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A LECTURE

ON

WIREWORM

WITH

METHODS OF PREVENTION AND REMEDY,

DELIVERED AT THE

ROYAL AGRICULTURAL COLLEGE,

CIRENCESTER,

BY

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WIREWORM: ITS HISTORY, ATTACKS, AND REMEDIES.

The following lecture on wireworm was delivered by Miss E. Ormerod, Special Lecturer on Economic Entomology at the College, and Consulting Entomologist to the Royal Agricultural Society, to the students of the Royal Agricultural College, Circncester, on Friday, June 22nd, 1883:—

On the previous occasions on which I have had the pleasure of addressing you, we have considered some of the main points in the history and the habits of injurious insects, and the manner in which a knowledge of the habits of these farm pests may help us to bring measures of agricultural treatment to bear on them at the times when they lie most in our power: and we have also considered the history and methods of prevention of "Turnip Fly" in some detail. At present I purpose offering you some obscrvations on the history and methods of prevention of "Wireworm."

The habits of this destructive insect enemy differ from those of almost all the other kinds which infest our British crops, inasmuch as they unite the three following distinctions. The lifetime of the grub extends over as much as five years, and during this time it feeds in winter as well as in summer, unless the cold is so severe as to cause torpidity, and (with the exception of mustard) it appears to feed on the roots, or underground portion of the leafage, of almost all kinds of common farm crops which may be successively put into the ground.

I believe that we are all of us pretty well acquainted with the "click beetles" which lay the eggs from which the wireworms are produced. There are many kinds of these Elaters, or "Skip Jacks," as they are often called, from their power of springing up in the air if they have been laid on their backs, and regaining their position with a skip, or a spring and a click; but the kinds most frequently met with are the striped click beetle, the *Elater* or *Agriotes lineatus*; also a kind which differs very little from it, excepting in being of a more general brownish or blackish tint, known as *Agriotes obscurus*; a smaller kind, the *A. sputator*, which besides occurring in profusion in all the common localities of click beetles, is stated to be often found in rubbish left by floods; and a fourth kind, the *Athous ruficaudis*, or *hæmorrhoidalis*, which has wing cases

and abdomen of a rusty or rufous colour. In shape they much resemble a single seed taken from a ripe sunflower head—they are narrow, often flattish, about half-an-inch long (some kinds more, some less), and the common kinds are of some shade from greyish or reddish brown to black.

These beetles lay their eggs amongst grass or other ground leafage, and for this reason the wireworms which are hatched from these eggs are most numerous in grass fields or clover leys, as year by year the beetles settle down on these suitable spots, and the wireworms remaining undisturbed thrive without drawbacks. In such places we may find them of all ages, from those hatched in the current season up to those which have been feeding for five years, and which, having reached the limit of their larval life, are now going deep down into the ground to change to chrysalids.

We all know the appearance of the common wireworm by its resemblance to a short piece of flattened wire, or of straw, which it resembles in colour, but some kinds found in decayed leaves or wood are of a deep pitchy brown. All of them have three pairs of little claw legs, and also jaws which they use only too readily.

Where wireworm is numerous in wheat or any other growing crop, if this crop is in good heart, or as was often the case last year (1882), if the weather is favourable, we may very possibly escape much damage. Or sometimes we may lessen the amount of injury that is going on by various measures, such as compressing the soil so as to prevent the wireworms travelling through the ground, or using applications which will attract the worm or drive it away, and so give the plant a temporary respite, or which will act as temporary fertilizers. Still, these special measures require special outlay, and it is a much better plan as far as we possibly can to forestall attack, and as wireworm is generally to be found in land broken up from old pastures, clover leys, or sainfoin, the treatment of these, both before and after breaking up, so as to lessen the amount of egg-laying, and also to diminish the numbers of the wireworms (which otherwise would have infested each successive crop for years), is an important item in prevention.

If we look first at the treatment recommended before breaking up grass or pasture land, or for reducing the ground into proper condition for the succeeding crop, we find the points aimed at are to make the surface quite unattractive for egg-laying, and to starve out the wireworms.

For this purpose it is found serviceable to feed sheep or cattle on the ground with cake, or other feeding stuff, "so that each inch of ground shall be trodden and eaten bare." In one locality this plan was carried out by penning such sheep as were to be fattened during the winter on the land. The sheep were fed with turnips, oats, and hay. The pen enclosed as much ground as could be thoroughly trodden by the animals in the course of a week, and was then moved forward, going on regularly from one side of the field to the

other, the ploughs following regularly so as not to retard spring operations. In this way (or with any adaptation of the principle that may be more convenient) the surface is so completely cleared of grass and herbage, and also sodden and consolidated, or "firmed," as it is sometimes phrased, by the droppings and by the trampling of the animals, that the beetle eggs are either not laid on the unsuitable ground, or are for the most part destroyed, and the wireworms are lessened in number or driven away by want of food, and difficulty of travelling in the firm and poisoned ground.

Various chemical manures have been found useful for top dressing in the same way. Salt, at the rate of five to six cwt. per acre, has been serviceable in many cases, and applied in heavier dressings up to ten or twelve cwt. some weeks before sowing, it has served not only to diminish the numbers of the wireworm, but also to clear out the twitch or couch grass, which serve for a most favourite head quarters of these insect vermin. Gas lime acts well, at the rate of five cwt. the acre, or applied fresh and in larger quantities may be used as a regular killing dressing fairly to stamp out all surface life, insect and vegetable, and "Alkali waste" (where procurable) is a valuable application for the same purpose. In the neighbourhood of chemical works this material is to be had for little if any cost beyond that of carriage, and its strongly caustic properties make it a thoroughly valuable application for killing everything objectionable on which it can be brought to bear. In heavy dressings it destroys the deepest rooted weeds, such as thistles or coltsfoot, as well as couch grass, and insect vermin fare no better in contact with it, and when its first work is over the process of oxidation turns it to a manure suitable to land on which gypsum is of use. The large amount of this material which is sometimes laid on in the neighbourhood of works where it is thrown out for the having, may be considered an extreme example of the principle of stamping out vegetable and insect enemies together, and letting the land rest a few months to recover itself; but in whatever way we set about the work, the various details of this very first commencement of getting infested ground into a fairly safe state turn on the points just brought forward of making the surface unattractive to the beetle for egg laying, of destroying the eggs, and of lessening the numbers of the wireworm by the state of the artificially sodden and poisoned and compressed ground.

It is not desirable that I should take up your time by entering on the details of the different agricultural measures used in breaking up pasture land for the prevention of future attack, but I will endeavour to point out how, in the general system of operations adopted by many agriculturists the main points are suited to act at once on known habits of the wireworms, and also how sometimes all the benefit hoped for may be lost for want of a little care or knowledge.

The general plan followed by many agriculturists may be shortly stated to be this—to have the pastures

eaten down as closely as possible, to break up the ground early in autumn, and to collect and burn all grass, weeds, and roots which might give shelter or food to eggs or wireworm. To thoroughly cultivate the land by ploughing, grubbing, or otherwise, working well into it lime (especially in a hot state) or lime and salt, or gas lime, or other applications unfavourable to insect life. Also such manure and fertilizers should be applied on the land, or drilled with the seed, as will put the crop in good heart. Heavy rolling to compress the soil about the young plants is another important item.

Amongst these operations the point of getting rid of the root rubbish acts in more ways than appears at the first glance. As a matter of course everything alive or dead that can give shelter or food to the wireworm should be destroyed, and collecting and burning it is the most convenient method, but the burning should follow as promptly as possible on the collecting, or else the wireworms which were in the heaps, feeling themselves ill at ease in the unnatural locality, will have gone down into the ground out of reach of injury. If the wireworms are *in* the fired heaps they cannot fail to be destroyed, but a very slight coating of earth between a grub and a fire above it serves for a much greater protection than is commonly supposed. Two inches of earth has been found enough to save a chafer grub from being injured by a strong fire raised above it, and the much more active wireworm is able to pass readily from an uncomfortable locality.

This power of the wireworm to withdraw itself gently and slowly, but very effectually, out of reach of persecution, is one of the points which we are perpetually, and in many kinds of ways, endeavouring to act upon in the greater part of the farm operations which we use for prevention or remedy of its ravages. If you look at this diagram of the creature, or, still better, if you will examine a specimen in your own hands, you will see how perfectly it is calculated to glide through the ground. The flattened or wedge-shaped head is just what is needed to pierce the way forward: the long narrow body, with its hard surface of almost glassy smoothness, offers little resistance in its passage through the ground; whilst the sucker-foot beneath the tail segment, together with the tip of the tail, helps it to gain good leverage for its operations. When it is annoyed it uses its power to remove elsewhere, sometimes to our benefit, for we may thus get rid of it by putting obnoxious dressings on the land: but sometimes much to our inconvenience, for on disturbance, or in frost, or when it is about to turn (when its long life in the larval state is done) to the chrysalis stage, it will leave the surface for a while, and when we have gone to much expense in, as we think, clearing the ground that all the time *it is not in*, the creature will come up again either just as destructive as ever, or in its beetle stage to lay eggs and begin a new attack.

In this power of movement, or of travelling, as it is termed, of the wireworm, we have the obvious reason why all measures to compress or firm the ground are of

use, by keeping these larvæ from straying about and injuring every plant near them, and it is a key to open out a knowledge of much that is not yet traced fully, as to the cause of prevalence of wireworm after particular crops.

If ground is open and porous, in consequence of the presence of roots, or other remains of the preceding crop, this state of things is just suitable to the wireworm, but how we are to remedy this appears to me to be a matter that must vary according to the nature of the soil, and other circumstances.

It is advised to break up old pastures in the autumn that the roots may decay, but on heavy land the turves may be so consolidated with roots, that this rotting may extend over a considerable length of time, and (apparently in consequence of this) we sometimes find wireworm much more troublesome in the *second crop* than in the one immediately following breaking up pasture.

This matter, that is, the land being kept open by vegetable remains, bears on the question of wireworms being injurious after crops (like beans or field cabbage) of which the old stalks or some portion of the haulm are ploughed in, and gives an additional reason for prevalence after clover, and it leads further (though it appears very difficult to carry this point out practically) to whether the opinion may not be perfectly correct which is held by some of our agriculturists, that the use of farmyard manure, in the state in which it is often worked into the land, *encourages* wireworm.

We know from entomological observation that the common wireworm, the larva of the common striped click beetle, *Agriotes lineatus*, has been found, and sometimes in great numbers, in animal as well as vegetable manure, or vegetable earth, also that the wireworm of another kind is to be found in thoroughly decayed stable manure. Now, looking at the practical side, we find that in some places where fern leaves are collected for bedding the cattle, the wireworm has been observed as being numerous in the crop to which the manure has been applied. This is an extreme case, almost equivalent to dressing with decayed leaves, but other opinions are given pointing to attack following on the use of farm manure, and the way in which the trampled straw or vegetable matter in the litter would keep the land open so exactly corresponds with the mechanical effect of the roots, which have to be got rid of after breaking up land, that the matter is worth considering.

In cases—which are not hard to find—where litter is carted out, and left to decay in large heaps, getting meanwhile as well covered with grass and weeds as if expressly arranged to attract the beetle for egg-laying, it is needless to point out what must be the consequences of literally *dressing the ground with wireworms*.

From the information which we have gained of the common habits of the wireworm, and also of its customs when in emergency, there appear to be full reasons for its general prevalence, and amongst these one

especial point is that the same general conditions which suit the growth of most of our crops suit also this destroyer of them. The good tilth by which we push on the first growth of the turnip crop is just suited for the travels of the wireworm, and though a firm soil may be desirable for wheat, yet the heavy pressure, sometimes described as making the land "as firm as a road," which is needed to keep the wireworm from drawing its glass-smooth surface through the soil, is quite beyond what is desirable for the good progress of the rootlets. Most of our crops thrive best in a condition of soil which admits of the action of the weather, such as sun-heat, and moisture, and some degree of air, and which, naturally or artificially, is free enough to allow the fibres of the roots to work their way forward, and here we have what the wireworm delights in. It is for this reason that it is of such immense importance to prevent this pest getting a footing in arable land, for when once it is established, although the healthy state of the crop is one great means of carrying it over attack, yet we often have to bring about a *special vigour* of growth by *special applications*, entailing a cost over and above that of the regularly needed applications. Also for these dressings to act with certainty they should be applied according to knowledge of how their presence in the soil will affect that of the wireworm.

I am particularly anxious to draw your attention to this point, for it too often happens that there is no idea, much less a well-founded knowledge, of what is best to do in case of attack, until the attack is causing such ruin to the crop that every hour is of importance. May I use a proverb which seems to me to be very appropriate, "The rainy day is not the time for thatching"—and similarly, when the crop-pests are destroying the plant is *not* the right time for beginning to seek in all directions for how to destroy them—but to do it.

In these cases the applications which we usually need are not so much the common plant food as a concentrated essence (so to call it) which we can procure at once, and which, by its rapid solution in rain or moisture, may be available for the plant *at once*; and also, if possible, may *at once* make the locality so unpleasant to the grub or other insect that the crop may at least have a respite. These effects are more or less brought about by the application of mineral or chemical manures, and as preventives or remedies for wireworm attack there is a long list of them.

We have many combinations of lime, applied as carbonate, sulphide (gradually changed by atmospheric action to sulphate), phosphate, and superphosphate, used under the names of lime, gas lime, and alkali-waste, bone dust, dissolved bones, and the recent or fossil animal remains, which are commonly used under the general description of "superphosphate." We have sodium in two forms—nitrate of soda and chloride, or common salt; potash, under the name of kainite; and phosphates mixed with ammonia in guano. Some

of these act directly as fertilizers, although if we had but better information it is likely we should find they had effect on the insect pest in the ground also, but in a few cases we can bring the dressing in a preliminary stage before it is altered by the air to act at once on the wireworms. Lime in its caustic state is always useful as a clearing dressing, and fresh gas lime, or alkali-waste, serves if need be to destroy all insect and weed life where it may be laid. Where alkali-waste is laid on in large amount, it washes down so readily that the drains will run milky at a depth of three feet in heavy land, and it may be made to serve as an absolute purifier of all live vermin some way down in the land. We do not often need its application to this extent, but it is very desirable to bear in mind against the sudden appearance of some pest which should be fairly stamped out, that there *is* a material which for little if any more outlay than the cost of carriage will serve for this purpose, and, after a few months' exposure has neutralised its poisonous properties, will leave all land to which sulphate of lime is applicable all the better for the temporary heavy dressing. Salt given at the rate of 5 to 10 cwt. the acre is serviceable as a dressing before breaking up land, both for killing couch grass and driving out wireworms. Also the property that salt possesses of attracting moisture may be turned to good service on heavy corn land which is infested. The moistened surface becomes slightly incrusted (or firmed, as it is termed), and consequently the wireworms are to some degree prevented from travelling at will amongst the plants. Nitrate of soda pushes on a rapid growth, and is of great value as an antidote to wireworm attack in the straw crops, but little is said regarding the effect of this and salt being used together. Looking at the difficulty of the nitrate being often too stimulating to the growth of the straw and leafage, whilst the effect of the chloride (that is to say, of the common salt) is to prevent undue luxuriance, it would appear worth while to try the effect of the mixture. We thus should have a dressing which, without being too stimulating, would be a thorough fertilizer, and would also cause a condition of surface soil to some extent unsuitable for wireworm movement. Further, judging by the effect of both the nitrate and chloride on other larvæ, it might very likely prove so distasteful to the wireworm as at least to diminish the amount of attack.

These are the kind of points on which we need full information. The requisite observations to gain this knowledge could not be carried on better anywhere than here, at the Royal Agricultural College, where the laboratory and the field experiments can so efficiently be made in connection with each other. Laboratory experiments are very useful in showing us which chemicals of those likely to be tried in sudden difficulty do *not* exercise any influence on larval or grub life, for thus much valuable time which might have been lost at the important moment is saved to us. But with regard to the applications which we mean to

take effect by *direct action* on the grubs, laboratory experiments are comparatively useless without field trials accompanying them, because it is rarely that the strength of solution needed to kill the grub can be brought to bear upon it practically without killing the plant it infests. Also, though the fluid may be strong enough to kill the larva if it touched it on the surface, yet its effect is rapidly weakened by passing through the earth; and further, the grub has in most cases both the instinct and the power to remove itself gradually from the annoyance, if any is caused to it by the chemical application filtered down into the ground.

We had some good information bearing on these points in the joint observations made in 1880, agriculturally by Mr. Fitton on his farm near Nantwich, in Cheshire, chemically by Mr. Smeatham, of Liverpool. In this case the grubs of the Daddy-long-legs were the kind experimented on, and it was found that in a solution of four per cent. of carbolic acid in water they were killed in from one to two minutes. In a solution of one part of the acid to 250 parts of water they were killed in eight minutes. The effect of the strong solution was tried in the field, and it proved useless—on examination the grubs were to be found within an inch of the ground which had been watered with the mixture. Sulphate of iron and sulphate of copper killed the grubs (in laboratory experiment) in about ten minutes, or rather less; lime appeared to have no effect upon them. In experiments made by Mr. George Brown, of Watten Mains, Caithness, as to effect of salt on the same kind of grubs, it was found that they went down lower and lower in the ground according to the strength of dressing applied.

I have no notes of the effect of direct application of chemicals to wireworm, but the observations regarding experiment on *Tipulæ* larvæ (that is to say Daddy-long-legs grubs) will serve to illustrate the point generally to which I desire to draw your attention. If we know, have it proved, that some common chemical likely to be tried has *no effect at all* on any given crop pest, this knowledge is valuable so far as it goes, for it saves the loss of time and capital in trying what its effect may be when the enemy is in the fields. But we greatly need to understand clearly and correctly in what way many dressings and applications which are known to be serviceable as preventives in cases of attack act on the grubs or insects. Most grubs appear rather to die of starvation than to feed on what is not suitable; if we can manage to fairly imbue the soil with anything which in solution must necessarily be in some degree swallowed by the grub as it feeds on the roots in the dressed ground, we must benefit (also in some degree) by the application. We find that in some cases the grub sinks deeper and deeper in the ground to avoid the unwholesome presence, just as it does in the case of increasing frost, but as yet, as far as I am aware, we have no field experiment on these points. Every year the same loss of time and of material goes on in *trying*, as it is said, and whilst the trial is going forward

the crop too often dies. If we had distinct experiments on the direct effects on insect life of nitrate of soda, kainite, guano—which is said (whether rightly or not I do not know) to destroy some larvæ, and also those of gas lime or alkali-waste, we should then have something to fall back on in the way of information when attack came, which could not fail to be of service.

We all know that wireworms are attracted by rape cake, but what is the special method of action of the kind known as Kurrachee, or Indian rape, really mustard cake? When in my own experiments I have limited the wireworms to food consisting of little but one of the above two kinds of cake, I found that although the larvæ in the mustard cake fed as greedily as the others for a time, yet in about a fortnight they died; and although when they began to perish I placed other food in their reach, they appeared past recovery and did not touch it.

We know that mustard is a good clearing crop, a good means of getting rid of wireworm, and in experiments with the cake I found that the wireworm would not enter it until the pungency which follows on mixing this mustard cake with water was gone off, and I would suggest that enquiry into the precise method in which mustard is obnoxious to wireworm would be very useful.

If this matter was fully investigated we might find that by a more frequent introduction of mustard into the rotation of crops we not only cleared the land of wireworm, but on suitable land secured a paying crop of mustard free from the ravages of the mustard beetle, which is too apt to become a ruinous scourge to this crop in districts where its cultivation is widespread and continuous.

Time does not allow me now to enter on full details of prevention of the pest we are especially considering, but I wish to draw your attention to its absence sometimes following on the application of seaweed being a matter worth enquiring into, as in this case we have the advantage of a manure often procurable at small cost which contains the alkaline and nitrogenous and mineral constituents we have seen are generally serviceable, joined in some cases to an amount of salt distasteful, to say the least, to the wireworm.

The mechanical measures by which attack may be checked by means which will consolidate the surface, and so prevent the wireworm travelling through the soil, are of great importance. We find notes of them in their adaptation to different soils, and different conditions of the land caused by weather influences, from the slight pressure given by driving the lightest sheep that can be put on, over the field, to the heavy treading of cattle; and the amount of pressure by weight of roller varies similarly from an ordinary light field roller to the Cambridge ring roller, or Crosskill's clod crusher.

For these and many other points of detail I must refer you to the paper recently published in the *Journal* of the Royal Agricultural Society, compiled from notes furnished relatively to wireworm prevention by some of

our best agriculturists, and which, as they passed through my hands as the Entomologist of the society, have given me the opportunity of forming my present observations.

But there is a lesson taught by this Report on Wireworm, and by the previous Report on Turnip Fly, which cannot be too well learnt. It is, the importance of a knowledge of the habits of our crop insects, and also of *using our own common sense* to counteract their ravages.

We seldom need any teaching as to how a crop insect injures us, that part of its life history is commonly only too plain. But where is it at other times? Where does it pass the winter? How deep does it go down into the ground? What special weeds encourage its presence which we, or perhaps our neighbours, are apt to grow in ornamental patches, making, as it is poetically remarked, the country to glow like a garden! But, so surely as you see that golden glow from the charlock blossoms, may you expect a following of turnip fly; so surely as you see the blades of couch grass, or water grass, or any grass weed in number in your crops, may you be sure there grows a home for wireworm. And so it is with other parts of the attack. Destroy the wireworms (as we have seen can be done) in the land that is infested before you put in your new crop, and it will in great measure escape. Destroy the rubbish in which the turnip beetle shelters in the winter, and destroy the plants where it feeds until we provide more pleasant sustenance at great cost, and we save much of our crop.

We cannot expect to get rid of injurious insects entirely, but we may fully hope and expect not to be necessitated to let them ravage the fields at their own pleasure. And the information we want for this purpose is by no means what is conveyed in what is commonly understood by the word *Entomology*. We do not need wearisome study as to slight distinctions between different species of insects, when they are all destroying our crop in the same way; but we do want very greatly to have true and useful knowledge of the habits and method of life of the creatures, one kind or many as the case may be, with which we are dealing, and when we have got the knowledge, to go forward and act boldly on it. So should we with certainty and with profit greatly diminish the amount of loss suffered, and reap comfort and benefit from solid application of well directed study.

At the close of her interesting lecture, Miss Ormerod was loudly cheered, and the Principal, on behalf of the students and staff, cordially thanked her for her instructive address.

[*From the Wilts and Gloucestershire Standard, Saturday, June 23rd*, 1883.]