. Publishes a communication from Prof. T. J. Burrill, in which it is stated that, beyond controversy, the tramping of the surface of the ground on base ball and croquet grounds, and where cattle pastured, saved grass the following year from injury by the white grub. This suggestion of heavy rolling could only apply in case of grasses. Swine and ducks useful in hunting out the grubs.

1873. Packard, A. S., Jr.—The May Beetle. 3d Rep. Mass. Ins. pp. 6–9, fig. 138. Treated in reference to its injuries to the strawberry plant. Habits and life history. Remedies and natural enemies.

Riley, C. V.—*Lachnosterna, quercina.* 5th Rep. St. Ent. Mo., p. 55. Original description of egg.

1874. Riley, C. V.—Idem. 6th Rep. St. Ent. Mo., pp. 123–126. Describes larva, cocoons, and imago of *Tiphia inornata*, Say, which insect is parasitic upon the white grub. Also states that he has bred *Rhipiphorus* [*Emmenadia*] *pectinatus* Fab. (var. known as *ventralis*) from *T. inornata.*

1875. Cook, A. J.—The May Beetle. Rep. Mich. St. Bd. Agr., 1874, pp. 111, 112, fig. 6. Natural history and remedies.

1876. Thomas, Cyrus.—*Phyllophaga fusca.* 6th Rep. St. Ent. Ill. pp. 97–100, fig. 8. Specific characters of imago. Abundance; life history. Term of life in perfect state two or three weeks. Most injurious to Indian corn, wheat, and nurseries following grass of several years standing. Fungus parasite. Remedies. Imago and larva of *Tiphia inornata* described.

1878. Thomas, Cyrus.—Idem. 7th Rep. St. Ent. Ill. p. 33, fig. 8. Reported instances of injuries to Indian corn in Illinois.

1880. Riley, C. V.—The White Grub Fungus. American Ent. III., pp. 137–140, figs. 53, 54. Suggests its practical utilization in destroying white grub. Allied species of fungi. Bibliography.

Lintner, J. A.—*Lachnosterna fusca.* Country Gent XLV., 439. Received specimens of larvæ which were found in stable manure which he identifies as being this species.

1883. B. M. C.—The White Grub. Western Rural, March 10, 1883. Correspondent states that lands well covered with oats or red clover do not have many grubs the next year. Do not eat clover roots or oats as long as there is other food. Does not find grubs in moist land and thinks that is a reason why oats and clover crops are beneficial. He determines what crop to sow by examining the land the autumn previous.

Lintner, J. A.—Idem. 43d Rep. N. Y. St. Agr. Soc. A general article of eighteen pages.

Claypole, E. W.—*Lachnosterna fusca.* Rep. Ent. Soc. Ont. 1882, p. 26. Believes moles to be destructive to the larvæ.

52. The Indian Cetonia.

(*Euphoria inda*, Linn.)

1767. Linne, Carl von.—*Scarabæus indus.* Syst. Nat. 12th ed. Tome. I., Pars. II., p. 556. Original description. Habitat in India.

1823. Say, Thomas.—*Cetonia barbata.* Jour. Acad. Nat. Sci. III., 239. Complete writings p. 140. Description of imago. Not uncommon in various parts of our country.

1842. Harris, T. W.—*Cetonia inda.* Rep. Mass. Insects. Description of imago. States that they are two-brooded and that the imagos of second brood alight in great numbers, about the middle of September, upon Indian corn stalks, where they feed upon the sweet sap.

1862. Harris, T. W.—Idem. Insects Injurious to Vegetation, 3d ed., p. 40, fig. 17. (See under 1842.)

1864. Glover, Townend.—Indian Cetonia. Rep. Com. Agr., 1863, p. 568. Brief description. Suggests trapping by hanging in the trees wide-mouthed bottles filled with sweetened water.

1869. Glover, Townend.—*Euryomia inda.* Rep. Com. Agr., 1868 p. 90, fig 84. Date of appearance of broods. States the probability that second brood passes the winter in a torpid state.

1874. Le Baron, William.—Idem. 5th Rep. St. Ent. Ill., p. 91. Says it sometimes burrows into ripe fruit and also feeds upon sweet corn in the milk.

1876. Thomas, Cyrus.—Idem. 6th Rep. St. Ent. Ill., p. 108. Specific characters of imago. Two broods; times of appearance. Chiefly injurious in beetle state, and especially to peaches.

1877. Lintner, J. A.—The Indian Cetonia. Country Gent. XLII., 585. A pernicious corn insect. Reported injurious to ears of green corn.

1879. Riley, C. V.—*Euryomia inda.* Rep. Com. Agr., 1878, p. 208. States that this species has been received from several correspondents as attacking green corn,—a habit which it was not before known to have, and which has beyond doubt been recently acquired.

1882. Lintner, J. A.—*Euphoria inda.* Rep. N. Y. Ins. I., 232–239. Bibliography. Complaints received from various sections of New York and New England that this insect is injuring standing Indian corn by burrowing beneath the husks and feeding upon the kernels. Description of imago. Attack probably follows previous injury. Time of its appearance; suggestion as to its larval habits; preventives and remedies.

Family Cerambycidæ.

53. The Tile-horned Prionus.

(*Prionus imbricornis*, Linn.)

1767. Linne, Carl von.—*Cerambyx imbricornis.* Syst. Nat. Ed. 12, Tome. I., Pars. II., p. 622. Original description. Habitat Carolina.

1869. Riley, C. V.—*Orthosoma cylindricum.* 1st Rep. St. Ent. Mo., pp. 124–128, figs. 67, 68, 69. Quotes Mr. I. N. Stuart as

saying that it occurs in the roots of INDIAN CORN stalks. Treats as a grape insect. Describes the larva.

1870. RILEY, C. V.—*Prionus imbricornis*. 2d Rep. St. Ent. Mo., pp. 89–91, fig. 63. States that the larva he described as *Orthosoma cylindricum* is probably that of above species. Gives food habits of two other closely allied species.

1871. GLOVER, TOWNEND.—Idem. Rep. Com. Agr., 1870, p. 72. Gives food plants according to Riley.

1876. THOMAS, CYRUS.—Idem. 6th Rep. St. Ent. Ill., p. 148. Distinguishing characters. Remedies.

Family CHRYSOMELIDÆ.

54. THE CORN ROOT WORM.

(*Diabrotica longicornis*, Say.)

1823. SAY, THOMAS.—*Galleruca longicornis*. Journ. Acad. Nat. Sci. Phila. III., 460. Complete writings II., 223. Original description. Obtained specimens near Rocky Mountains.

1879. RILEY, C. V.—*Diabrotica longicornis*. Rep. Com. Agr., 1878, p. 208. Correspondent from Missouri reports that his INDIAN CORN was seriously damaged by larvæ of this insect.

1880. FRENCH, G. H.—A Corn Insect. Prairie Farmer, Aug. 9. Publishes a letter from Dr. E. R. Boardman, Stark county, Ill., [see following entry] accompanying corn root worms. Describes these briefly, notes their resemblance to larvæ of *Diabrotica vittata* and determines them doubtfully as larvæ of Chrysomelidæ.

BOARDMAN, E. R.—Idem. Prairie Farmer, Aug. 9. In a letter to Prof. French reports serious injury to roots of INDIAN CORN, and sends larvæ evidently responsible for it.

FRENCH, G. H.—The New Corn Insect. Prairie Farmer, Sept. 4. Reports additional letters from Dr. Boardman (see following entry); identifies larva as that of *Diabrotica longicornis* by breeding; and infers from the life history of *D. vittata* that *D. longicornis* will prove to be two- or three-brooded, and that it deposits its eggs at the roots of INDIAN CORN. Discusses clean culture, rotation of crops, and alkaline applications as remedies.

BOARDMAN, E. R.—Idem. Prairie Farmer, Sept. 4. Letters to Prof. French reporting great abundance of *Diabrotica longicornis* in localities infested by the corn root worm, and expressing the belief that the latter is the larva of that species. Gives additional details on life history and extent of injury to INDIAN CORN, and notes abundance of imago on rag weed. Approves rotation of crops and suggests destruction of rag weed as a remedy.

French, G. H.—The Corn Root Worm. Prairie Farmer, Sept. 18. Reports letters of S. A. Forbes and E. R. Boardman; repeats suggestion of clean culture and rotation of crops; and expresses belief that larvæ will be found feeding upon the roots of Compositæ.

Forbes, S. A.—Idem. Prairie Farmer, Sept. 18. Reports to Prof. French absence of imagos in food of birds, and determines, by dissection, that adults feed upon pollen of thistles.

Boardman, E. R.—Idem. Prairie Farmer, Sept. 18. Gives additional data on life history and injuries to Indian corn; notes damage done by imagos by eating silk and preventing fertilization. Reports that he has found larvæ in roots of rag weed, and thinks proof conclusive that the insect is more than one-brooded.

Riley, C. V.—*Diabrotica longicornis* Amer. Ent. III., October, p. 247. Date of first receipt of larvæ and pupæ, August, 1874. Invariably found in conjunction with real wireworm, *Drasterius amabilis*, which he believes feeds upon corn root worm. Suggests rotation of crops, destruction of ragweed, and the application of lime and ashes.

Webster, F. M.—More about the New Corn Insect. Prairie Farmer, October 2, 1880. Notes no damage at time of writing, although in cornfields in numbers double that of year preceding. *Leptotrachelus dorsalis* more abundant than formerly.

1881. Thomas, Cyrus.—*Diabrotica longicornis*. 10th Rep. St. Ent. Ill., pp. 44–46. Contains a letter from Dr. E. R. Boardman, of Stark county, Ill. (See under 1880, French, G. H.) Describes larva and imago; gives distribution; and expresses the opinion that the insect is not likely to prove troublesome.

1882. French, G. H.—Idem. 11th Rep. St. Ent. Ill., pp. 65–73. Character and amount of injury done as reported by several correspondents. Said to live in roots of ragweed as well as in Indian corn, and thought to be two- or more brooded. Food of imagos. Rotation of crops and clean culture recommended. Description of larva and imago.

Saunders, W.—Idem. Rep. Ent. Soc. Ont., 1881, p. 7. Brief synopsis of the account of this insect in 10th Rep. St. Ent. Ill.

Forbes, S. A.—The Corn Root Worm in McLean County. Bloomington "Leader," September, 1882. Means of identify- the injuries of this insect. Finds it in nearly all the fields of Indian corn visited, retarding growth of plant. Rotation of crops a complete remedy.

Forbes, S. A.—The Corn Root Worm, *Diabrotica longicornis*, Say. Illinois Department of Agriculture, Circular No. 94, Illinois Crops for 1882, p. 122. Reports the recent discovery of the eggs of the imago, and gives first correct statement

of life history. Describes character and amount of injury to INDIAN CORN, and demonstrates sufficiency of rotation of crops as a remedy.

BOARDMAN, E. R.—Economic Entomology. Stark County News, December 21. General article reporting the discovery that heavy manuring is protection against the injuries of the root worm.

FORBES, S. A.—Idem. Prairie Farmer, December 30. Reports this insect as one of the most destructive enemies o INDIAN CORN in central Illinois. Gives description and life history of insect, and first figures of egg, imago, and larva; details method, amount, and distribution of injury to corn by larvæ and imagos, and again recommends rotation of crops as a preventive.

1883. FORBES, S. A.—Notes of the Season. Prairie Farmer, Dec. 8. Reports occurrence of larva in roots of sorghum, its absence in broom corn, and continued injury to MAIZE.

POPENOE, E. A.—*Diabrotica longicornis*. Third Biennial Rep. Kan. St. Bd. Agr., VIII., 616. Probable occurrence in Kansas. Brief account of its habits, characters, and of preventive measures.

FORBES, S. A.—Idem. A Lecture on Insects Affecting Corn, pp. 6–12. One-brooded; eggs laid in autumn, hatching June or July following. Larvæ resulting, immediately attack roots of INDIAN CORN. Rotation of crops a thorough safeguard.

FORBES, S. A.—Idem. 12th Rep. St. Ent. Ill., pp. 10–31, figs 1, 2, 3, 4, 5. "A minute, slender, white grub, about two-fifths of an inch long, boring the roots of INDIAN CORN in the ground from June to August, transforming into a grass-green beetle which feeds upon the pollen and silk of the corn, and upon the pollen of other plants." A recent addition to the list of insect pests. Extent and amount of injuries. Imago, pupa, larva, and egg fully described, and life history of each given in detail. Injuries to corn; natural and artificial enemies.

1885. FORBES, S. A.—Idem. 14th Rep. St. Ent. Ill., p. 5. Under head of "Entomological Calendar," states that the corn root worm has continued its injuries, interrupted only by the growing disposition to practice rotation of crops.

55. BROAD-STRIPED FLEA BEETLE.

(*Systena blanda*, Melsh.)

1848. MELSHEIMER, F. E.—*Systena blanda*. Proc. Acad. Nat. Sci. Phila., III., 164. Original description.

1874. GLOVER, TOWNEND. Idem. Rep. Com. Agr. 1873, p. 152, fig. 1. Correspondent writes from Pennsylvania that these beetles

have nearly devastated a field of INDIAN CORN, eating the leave and leaving the bare stalks standing. Brief description of imago.

LE BARON, WM.—Idem. 5th Rep. St. Ent. Ill., p. 173. Descriptive note, with mention of iniuries to young INDIAN CORN in the Middle States.

1884. FORBES, S. A.—Idem. 13th Rep. St. Ent. Ill. p. 86. Already known to be injurious to INDIAN CORN, and found also feeding on strawberry plant.

56. THE BRASSY FLEA BEETLE.

(*Chætocnema pulicaria*, Melsh.)

1848. MELSHEIMER, F. E.—*Chætocnema pulicaria*. Proc. Acad. Nat. Sci. Phila., 1847, p. 167. Original description.

1885. FORBES, S. A.—Idem. 14th Rep. St. Ent. Ill. p. 22. Twice noticed during the season in sufficient numbers to do injury by riddling the leaves of young INDIAN CORN with small holes.

Family TENEBRIONIDÆ.

57. TENEBRIO OBSCURUS, Fab.

1792. FABRICIUS, J. C.—*Tenebrio obscurus*. Ent. Syst. I., 111. Original description.

1870. WALSH & RILEY.—Idem. Amer. Ent. II., 111. Abundance compared to that of *T. molitor*. Introduction into Europe.

1874. LE BARON, WM.—Idem. 5th Rep. St. Ent. Ill. p. 123, fig. 57.

1877. RILEY, C. V.—Idem. 9th Rep. St. Ent. Mo., p. 43. Abundance compared to that of *Tenebrio molitor*.

58. TENEBRIO MOLITOR, Linn.

1767. LINNE, CARL VON.—*Tenebrio molitor*. Syst. Nat. Tome I., Pars II., 12th ed. p. 674. Original description.

1862. HARRIS, T. W.—Idem. Insects Injurious to Vegetation, 3d ed. pp. 10, 11; fig. 1, larva; fig. 2, pupa; fig. 3, imago. Mentioned as a meal worm.

1869. GLOVER, TOWNEND.—Idem. Rep. Com. Agr., 1868, p. 100, fig. 161. Brief description and habits of larva and imago. Injuries compared to those of *T. obscurus*.

PACKARD, A. S., JR.—Idem. Guide to the Study of Insects, p. 474. Brief description of larva and imago. Found about corn and rye meal.

1870. WALSH AND RILEY.—Idem. Amer. Ent. II., 100. Abundance compared with that of *T. obscurus*.

1874. Le Baron, Wm.—Idem. 5th Rep. St. Ent. Ill., pp. 121, 123, 129. General characters of larva and imago.

1877. Riley, C. V.—Idem. 9th Rep. St. Ent. Mo., p. 43. Abundance compared to that of *T. obscurus*.

Family Meloidæ.

59. The Striped Blister Beetle.

(*Epicauta vittata*, Fab.)

1789. Olivier, A. G.—*Cantharis vittata*. Ins. 46, tab. I., fig. 3. (*Teste* Fabricius.)

1798. Fabricius, J. C.—*Lytta vittata*. Ent. Syst. Tome I., Pars II., 86. Original description.

1869. Riley, C. V.—Idem. 1st Rep. St. Ent. Mo., p. 96, fig. 39. Treated as a potato insect. Distribution.

1876. Thomas, Cyrus.—*Epicauta vittata*. 6th Rep. St. Ent. Ill., p. 125, fig. 14. Description; distribution. Feeds on potato.

1878. Riley, C. V.—Idem. Rep. U. S. Ent. Com., I., 297. [From Trans. Acad. Sci. St. Louis, Vol. III., 549.] (On the larval characters and habits of the blister beetles belonging to the genera Macrobasis, Lec., and Epicauta, Fab. with remarks on other species of the family Meloidæ.) Larvæ subsist on grasshoppers' eggs.

1880. Riley, C. V.—Idem. Amer. Ent. III., 196. Rep. U. S. Ent. Com. II., 260. Retarded development of this insect.

1883. Forbes, S. A.—Idem. 12th Rep. St. Ent. Ill., p. 104. Seen by Mr. F. M. Webster eating silk from young ears of Indian corn, in August, 1882.

60. The Black Blister Beetle.

(*Epicauta pennsylvanica*, De Geer.)

1775. De Geer, Carl.—*Meloe pennsylvanica*. Ins. V., 16, I., tab. 13, fig. I. (*Teste* Fabricius.) Original description.

1792. Fabricius, J. C.—*Lytta atrata*. Ent. Syst. Tome I., Pars. II., 86. Description of imago.

1869. Riley, C. V.—Idem. 1st Rep. St. Ent. Mo., p. 98. Treated as a potato insect.

1878. Riley, C. V.—*Epicauta pennsylvanica*. Rep. U. S. Ent. Com. I, 298. Trans. Acad. Sci. St. Louis, Vol. III., 549. (See under previous species, 1878.)

1883. Forbes, S. A.—Idem. 12th Rep. St. Ent. Ill., p. 104. (See under preceding species, 1883.)

Family Otiorhynchidæ.

61. The Imbricated Snout Beetle.

(*Epicærus imbricatus*, Say.)

1823. Say, Thomas.—*Liparus imbricatus*. Journ. Acad. Nat. Sci. Phila. III., 317. Complete writings, II., 178. Original description.

1872. Riley, C. V.—*Epicærus imbricatus*. 3d Rep. St. Ent. Mo., p. 58, fig. 21. Doing considerable damage to fruit trees by gnawing twigs and fruit. Common in Western States.

1876. Thomas, Cyrus.—Idem. 6th Rep. St. Ent. Ill., p. 131. Specific characters of imago. Frequent in Missouri and Iowa. Injuries to fruit.

1880. Comstock, J. Henry.—Idem. Rep. Com. Agr. 1879, p. 249. Correspondent writes from Tennessee that this insect destroyed Indian corn among many other plants.

Riley, C. V.—Idem. Amer. Ent. III., 200, fig. 106. Receives specimens from Delaware, where it destroyed early cabbages eating the leaves and sucking the juice from the stems.

1883. Forbes, S. A.—Idem. 12th Rep. St. Ent. Ill., p. 104. Found feeding on the blossoms of red clover at Normal in June, 1882.

1885. Riley, C. V.—Idem. Rep. Com. Agr. 1884, p. 300. Has received it from Iowa, reported as damaging Indian corn. Treated with reference to its injuries to cabbages.

Family Calandridæ.

62. Sphenophorus pertinax, Oliv.

1789–1808. Olivier, A. G.—*Calandra pertinax*. Ent. V., 83, p. 90, pl. 28, fig. 417. (*Teste* Horn.) Original description.

1873. Horn, G. H.—*Sphenophorus pertinax*. Proc. Amer. Phil. Soc. 1873, p. 418. Description, synonymy, and bibliography. Injurious to Indian corn. Occurs from Canada to Louisiana, and from the Atlantic to the Pacific, and, unfortunately for farmers, is not rare.

1882. Riley, C. V.—Idem. Rep. Com. Agr. 1881, p. 141. This species "has long been known as greatly injurious to Indian corn."

63. The Corn Bill-Bug.

(*Sphenophorus robustus*, Horn.)

1873. Horn, G. H.—*Sphenophorus robustus*. Proc. Amer. Phil. Soc. 1873, p. 419. Original description. Occurs as widely as *S. pertinax*, Oliv, but is less common.

1881. Comstock, J. Henry.—*Sphenophorus pertinax*. Rep. Com. Agr. 1880, p. 272. Received specimens from correspondents in Alabama, where it was said to be injuring young Indian corn extensively, by piercing the stalk just below the ground. Ravages confined to low, wet land.

1882. Riley, C. V.—*Sphenophorus robustus*. Rep. Com. Agr. 1881, pp. 138–142. Pl. viii, fig. 2. Description of imago, larva, and pupa. Habits, natural history, injury, and preventives. Damage is done principally in early spring, as the young Indian corn appears above ground, by puncturing the stalk and sucking the sap.

64. Sphenophorus cariosus, Oliv.

1789–1808. Olivier, A. G.—Ent. V., 83, p. 91, pl. 29. fig. 415. (*Teste* Horn.) Original description.

1871. Glover, Townend.—*Sphenophorus cariosus*. Rep. Com. Agr. 1870, p. 68. Receives this insect from New Jersey, where it is said to be very destructive to young Indian corn plants.

1873. Horn, G. H.—Idem. Proc. Amer. Phil. Soc. 1873, p. 420. Description, synonymy, bibliography. Occurs in Middle States rarely; in Gulf States abundantly.

1876. Le Conte, J. L.—Idem. Proc. Amer. Phil. Soc. XV., 425. (The Rhyncophora of America.) Favors uniting *S. callosus* Oliv. with above species.

65. The Sculptured Corn Curculio.

(*Sphenophorus sculptilis*, Uhler.)

1855. Uhler, P. R.—*Sphenophorus sculptilis*. Proc. Acad. Nat. Sci. Phila. VII., 416. (A description of a few species of Coleoptera supposed to be new.) Original description.

1857. Fitch, Asa.—*Sphenophorus venatus*. The Cultivator, 3d series, V., 273. Receives specimens from correspondents in New York State, where it is seriously injuring Indian corn. Collecting the beetles the most effectual remedy.

1867. Walsh, B. D.—*Sphenophorus zeæ*. Pract. Ent. II., 117. Reported from New York State as making sad havoc with Indian corn, destroying whole fields in some instances. Redescribed as a new species.

1871. Riley, C. V.—Idem. 3d Rep. St. Ent. Mo., p. 59, fig. 22. Description and brief account of its habits,—after Walsh.

1873. Horn, G. H.—Idem. Proc. Amer. Phil. Soc., 1873, p. 423. Description of imago. Bibliography. Occurs in Middle States, Georgia, and Kansas.

Horn, G. H.—*Sphenophorus sculptilis.* Proc. Amer. Phil. Soc. 1873, p. 423. Description of imago. Middle, Western, and Southern States.

1876. Le Conte, J. L.—Idem. Proc. Amer. Phil. Soc. XV., 425. Unites *S. zeæ*, Walsh, with this species.

1877. Packard, A. S., Jr.—*Sphenophorus zeæ.* Hayden, Rep. IX., U. S. G. G. Surv. Terr., 1875, p. 718. Description, injuries, and remedies. Detected this species at Hyannis, Massachusetts, June 25.

1878. Thomas, Cyrus.—Idem. 7th Rep. St. Ent. Ill., p. 34. Description of imago and brief account of habits,—after Walsh.

1879. Comstock, J. Henry.—Idem. Rep. Com. Agr., 1879, p. 248. Receives specimens of this species from Missouri, where it destroyed two plantings of Indian corn and injured the third. The corn was in dry land, sufficiently rolling to drain well.

1879. Lintner, J. A.—Idem. Country Gent. XLIV., 439. Description and distribution. Received specimens of this insect from New Jersey where it is reported to be injuring Indian corn. Account of some recorded injuries.

1881. Comstock, J. Henry.—*Sphenophorus sculptilis.* Rep. Com. Agr., 1880, p. 272. Received specimens from South Carolina, where they were represented as injuring young Indian corn by piercing the stalk at or above the surface of the ground.

1882. Riley, C. V.—Idem. Rep. Com. Agr., 1881, p. 139. Occurs in the South and West and is common in Illinois and Missouri. Has been received from Florida and Alabama as injuring Indian corn.

Lintner, J. A.—Idem. 2d Rep. N. Y. Insects, pp. 253-263, fig. 76. Received specimens from New Jersey, where they caused serious injury to Indian corn. Gives synonymy; description of imago; recorded injuries; distribution; breeding ground; original food plant; and food plants and habits of allied species. Testimony concerning the presence of curculio larvæ in the stems of Indian corn; probably unsuspected cause of much injury to it. Remedies.

1885. Lintner, J. A.—Idem. 2d Rep. N. Y. Insects, p. 52. Some account of its early history in New York. Correspondent from Kansas believes the larvæ to be lignivorous.

66. Sphenophorus parvulus, Gyll.

1823. Gyllenhal, L.—*Sphenophorus parvulus.* Schönh Gen. Curc. IV., 961. Original description.

1873. Horn, G. H.—Idem. Proc. Am. Phil. Soc. 1873, p. 427. Description of imago. Occurs in Pennsylvania, Georgia, and Kansas.

1882. Riley, C. V.—Idem. Rep. Com. Agr. 1881, p. 139. Received from Missouri as injuring Indian corn.

67. The Rice Weevil.

(*Calandra oryzæ*, Linn.)

1763. Linne, Carl von.—*Curculio oryzæ.* Amoen. Ac. VI., 395. (*Teste* Horn.) Original description.

1842. Harris, T. W.—*Calandra oryzæ.* Rep. Mass. Insects. Injurious to Indian corn in Southern States. Description, habits, life history. Appearance in spring. Recommends collecting them by winnowing the rice which they attack.

1861. Coble, John A. M.—Black Weevil. Cultivator, 3d series, IX., 83. Writes from North Carolina that he has used salt effectually against this pest.

1862. Hvrris, T. W.—*Calandra oryzæ.* Insects Injurious to Vegetation 3d ed., p. 83, pl. ii, fig. 8. (See under 1842.)

1864. Glover, Townend.—Southern Rice Weevil. Rep. Com. Agr. 1863, p, 572. Compares it briefly with *Calandra granaria.* and suggests frequent stirring and kiln-drying as remedies.

1869. Packard, A. S., Jr.—*Sitophilus oryzæ.* Guide to the Study of Insects, p. 490, fig. 45, *c.* Brief mention.

1873. Horn. G. H.—*Calandra oryzæ.* Proc. Am. Phil. Soc. 1873, p. 430. Description of imago. Bibliography. Says this species occurs in all parts of the world.

1881. Comstock, J. Henry.—Idem. Rep. Com. Agr. 1880, p. 273. Two chalcids bred from this species and described by Mr. L. O. Howard as *Pteromalus calandræ.*

Thomas, Cyrus.—*Sitophilus oryzæ.* Farmer and Fruit Grower, July 27, 1881. Injurious to wheat in Southern Illinois. Believes that the cold winter succeeding has destroyed the insects.

1882. Forbes, S. A.—Idem. Farmers' Review. Dec. 1, 1882. Mention.

1885. Riley, C. V.—*Calandra oryzæ.* Rep. Com. Agr., 1884, p. 424. Correspondent from Florida suggests cribbing corn with the shuck on as a safeguard against this insect.

68. The Grain Weevil.

(*Calandra granaria*, Linn.)

1767. Linne, Carl von.—*Curculio granarius*. Syst. Nat. 12th ed., Tome I., Par. II., 608. Original description.

1842. Harris, T. W.—*Calandra granaria*. Rep. Mass. Insects. Description, life history, power of multiplication, remedy.

1862. Harris, T. W.—Idem. Insects Injurious to Vegetation, 3d ed., p. 83. (See under 1842.)

1864. Glover, Townend.—Northern Granary Weevil. Rep. Com. Agr. 1863, p. 572. Compares it to Southern rice weevil, and suggests remedies.

1869. Walsh and Riley.—*Sitophilus granarius*. Amer. Ent. I., 179. Insect may be used for blistering. Suggest care in use of grain attacked by it.

Packard, A. S., Jr.—Idem. Guide to the Study of Insects, p. 489, fig. 467, *e*. Brief mention of habits and injury.

1876. Western Farm Journal, June 16.—Corn Weevils in Foreign Grain. Foreign Indian corn infested by weevils at Philadelphia Exposition.

1880. Riley, C. V.—Grain Weevils. Amer. Ent. III., 26. Quotes a French journal as saying that these insects were attracted to a tub of anise seed, and thereby killed.

Elliot, A. T.—Idem. Amer. Ent. III., 179. Reports an instance of the effectual use of pyrethrum in destroying this insect.

Rilliet, Chas.—*Butalis granaria*. Rural New Yorker, May 1, 1880. Reports from Lake county, Illinois, an instance of severe injury to unthreshed wheat, while similar wheat in granary was uninjured.

1882. Forbes, S. A.—*Sitophilus granaria*. Farmers' Review, December 1, 1882. Brief account of habits and remedies, in reply to an inquiry from Missouri.

Order HEMIPTERA.

Family Lygæidæ.

69. The Chinch Bug.

(*Blissus leucopterus*, Say.)

1831. Say, Thomas.—*Lygæus leucopterus*. (Descriptions of new species of Heteropterous Hemiptera of North America. Transactions of the New York State Agricultural Society, p. 774. Complete writings, I., 329. Original description. Described from single specimen taken in Virginia.

1845. PRAIRIE FARMER, V., 227. Injuries in Hancock county, Illinois.

PRAIRIE FARMER, V., 287.—Chinch Bugs. Injuries in Tazewell county, Illinois. An account of their season's history.

1846. PRAIRIE FARMER, VI., 134.—The Chinch Bug. Injuries in Sangamon county, Illinois.

PRAIRIE FARMER, VI., 245.—Chinch Bugs. Injuries in Cass county, Illinois.

1850. LEBARON, WM.—*Rhyparochromus devastator*. Prairie Farmer, X., 200. Description of imago, nomenclature, habits, life history, and injuries.

1851. PRAIRIE FARMER, XI., 335.—The Chinch Bug. Distribution within the State of Illinois.

1852. HARRIS, T. W. *Rhyparochromus leucopterus*. Treatise Insects Massachusetts. Brief description of imago, distribution and injuries.

1855. FITCH, ASA.—*Micropus leucopterus*. The Cultivator, 3d series, III., 237–239. Correspondent writes from Indiana giving account of habits and injuries. Past history and nomenclature.

1856. FITCH, ASA.—Idem. 2d Rep. Ins. N. Y., pp. 277–297. Its first appearance; appearance in 1839 in North Carolina and in Illinois; its destructiveness, distribution, nomenclature, remedies.

1862. HARRIS, T. W.—*Rhyparochromus leucopterus*. Insects Injurious to Vegetation. 3d ed., pp. 197–200, fig. 84. (See under 1852.)

1866. WALSH, B. D.—Chinch Bugs. Pract. Ent., I., 95. Reports a case of the prevention of injuries by surrounding INDIAN CORN field with a barrier of pine boards set up edgewise and keeping the upper edge moist with coal-tar.

WALSH, B. D.—*Micropus* (*Lygæus*) *leucopterus*. Pract. Ent. II., 21. Receives specimens from Canada whose wings are half the length of the body, and infers that they are a geographical variety.

1868. SHIMER, HENRY.—*Blissus leucopterus*. Proc. Acad. Nat. Sci. Phila., XIX., 75–80. Notes on *Micropus* (*Lygæus*) *leucopterus* with an account of the great epidemic among these insects in 1863. Gives an account of their abundance and habits in 1864.

1869. WALSH AND RILEY.—*Micropus leucopterus*. Amer. Ent. I., 169, 177, 194, 199, figs. 122, 138, 139. Past history; natural history. Natural checks: heavy rains, cannibal foes. Injuries; remedies. Four points thought to be established: 1st, chinch bugs hibernate in the winged state in any dry rubbish, hence such material should be burned in the spring; 2d, the earlier small grain can be sown the more likely it is to escape the chinch bug; 3d, the harder the ground when the grain is sowed, the less injury; 4th, a single heavy rain immediately checks the propagation of the chinch bugs.

PACKARD, A. S., Jr.—*Blissus leucopterus.* Guide to the Study of Insects, pp. 543, 544, fig. 547. Description of imago; habits, injuries, epidemic disease of 1865, remedies.

1870. RILEY, C. V.—*Micropus leucopterus.* 2d Rep. St. Ent. Mo., pp. 15–47, figs. 1, 2. (See under 1869, Walsh and Riley.)

1871. GLOVER, TOWNEND.—*Rhyparochromus* (*Micropus*) *leucopterus.* Rep. Com. Agr. 1870, p. 89. Deposition and hatching of eggs. Mode of injury. Two broods annually, perhaps three in the South. Most destructive in hot, dry summers. Early grain most likely to escape their ravages. Remedies.

1872. BETHUNE, C. J. S.—*Micropus leucopterus.* Rep. Ent. Soc. Ont., 1871, p. 55. Past history and injuries, description, natural and artificial remedies.

LE BARON, WM.—Idem. 3d Rep. St. Ent. Mo., pp. 142–156. Excessive prevalence in 1871. Methods and agencies for their destruction. Natural enemies. Anticipating ravages by sowing grain early; saving crop by preventing migrations of insect; destroying by burning rubbish in fall; preventing breeding of insect by abstaining from the cultivation of those grains upon which they chiefly subsist.

LE BARON, WM.—Chinch Bug. Experience of 1872. Prairie Farmer, August 24, 1872. Believes that a sufficient number of these insects hibernate under dead leaves in the woods to perpetuate the species; also that the wet spring of 1872 destroyed large numbers of the chinch bugs.

GLOVER, TOWNEND.—*Rhyparochromus leucopterus.* Rep. Com. Agr. 1871–72, p. 84. Localities in which it is injurious.

GLOVER, TOWNEND.—*Micropus* (*Rhyparochromus*) *leucopterus.* Rep. Com. Agr. 1872, p. 121. Especially destructive to sorghum in a few counties in Ohio, Indiana, Missouri, and Kansas, and to wheat in other counties of the same States. In Crawford county, Mo., three distinct broods noticed, appearing, respectively, first of May, last of June, last of August. INDIAN CORN in milk at last visitation, and it was seriously injured.

1874. B. F. J. [JOHNSON.]—Chinch Bug. Country Gent. XXXIX., 661. So abundant upon green corn fodder in central Illinois as to be seriously injurious to the health of horses and cattle, and in some cases caused their death.

1875. GLOVER, TOWNEND.—*Micropus* (*Rhyparochromus*) *leucopterus.* Rep. Com. Agr. 1874, p. 127. Localities in which it is injurious.

EVEREST, H. J.—*Blissus leucopterus.* Western Rural, July 17. Barricading with boards and coal tar.

RILEY, C. V.—*Micropus leucopterus.* 7th Rep. State Ent. Mo., pp. 19–50, figs. 2, 3, 4. Description of egg, larval stages, pupa, and imago. Past history; destructive powers; injuries in 1874; food plants; mode of reproduction and hibernation; disposition of eggs; flight. Remedial agencies exhaustively treated.

1876. Uhler, P. R.—*Blissus leucopterus.* List of Hemiptera west of the Mississippi river, p. 40. Distribution in United States.

1878. Thomas, Cyrus.—Idem. 7th Rep. St. Ent. Ill., pp. 40–71, fig. 10. Description of its various stages. Extended account of injuries. Two broods in northern Illinois; some evidence of a third in extreme southern Illinois. Hibernation; migrations; natural agencies which assist in their destruction; remedies, followed by account of proposed remedies as given by LeBaron in 3d Rep. St. Ent. Ill., p. 144.

1879. Thomas, Cyrus.—Idem. Bul. U. S. Ent. Com. No. 5. Ten figures and map showing distribution. A *resumé* of the present knowledge of its history, characters, and habits, and the means of destroying it or lessening its injuries.

1880. Thomas, Cyrus.—Temperature and Rainfall as affecting the Chinch Bug. Periodicity in its increase. Amer. Ent. III., 240–242.

1881. Thomas, Cyrus.—The Relation of Meteorological Conditions to Insect Development. 10th Rep. St. Ent. Ill., pp. 47–59. Believes there will be but two chinch bug years in seven, corresponding to certain meteorological conditions.

The Farmers' Review, July 21, 1881.—The Chinch Bug Pest. Wide-spread complaint of injuries from this pest the current season. Damage most severe on old land. Fertilizers a protection against ravages of the chinch bug.

1882. Riley, C. V.—Chinch Bug Notes. Rep. Com. Agr., 1881, pp. 87–89. Predictions in relation to injury. Injury in spring of 1882. Remedies and preventive measures—irrigation mentioned.

Forbes, S. A.—The Chinch Bug in 1882. St. Dept. Agr., Circular No. 92, Illinois Crop Prospects, August 1, p. 77. Reports apparent retardation of hatching and unusual method of attack due to extraordinarily cold, wet, and late spring. Determines experimentally that wet weather takes no injurious effect upon adults. Finds small brown ant, *Lasius alienus*, attending young chinch bugs and feeding upon their fluid excrement. Determines by dissection that a predaceous beetle (*Agonoderus comma*) feeds upon the young. Reports presence of bacterial disease among chinch bugs. Mentions successful experiments for killing chinch bugs with kerosene emulsion, at a cost of about three fourths of a cent per gallon.

1882. Forbes, S. A.—Bacterium, a Parasite of the Chinch Bug. Amer. Nat. XVI., (Oct.) p. 824. Gives account of discovery of parasitic disease among chinch bugs, with observations and experiments indicating its connection with a Bacterium found in the alimentary canal.

Forbes, S. A.—Another Chinch Bug Parasite. Prairie Farmer, Dec. 9, 1882. Brief account of a fungus found destroying chinch bugs in corn fields near Jacksonville, Ill. Mention also of the Bacterium parasite *Micrococcus insectorum*, Burrill. Predicts immunity from the chinch bug in 1883.

1883. Forbes, S. A.—Studies on the Chinch Bug (*Blissus leucopterus*, Say.) 12th Rep. St. Ent. Ill., pp. 32–63, figs. 6, 7. Life history. Natural enemies: insects, birds, and microscopic parasites. Elaborate account of bacterial disease. Topical applications; experiments with them reported. A mechanical mixture of water and three per cent. of kerosene is deadly to chinch bugs of all ages.

Forbes, S. A.—A Lecture on Insects affecting corn, pp. 19, 20. Brief account of life history, effects of weather, remedial measures, insect enemies, and contagious diseases.

Forbes, S. A.—Experiments on the Chinch Bug. Rep. U. S. Dept. Agr., Div. Ent., Bul. No. 2, pp. 23–25. Memoranda of experiments relating to use of kerosene emulsions on chinch bugs.

Forbes, S. A.—Entomological Notes of the Season. St. Dept. Agr., Circular No. 106, Illinois Crops for 1883, p. 177. Reports deposit, in spring, of eggs of first brood about the roots of Indian corn.

Lintner, J. A.—The Chinch Bug. Albany Argus, Oct. 10, 1883. Its ravages in northern New York; habitat; method of attack and destructiveness; how to combat it.

Lintner, J. A.—The Chinch Bug in New York. Country Gent., Nov. 8, 1883. Directions for coöperation against the insect in New York State.

1884. Saunders, W.—*Micropus leucopterus*. Rep. Ent. Soc. Ont., 1883, pp. 59–62. Its appearance in New York State and a general account of the insect,—principally after Lintner.

1885. Lintner, J. A.—*Blissus leucopterus*. 2d Rep. Insects N. Y., pp. 148–164. Description; bibliography; history; transformations; early brood; second brood; hibernation; dimorphic form; injuries; operations in New York; measures recommended to arrest the attack, etc.

Bruner, Lawrence.—Idem. Rep. Com. Agr., 1884, p. 399. An instance of the sudden disappearance of vast armies of this insect immediately after several heavy rains.

Riley, C. V.—Chinch Bug Notes. Rep. Com. Agr., 1884, pp. 493, 405. Injuries in New York State in 1882. Different views of the origin of the outbreak discussed.

Family Tettigonidæ.

Leaf Hoppers.

70. Jassus inimicus, Say.

1831. Say, Thomas.—*Jassus inimicus*. Jour. Acad. Nat. Sci. Phila. VI., 305. Complete writings, II., 382. Original description. Reported from Virginia as depredating on the roots of wheat.

1885. Forbes, S. A.—Idem. 14th Rep. St. Ent. Ill. pp. 22, 67. Has occasionally occurred in June and July in sufficient numbers to injure young Indian corn appreciably.

71. Cicadula nigrifrons, Forbes.

1885. Forbes, S. A.—*Cicadula nigrifrons* 14th Rep. St. Ent. Ill., pp. 22, 67, pl. v, fig. 3. Original description. Food plants: wheat and Indian corn. Occasionally in sufficient numbers to injure latter.

72. Cicadula quadrilineatus, Forbes.

1885. Forbes, S. A.—*Cicadula quadrilineatus.* 14th Rep. St. Ent. Ill., pp. 22, 68, pl. v, fig. 4. Original description. Food plants: wheat and Indian corn. Occasionally in sufficient numbers to injure Indian corn.

73. Macropsis nobilis.

1885. Forbes, S. A.—*Macropsis nobilis.* 14th Rep. St. Ent. Ill., p. 22. Occasionally occurs in sufficient numbers, in June and July, to injure young Indian corn plants.

Family Aphididæ.

74. The Corn Plant Louse.

(*Aphis maidis*, Fitch.)

1856. Fitch, Asa.—*Aphis maidis.* 2d Rep. Ins. N. Y. pp. 318–320. Original description of ærial larva and wingless and winged females. Mentions the occurrence of the ærial form on Indian corn and predicts that it will probably multiply at times sufficiently to do much injury.

1863. Walsh, B. D.—Idem. Proc. Ent. Soc. Phila., I., 300 wingless ♀ fig. 3, winged ♀ fig. 1. (On the genera of Aphidæ found in the United States.) Description of wingless and winged females of root form.

1865. Walsh, B. D.—The Corn Root Louse. Trans. Ill. St. Agr. Soc. V., pp. 491–497. (A New Enemy of the Corn.) Relation of ants to plant lice. Occurrence of corn plant louse near Rock Island.

1878. Thomas, Cyrus.—*Aphis maidis.* 7th Rep. St. Ent. Ill., pp. 75–78, fig. 18. Description of wingless and winged individuals found on tassels. Statement from correspondents as to injuries. Remedies.

1880. Thomas, Cyrus.—Corn Aphis. 9th Rep. St. Ent. Ill., p. 2. Root form most injurious. Recommends rotation of crops, thorough fall plowing and turning under strong lime.

1882. Boardman, E. R.—*Aphis maidis.* Stark County News. General accounts of its life history. Rotation advocated as the most effectual remedy.

1883. Forbes, S. A.—Idem. A Lecture on Insects Affecting Corn, pp. 12–14. Relation of ants to corn plant lice. Known life history.

Popenoe, E. A.—The Corn Plant Louse on Cane. 3d Biennial Rep. St. Bd. Agr. Kan., VIII., 617. Relation of the

larvæ of Syrphus fly to corn plant louse. Injurious to sorghum in Kansas.

FORBES, S. A.—*Aphis maidis.* 12th Rep. St. Ent. Ill., pp. 44, 116. Ants (*Lasius flavus* [*alienus*]) caring for corn plant lice. *Megilla maculata, Hippodamiga convergens* and *H. glacialis* as enemies.

1884. FORBES, S. A.—Idem. 13th Rep. St. Ent. Ill., pp. 46–50, pl. III, fig. 5; pl IV, figs. 1, 2, 3. Treated in reference to its injuries to sorghum and broom corn. Description of imago; life history; natural enemies and remedies.

1885. GARMAN, H.—Idem. 14th Rep. St. Ent. Ill., pp. 23–33. Description of pupæ and winged and wingless females of both root and ærial forms. Suggests various theories of hibernation. Life history and habits. Parasites and predaceous insect enemies, and artificial remedies.

ORDER ORTHOPTERA.

Family GRYLLIDÆ.

75. THE WESTERN CRICKET.

(*Anabrus simplex*, Hald.)

1852. HALDEMAN, S. S.—*Anabrus simplex.* Stanbury's Expedition to the Great Salt Lake, p. 372, pl. x, fig. 4. Original description. States that it seemed to be one of the species eaten by the aborigines.

1877. PACKARD, A. S., Jr.—Idem. 9th Rep. U. S. G. G. Surv. Terr. pp. 691–693. Description of imago. Injuries to INDIAN CORN. Preventive measures.

1880. PACKARD, A. S., Jr.—Idem. 22d Rep. U. S. Ent. Com. pp. 163–178, figs, 2, 3, 4, 5. Habits and ravages; food; predaceous enemies and internal parasites; breeding habits; remedies; distribution; distinguishing characters; anatomy.

1883. BRUNER, LAWRENCE.—Idem. 3d Rep. U. S. Ent. Com. pp. 61–64. Ravages, habits and natural history. Breeding habits; distribution; parasites.

Family LOCUSTIDÆ.

76. ORCHELIMUM VULGARE, Harr.

1842. HARRIS, T. W.—*Orchelimum vulgare.* Rep. Mass. Ins., p. 130. Original description.

1862. HARRIS, T. W.—*Idem.* Insects Injurious to Vegetation, 3d ed., pp. 161, 162, fig. 77. (See under 1842.)

1863. RATHVON, S. S.—Idem. Rep. Com. Agr. 1862, p. 382. Brief description of imago. Abundant species.

1869. PACKARD, A. S., Jr.—Idem. Guide to the Study of Insects. p. 567. Brief description of imago. Common northward.

1885. Forbes, S. A.—Idem. 14th Rep. St. Ent. Ill., p. 23. Injury to Indian corn in Southern Illinois.

Family Acrididæ.

77. The Red-Legged Locust.

(*Pezotettix femur-rubrum*, DeG.)

1773. De Geer, Carl.—*Acridium femur-rubrum*. Mem. pour Serv., p. 498, pl. 42, fig. 5. Original description.

1842. Harris, T. W.—*Acrydium femur-rubrum*. Rep. Mass. Ins. Description of imago, and brief account of habits, life history, and injuries.

1862. Harris, T. W.—Idem. Insects Injurious to Vegetation, 3d ed., p. 174. (See under 1842.)

1865. Thomas, Cyrus.—*Acridium femur-rubrum*. Trans. Ill. St. Bd. Agr. V., 451. Description of imago; habits; and distribution.

1868. Walsh and Riley.—*Caloptenus femur-rubrum*. Amer. Ent. I., 16. Abundance in Illinois in 1868.

1868. Walsh, B. D.—Idem. 1st Rep. St. Ent. Ill., pp. 99–101. Compared to *Caloptenus spretus*. Injuries to Indian corn. Occurrence and past history in Illinois.

1869. Packard, A. S., Jr.—Idem. Guide to the Study of Insects, pp. 569, 570, fig. 564b. Abundance and distribution.

1872. LeBaron, Wm.—Idem. 3d Rep. St. Ent. Ill., p. 157. Account of a parasitic mite.

1873. Thomas, Cyrus.—Idem. Rep. U. S. Geol. Surv. Terr. V., Part I., 163. (Synopsis of the Acrididæ of N. A.) Description of imago. Distribution.

1875. Glover, Townend.—Idem. Rep. Com. Agr. 1874, pp. 126, 136. Occurrence and damage in Eastern States.

1877. Thomas, Cyrus.—Idem. 6th Rep. St. Ent. Ill., p. 45. Replaced in Illinois during season of 1875 by *Caloptenus atlanis*.

1878. Riley, C. V.—Idem. 1st Annual Rep. U. S. Ent. Com., pp. 443–448. Migratory habit, distribution, and injuries.

Thomas, Cyrus.—Idem. 7th Rep. St. Ent. Ill., pp. 38–40. Description of male and female, and comparison with *Caloptenus spretus*.

1880. Thomas, Cyrus.—Idem. 9th Rep. St. Ent. Ent. Ill., pp. 124–126, 131–140. Description of male and female; life history; injuries; remedial agencies.

1885. Forbes, S. A.—*Pezotettix femur-rubrum*. 14th Rep. St. Ent. Ill., p. 23. Injury to Indian corn.

78 The Lesser Locust.

(*Pezotettix atlanis*, Riley.)

1875. Riley, C. V.—*Caloptenus atlanis*. 7th Rep. St. Ent. Mo., p. 169. Original description.

1878. Riley, C. V.—Idem. 1st Annual Rep. U. S. Ent. Com. pp. 443–448. Flights; injuries; distribution; migratory habits.

Thomas, Cyrus.—Idem. 7th Rep. St. Ent. Ill., p. 38. Description of imago. Comparison to allied forms.

1884. Riley, C. V.—Idem. Rep. Com. Agr. 1883, pp. 170–180. Its ravages in New Hampshire. Past History. Injury to corn. Characters; range and life history; natural enemies; remedies.

1885. Forbes, S. A.—*Pezotettix atlanis*. 14th Rep. St. Ent. Ill., p. 23. Injury to Indian corn.

79. The Rocky Mountain Locust.

(*Pezotettix spretus*, Thos.)

1865. Thomas, Cyrus.—*Acridium spretis*. Trans. Ill. St. Agr. Soc. V., 450. Original description.

1867. Glover, Townend.—*Caloptenus spretus*. Rep. Com. Agr. 1866, pp. 27, 28. Injuries in Kansas. Letters of inquiry and answers.

1868. Walsh, B. D.—Idem. Pract. Ent. II., 1–5, and 22. (Grasshoppers and Locusts.) First specificably recognizable mention of this species. Its ravages and migrations; probable limit of its range; preventing its increase. Injuries to Indian corn, pp. 3 and 4.

Nickerson, M. C. "Grasshoppers." Am. Ent. I., 27. (Devastations in western Iowa, and the good that resulted from them.) Destroyed late planted Indian corn. Seeds of *Vilfa vaginæflora* imported by them.

Walsh, B. D.—*Caloptenus spretus*. 1st Rep. St. Ent. Ill., pp. 82–103. Eastern limit of the range of the locust. Occurrence and ravages in Texas and Missouri in 1866, and in the Mississippi Valley in 1867. Past history; compared to *C. femur-rubrum*. Injuries to Indian corn, pp. 88, 90, 95.

Walsh and Riley.—Idem. Amer. Ent. I., pp. 73–76, fig. 65. Distinguished from *C. femur-rubrum*. Its native haunts, migrations, geographical range, and ravages.

1869. Packard, A. S., Jr.—Idem. Guide to the Study of Insects, p. 570, fig. 564a. Abundance, distribution, and ravages.

Byers, W. N.—The "Colorado Grasshopper." Amer. Ent. I., pp. 94, 95. Native haunts, migrations, ravages, and enemies.

1873. Thomas, Cyrus.—*Caloptenus spretus*. Rep. U. S. Geol. Surv. Terr. V., Part I., 164. (Synopsis of the Acrididæ of North America.) Description of the imago. Distribution.

1875. Riley, C. V.—Idem. 7th Rep. St. Ent. Mo., pp. 121–196, figs. 23–39. Its characters; natural and chronological history; habits; ravages; predaceous enemies and parasites; home; migrations and geographical distribution; means of preventing its ravages. Injuries to Indian corn, pp. 146, 150, 152. Food plants, 158.

Thomas, Cyrus.—Idem. Daily Inter Ocean, October 9, 1875. Origin and movements; hatching grounds and highways on our western frontiers; means of counteracting their inroads.

Glover, Townend.—Idem. Rep. Com. Agr. 1874, pp. 125, 126, 136, 137. Injury and suffering caused.

Bethune, C. J. S.—Idem. Rep. Ent. Soc. Ont. 1874, pp. 29–42, figs. 30–34. Past history. Plague of 1874. Locust in Manitoba. Description of imago compared to *C. femurrubrum*. Means of reducing its ravages.

1876. Bethune, C. J. S.—Idem. Rep. Ent. Soc. Ont., 1875, pp. 45–54. Compiled account of its occurrence and doings in 1875. Extracts from Riley's Eigth Report on means of reducing ravages, etc.

Riley, C. V.—Idem. 8th Rep. St. Ent. Mo., pp. 57–156, figs. 39–47. Detailed account of its ravages in Missouri and neighboring states in 1875. Natural history of young; definition of the species; its native home; migrations and ravages; compensations that follow their ravages; natural and artificial means of reducing them. Use of locusts as food.

1877. Riley, C. V.—Idem. 9th Rep. St. Ent. Mo., pp. 57–124, figs. 16–29. Its doings in 1876 in the northern and western states and territories of the Mississippi Valley. Detailed reports from counties in Missouri. Source of the swarms of 1876; direction, rate, and extent of their flight. Geographical range and that of its allies. How the eggs are laid and hatched. Predaceous enemies and parasites. Experiments to determine the best artificial means of reducing its ravages. Legislation on the subject by Missouri, Kansas, and Minnesota. Injuries to Indian corn, pp. 63, 64, 65.

Packard, A. S., Jr.—Idem. 9th Rep. U. S. G. G. Surv. Terr., pp. 591–684. Their occurrence and ravages in Colorado, Kansas, Wyoming, Utah, New Mexico, and Nevada. Their northern range; their invasion in 1876; their habits, seasons, and development. Classificatory characters, geographical distribution and migrations; external enemies and parasites. Preventive measures; summary of our present knowledge. Meteorological data.

Thomas, Cyrus.—Idem.—6th Rep. St. Ent. Ill., pp. 44–56. Its invasions and migrations; extent of hatching ground; remedial agencies. Injuries to Indian corn, p. 51.

1878. Riley, Packard, and Thomas.—Idem. 1st Annual Rep. U. S. Ent. Com. An elaborate treatment of the subject, with a consideration of the best means of preventing the injuries and guarding against the invasions of the insect.

THOMAS, CYRUS.—Idem. 7th Rep. St. Ent. Ill., pp. 36-38, fig. 8. Description of male and female, and comparison with allied forms.

1880. THOMAS, CYRUS.—Idem. 9th Rep. St. Ent. Ill., pp. 121-123, figs. 19, 20, 21. (Acrididæ of Illinois.) (See under 1878.)

RILEY, PACKARD, AND THOMAS.—Idem. 2d Annual Rep. U. S. Ent. Com. Additions to the chronology of ravages, and their relation to agriculture and the settlement of the territories. Meteorological influences. Southern limits of distribution. Summary of locusts' flights. The air sacs of locusts with reference to their powers of flight. Histology of the brain, further facts about natural enemies. Courses that may be adopted by general government to lessen injury.

1883. BRUNER, LAWRENCE.—Idem. 3d Rep. U. S. Ent. Com., pp. 8-52. Occurrence in Montana in 1880; in Wyoming, Montana, etc., in 1881.

1885. BRUNER, LAWRENCE.—Idem. Rep. Com. Agr., 1884, p. 398. Occurrence in Nebraska in 1884.

80. PEZOTETTIX DIFFERENTIALIS, Thos.

1865. THOMAS, CYRUS.—*Acridium differentialis.* Trans. Ill. St. Agr. Soc., V., 450. Original description.

1868. WALSH & RILEY.—*Caloptenus differentialis.* Amer. Ent., I., 16. Abundance in Illinois in 1868, and its replacement by *Caloptenus bivittatus* in vicinity of Chicago.

1871. THOMAS, CYRUS.—Idem. Proc. Acad. Nat. Sci. Phila., 1871, p. 149. Species more fully described, male and female.

1873. THOMAS, CYRUS.—Idem. Rep. U. S. Geol. Surv. Terr. V., Part I., p. 166. (Synopsis of the Acrididæ of N. A.) Description of imago, and distribution.

1875. THOMAS, CYRUS.—Idem. Daily Inter Ocean, October 9, 1875. Notes the flights of this species, and believes it will never become habitually migratory.

1877. THOMAS, CYRUS.—Idem. 6th Rep. St. Ent. Ill., pp. 44, 45. Instance of its migration in Illinois. This probably not habitual.

1878. RILEY, C. V.—Idem. 1st Annual Report U. S. Ent. Com., pp. 443-448. Migratory habit, distribution, injuries. Modified form of migratory insects.

1880. THOMAS, CYRUS.—Idem. 9th Rep. St. Ent. Ill., pp. 127, 131-140. Description of imago; life history; injuries; remedial agencies.

1885. BRUNER, LAWRENCE.—Idem. Rep. Com. Agr. 1884, p. 399. Largely on the increase in western Iowa and eastern and central Nebraska.

1885. FORBES, S. A.—Idem. 14th Rep. St. Ent. Ill., p. 23. Injury to INDIAN CORN in Southern Illinois.

81. Acridium dmericanum, Drury.

1773. Drury, Drew.—*Gryllus americanus.* Ill. II., 128, fig. 1; pl. 4, fig. 2. Original description.

1865. Thomas, Cyrus.—*Acridium americanum.* Trans. Ill. St. Agr. Soc. V., 448, 452. Description of imago; distribution, and injuries.

1875. Thomas, Cyrus.—Idem. Rep. U. S. Geol. Surv. Terr. V., Part I., 172. (Synopsis of Acrididæ of North America.) Description of imago and distribution.

Riley, C. V.—Idem. 7th Rep. St. Ent. Mo., pp. 173, 174. Injuries to vegetation in Virginia.

1876. Riley, C. V.—Idem. 8th Rep. St. Ent. Mo., pp. 103, 104. Its occurrence with *Pezotettix spretus.*

1877. Riley, C. V.—Idem. 8th Rep. St. Ent. Mo., p. 84. Flights of this species reported from Ohio, Indiana, North Carolina, and Georgia.

Packard, A. S., Jr.—*Acrydium americanum.* 9th Rep. U. S. G. G. Surv. Terr., pp. 690. 691, pl. xliv, fig. 6. Occasionally very destructive to vegetation in Southern States, particularly to Indian corn and cotton.

1878. Riley, C. V.—*Acridium americanum.* 1st Annual Rep. U. S. Ent. Com. pp. 448–450. Migratory habits.

1880. Thomas, Cyrus.—Idem. 9th Rep. St. Ent. Ill., pp. 129–140. Description, life history, injuries, remedial agencies. Injury to Indian corn, p. 135.

Thomas, Cyrus.—Idem. Amer. Ent. III., 250. Sudden increase in southern Illinois, caused by dry weather.

1885. Forbes, S. A.—Idem. 14th Rep. St. Ent. Ill., p. 23. Injury to Indian corn in southern Illinois.

For further bibliography of the locusts of America, see 1st Ann. Rep. U. S. Ent. Com., 1877, Appendix xxvii, by B. Pickman Mann.

Class MYRIAPODA.

Family Iulidæ.

82. The Corn Myriapod.

(*Iulus impressus*, Say.)

1821. Say, Thomas.—*Julus impressus.* Proc. Acad. Nat. Sci. Phila., II., 102. Complete writings, II., 24. Original description.

1882. Coquillet, D. W.—Idem. 11th Rep. St. Ent. Ill., p. 44. Characters; condition necessary for its existence. Feeds upon the ears of Indian corn which lie upon the ground.

1884. Forbes, S. A.—*Iulus impressus.* 13th Rep. St. Ent. Ill., p. 140. Reported injury to stalks of currant bushes.

SYSTEMATIC LIST OF CORN INSECTS.

Hymenoptera.

1. Solenopsis fugax, Latr. (Small Yellow Ant).
2. Solenopsis molesta, Say.

Lepidoptera.

3. Arctia arge, Drury. (The Arge Tiger Moth).
4. Leucarctia acræa, Drury. (The Salt Marsh Moth).
5. Spilosoma virginica, Fab. (The Yellow Bear).
6. Empretia stimulea, Clemens. (Saddle Back Caterpillar).
7. Hyperchiria io, Fab. (The Io Moth).
8. Apatela oblinita, Sm. and Abb. (The Smeared Dagger).
9. Agrotis c-nigrum, Linn. (Spotted Cutworm).
10. Agrotis subgothica, Haw. (The Dingy Cutworm).
11. Agrotis herilis, Grote. (Western Striped Cutworm).
12. Agrotis clandestina, Harr. (W-marked Cutworm).
13. Agrotis messoria, Harr. (Dark-sided Cutworm.)
14. Agrotis tessellata, Harris. (Striped or Corn Cutworm).
15. Agrotis ypsilon, Rott. (Greasy or Black Cutworm).
16. Agrotis saucia, Hübn. (Variegated Cutworm).
17. Hadena devastator, Brace. (Glassy Cutworm).
18. Hadena arctica, Boisd. (The Yellow-headed Cutworm).
19. Laphygma frugiperda, Guen. (The Fall Army Worm).
20. Nephelodes violans, Guen. (The Bronze-colored Cutworm).
21. Gortyna nitela, Guen. (The Stalk Borer).
22. Achatodes zeæ, Haw. (The Spindle Worm).
23. Heliophila unipuncta, Haw. (The Army Worm).
24. Heliothis armiger, Hübn. (The Corn Worm).
25. Asopia farinalis, Linn. (Meal Snout Moth).
26. Pempelia lignosella, Zeller. (The Smaller Corn Stalk Borer).
27. Crambus zeëllus, Fernald. (The Root Web Worm).
28. Diatræa saccharalis, Fab. (The Corn Stalk Borer).
29. Lophoderus triferana, Walk. (The Red-banded Leaf Roller).
30. Dichelia sulphureana, Clemens. (The Sulphur Leaf Roller).

31. Sitotroga cerealella, Oliv. (Angoumis Grain Moth).
32. Tinea granella, Linn. (The Grain Moth).
33. Tinea zeæ, Fitch. (The Indian Meal Moth).

Diptera.

34. Sciara sp., ? (The Black-headed Grass Maggot).
35. Anthomyia zeæ, Riley. (The Seed-corn Maggot).
36. Diastata sp. ? (The Corn Leaf Miner).

Coleoptera.

37. Omophron labiatum, Fab.
38. Megilla maculata, DeG. (The Common Lady Bug).
39. Silvanus surinamensis, Linn.
40. Silvanus cassiæ, Reich.
41. Silvanus advena, Waltl.
42. Typhœa fumata, Linn.
43. Ips fasciatus, Oliv.
44. Tenebrioides dubia, Melsh.
45. Agriotes mancus, Say.
46. Melanotus communis, Gyll.
47. Melanotus cribulosus, Lec.
48. Sitodrepa panicea, Linn.
49. Aphodius lutulentus, Hald.
50. Macrodactylus subspinosus, Fab. (The Rose Beetle).
51. Lachnosterna sp. (The White Grub).
52. Euphoria inda, Linn. (The Indian Cetonia).
53. Prionus imbricornis, Linn. (The Tile-horned Prionus).
54. Diabrotica longicornis, Say. (The Corn Root Worm).
55. Systena blanda, Melsh. (Flea Beetle).
56. Chætocnema pulicaria, Melsh. (The Brassy Flea-Beetle).
57. Tenebrio obscurus, Fab.
58. Tenebrio molitor, Linn.
59. Epicauta vittata, Fab. (The Striped Blister Beetle).
60. Epicauta pennsylvanica, DeG. (Black Blister Beetle).
61. Epicærus imbricatus, Say. (The Imbricated Snout Beetle).
62. Sphenophorus pertinax, Oliv.
63. Sphenophorus robustus, Horn. (Corn Bill-Bug).
64. Sphenophorus cariosus, Oliv.
65. Sphenophorus sculptilis, Uhler. (Sculptured Corn Curculio).
66. Sphenophorus parvulus, Gyll.
67. Calandra oryzæ, Linn. (The Rice Weevil).
68. Calandra granaria, Linn. (The Grain Weevil).

Hemiptera.

69. Blissus leucopterus, Say. (Chinch Bug).
70. Jassus inimicus, Say.
71. Cicadula nigrifrons, Forbes.
72. Cicadula quadrilineatus, Forbes.
73. Macropsis nobilis.
74. Aphis maidis, Fitch. (Corn Plant Louse).

Orthoptera.

75. Anabrus simplex, Hald. (Western Cricket).
76. Orchelimum vulgare, Harr.
77. Pezotettix femur-rubrum, DeG. (Red-legged Locust).
78. Pezotettix atlanis, Riley. (Lesser Locust).
79. Pezotettix spretus, Thos. (Rocky Mountain Locust).
80. Pezotettix differentialis, Thos.
81 Acridium americanum, Drury.

Class Myriapoda.

82. Iulus impressus, Say.

NOTES FROM LIVINGSTON AND ADJACENT COUNTIES.

Dr. F. W. Goding, of Ancona, Livingston county, acted during the season as a local observer for the office, and from his notes and letters the following data are gleaned:

May 16, WIREWORMS were found in great numbers in recently planted corn, eating the root sprouts of the kernels; in no case attacking the young plant. They were found in about fifteen per cent. of the hills examined, in some cases so affecting the corn as to necessitate replanting. The injury continued for about two weeks, during which the weather remained dry and clear, but complaints ceased with the appearance of the first rains.

GRASSHOPPERS were first noticed in abundance, feeding upon corn, on the 29th of June, at which time they were still in their larval stage. "July 23, I called at Mr. D. Rice's where the insects were to be seen by the millions,—in the pupa stage, usually."

"There were several species, the greater number being *Pezotettix femur-rubrum*, *P. atlanis* and *P. bivittatus*, mature. In the field we examined them carefully. As the mower, in its work, gradually decreased the area of standing grass, the insects accumulated in such numbers that the field was blackened, while the grass was crushed to the earth. Millions upon millions were to be found. The hay-cocks were covered so closely that the forks in the hands of the laborers inevitably speared many. The air above and around was literally alive with the grasshoppers, causing a premature twilight to appear. The barns were so thoroughly covered that the color of the paint could not be distinguished.

"The greatest damage, however, was to the oat crop. The insects were found in the usual countless myriads engaged in destroying the grain. They would gnaw off the stalk just below the head, which dropped to the ground and was lost. I passed by several fields the edges of which had been ruined,—rarely a head of grain to be seen for a distance of several rods from where I stood. This was continued, in many fields, over the entire surface—in such instances the crop of course being a total failure. Many fields of grain harvested which, had it not been for the ravages of the pest, would have yielded at least fifty bushels per acre, gave only from three to sixteen bushels per acre. In every case the entire field was damaged more or less, but always to a greater degree around the edges.

"From August 15 to Sept. 1 I was in Kane county, where I learned of the damage to oats and corn by the locusts. Oats were damaged from three to thirty bushels per acre. One farmer had previously estimated his oat crop at forty-five bushels per acre; he realized

three bushels. Others estimated their loss at from three to fifteen bushels per acre. I examined corn fields in the vicinity of Blackberry (Kane county) that had been damaged by locusts. The insects would gnaw off the end of the ear (cob, kernel, and husk with silk) with as great a degree of nicety as could be attained with a sharp knife. The kernels would then be eaten for quite a distance towards the butt of the ear, beneath the husks. The damage was estimated by farmers at about fifteen bushels per acre—rather high, I think.

"In Livingston county the locusts appeared in injurious numbers in a strip averaging five miles in width. On either side of the borders the locusts were not heard from."

The CHINCH BUG was extremely rare in his vicinity, not coming to his notice until August 3, when a number were found in the larval stage.

The GRAPE BERRY MOTH (*Eudemis botrana*, Schiff.) has been very destructive to grapes in Livingston county for the past two years.

A *dipterous larva* was noticed injuring celery, both last year and the preceding, in both Livingston and Kane counties. It begins to gnaw the base of the stalk, gradually progressing upwards. Its presence is easily traced by worm-eaten passages, which early turn to a rusty color. The maggot is about three fourths of an inch long, footless, dirty pale yellow, posterior extremity truncate, the head with the usual two black hooks of dipterous larvæ. It pupates within the celery stalk, emerging as an imago early in June. "The single fly I obtained may be described as follows: The general color is black, sprinkled with yellow hairs, the head being dark brown. The wings are clear, with veins light yellow, as also are the legs. The body is about 7 mm."

The following notes on the prevalence of the CABBAGE WORM will be of interest as related to the effect of *flacherie:*

"While in Kane county, I found the cabbage plants to be almost totally destroyed so far as heading was concerned. *Pieris rapæ* was everywhere numerous. The heading process having been prevented, the plants grew rapidly upwards to a considerable hight, putting out long, slender leaves, and presenting a very peculiar appearance. These leaves were infested by the cabbage aphis. The crop in Blackberry and Kaneville townships was a failure. This was in striking contrast with the cabbage patches of Reading township (my own home). Here, in the previous years, the *Pieris rapæ* had almost entirely prevented the rearing of a sound cabbage head, while during the past year I failed to obtain a single specimen of the larva, though occasionally an imago would be seen flitting by. Their absence was due chiefly, I think, to the parasitic disease which destroyed so many two years ago. Around Streator, where large fields of cabbage may be seen every year, the pest was far less troublesome than in former years. While on the subject of *P. rapæ*, I will remark that I repeated the experiment, several times this summer, of preventing oviposition of the female by applying kerosene emulsion freely on the plants during the time the butterflies were about."

THE RASPBERRY MEASURING WORM, *Eutrapela transversata*, Drury, was sufficiently numerous near Ancona, during the summer of 1884,

to injure seriously the raspberry crop. "It is mentioned by Dr. Packard as having been found by him on red maple leaves, and he also mentions the sweet pepper bush (*Clethra alnifolia*) as its food plant, while Mr. Emerton observed it on the currant. [Prof. French has observed it near Carbondale feeding on *Lepidium virginicum* and *Polygonum aviculare*.] As this species is not mentioned in any of the numerous entomological reports or works on applied entomology [excepting by French], it has probably not heretofore been injurious. The larva injures the crop by eating the leaves and berries, and the same articles of diet were taken by all the specimens reared by me. I first noticed them during the middle of June, at which time they were about half grown. Those reared in confinement made the cocoons July 5th to 7th, the larvæ changing to chrysalids two days later.

"The larva is of a beautiful reddish violet color, marked transversely with reddish stripes, and 2½ to 3 inches long. On the third thoracic ring is a sharp tubercle, while just behind the middle of the body is a large wart, and also one on each side of the middle; just in front of the last pair of abdominal feet, on the back, is quite a large hump. The larva is a handsome object, and when once seen and identified, is easily recognized afterwards. The cocoons were made of raspberry leaves and berries, in nearly circular arrangement, the whole mass held together with silk. The cocoons were all formed on the floor of the breeding cages. In one instance the larva crawled into a cocoon that had been made by another species, and in due time emerged as a moth. The pupa is three fourths of aninch long, flesh-colored except the end of the abdomen, which is reddish brown. On the back is a row of black dots, one for each ring, and on the side are three rows, one continuing to the head. The whole is sprinkled with reddish dots. The venation of the wings and the antennæ were plainly to be seen.

"The moths appeared July 24 and 25. They were quite variable in color and markings, yet there was a close general resemblance. Usually of a fawn color, some were light ochreous and others dark reddish brown. On the fore wings were usually found two chocolate brown lines, the outer one making an acute angle near the apex, and as a rule passing over the surface of the hind wings also, while the inner line was more wavy and rarely passed on to the posterior wings. Outside of the outer line were several darker shades, which, in many specimens, were brown patches. Near the center of each wing the discal dot was always present.

"When the matter of remedies is to be considered, one is to be sought for that will not only destroy the pest, but also leave the fruit in an edible condition. The kerosene emulsion and arsenical preparations were tried and found effectual for the destruction of the insect, but when applied while the fruit was yet on the plants they of course rendered it unfit for use. When for any reason the fruit is not to be gathered, or when the caterpillars appear after the fruit has been harvested, the above preparations may be used with benefit. The remedy found most useful was hand-picking or beating the bushes with large broom-corn brushes, and then crushing the larvæ as they fall to the earth. As yet the time and place of

oviposition are not known, and it may be that they are most vulnerable in the egg state. If so the kerosene emulsion will be effective if the eggs are in exposed location.

"Last winter and this spring the small plain brown beetle known as *Stenosphenus notatus*, Oliv., was present in immense numbers, seriously injuring and destroying vast numbers of hickory trees in the woods about here. Unless preyed upon by many parasites it will soon exterminate our hickory trees."