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The Woolly-Aphis of the Apple.

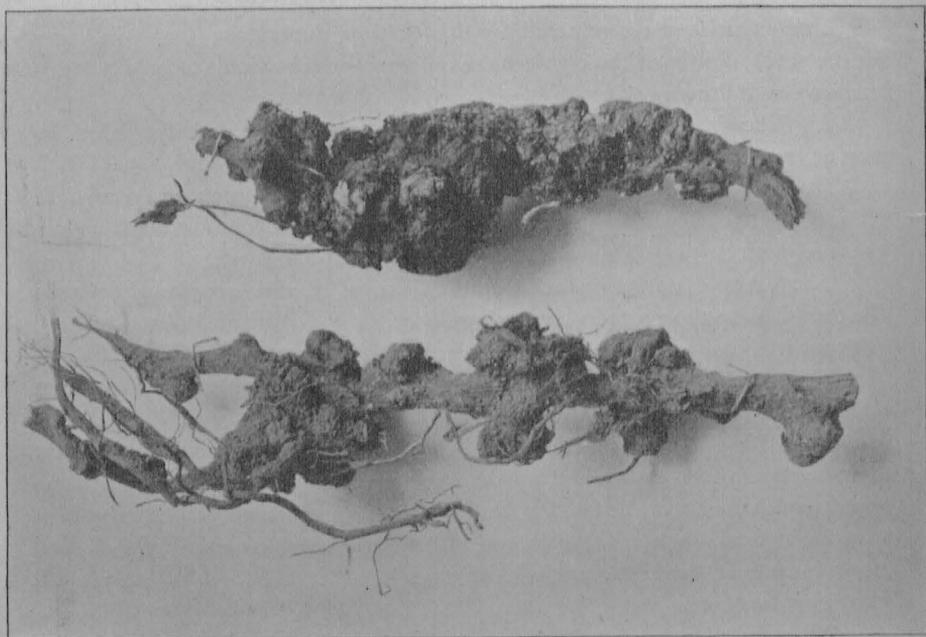


Fig. 1.—Roots from a two-year-old apple tree, showing the abnormal growths and knotty excrescence caused by the Woolly-Aphis. One-half natural size. (Original.)

The Woolly-Aphis of the Apple or the **Apple-Root Plant-Louse.**

Schizoneura lanigera, (HAUSM.)

BY J. M. STEDMAN, Entomologist.

The experiments conducted by this station during the past two years on the woolly-aphis of the apple have given results which are briefly summarized as follows:

I. The limb or aerial form of this insect can be readily killed by one or two thorough sprayings with strong kerosene emulsion.

II. Apple seedlings, buds, and grafts should be planted in a small trench filled with finely powdered tobacco or tobacco dust and lightly covered with earth. This will keep the woolly-aphis away.

III. Apple nursery stock should have a liberal supply of tobacco dust applied to the roots every spring in order to kill the woolly-aphis and prevent it from establishing itself there. It should be applied by removing some of the earth from around the roots, filling the excavation with tobacco dust, and lightly covering it with earth.

IV. Newly cleared timber land should be cultivated in corn or other crop for two years before the apple trees are set out, in order to kill the woolly-aphis that may be on the roots of the wild crab and allied trees.

V. Apple nursery stock should have the roots cleaned and dipped for a minute in strong kerosene emulsion in order to kill the woolly-aphis that may be there.

VI. In planting apple trees tobacco dust should be freely used among and over all the roots, and close around the trunk, in order to kill and prevent the woolly-aphis from establishing itself there.

VII. Every spring, as soon as settled warm weather appears, each tree should have a liberal supply of tobacco dust applied to its roots by removing the earth from around the trunk for a distance of two feet and four inches in depth, evenly filling this with the tobacco dust and covering it with earth.

VIII. The root form of the wooly-aphis may be cheaply and easily killed and kept away from an apple tree by the liberal use of tobacco dust. About five or six pounds of this substance should be applied as above directed to the roots of every infested tree, and one half this amount should be applied in a similar manner each succeeding spring. Costing approximately two cents per tree per year.

IX. This insect may also be killed by injecting one fluid ounce of carbon bisulphide two feet away from the trunk on two sides of the tree, but the use of this substance is not advised except in extreme cases, since a little carelessness may injure the tree, and it is always necessary to immediately treat the trees with tobacco dust in order to keep the insect away.

INJURY, HABITS, AND LIFE HISTORY.

The wooly-aphis of the apple, *Schizoncra lanigera*, (Hausm.) is found in nature in two so-called forms. One infests the limbs and twigs, while the other lives under the ground upon the roots. Entomologists designate the aerial form "wooly-louse of the apple," and the subterranean form "apple-root plant-louse." Some entomologists have described these two forms as distinct species, but at present all appear to be agreed that these two forms are the same species, differing only in habits. The laboratory experiments conducted at this station with this insect go to show that the root inhabiting form will, under certain conditions, establish colonies upon the branches or limbs and there thrive in a perfectly natural manner, and *vice versa*.

The presence of the aerial form of the wooly-aphis is readily detected by the bluish-white cottony or downy looking substance that is excreted by and covers the greater part of each wingless individual aphis; and since these insects live in clusters or colonies, the patches of white matter are very conspicuous, and can scarcely escape the notice of even the most casual observer. It has been my experience to find in nature this aerial form in Missouri only in rare cases, and then only in those places where

some injury had caused an abrasion of the bark, or some limb or twig had been cut or broken off, or where they had been crowded from the ground up to the base of the trunk or on the suckers that had been allowed to grow around the tree. They are frequently artificially induced to attack the trunk by mulching, or by using wrappers around the base of the tree as a protection against borers and rabbits. But whatever may be the cause of their presence above the ground, the result is the same, namely; to cause an abnormal growth of the infested portion resulting in the formation of a rough and pitted surface, and at times cause the death of the limb at the point infested. However, this injury is so slight in this state that it is insignificant in comparison with that found in the northern and eastern states, and especially in Europe, where apple trees are frequently killed outright by this aerial form.

The presence of the root inhabiting form is readily detected by removing the earth from the roots near the trunk of the infested tree. The appearance of a bluish-white cottony or mildew looking substance, or of knotty and distorted roots will indicate its presence. It is this root or subterranean form that causes so much damage to the apple orchards in the southern half of Missouri, and to apple nursery stock throughout the state. The infested apple tree appears sickly; it does not grow as it should; its leaves are less numerous and they have more of a pale green or yellowish color than is natural; and finally the tree dies outright or is blown over with the first slight wind. Such are the outward indications that a tree is badly infested with this pest. Sometimes the tree blows over with a heavy wind without showing these outward appearances in so marked a degree, but one soon becomes familiar with the appearance of infested trees and can readily locate them before they are past recovery. In orchards it appears that the great bulk of the damage from this pest comes directly from the fact that the trees blow over so easily, the roots breaking off close to the trunk. Of course this is due to the fact that the roots have decayed; and I am fully convinced from actual observation that ninety-five per cent of the cases of so-called "root-rot" in apple trees in this state are in reality the result of the attack of the wooly-aphis. In nursery stock, the damage comes directly from the inability to sell badly infested trees, and not from the death of the trees themselves.

The wooly-aphis sucking the juices from the roots of the apple tree causes an abnormal growth of the attacked portion of the roots resulting in the formation of gall-like swellings or excrescences. These swellings are

usually irregular and knotty in appearance and sometimes attain considerable size, while that portion of the roots between the excrescences is frequently undeveloped. Figure 1, which is a photograph of two such roots, will give one a good idea of the appearance of the attacked portion. The wooly-aphis and the dirt were removed in order to show the exact condition of the roots themselves.

The wooly-aphis will be found in large numbers and in clusters over the surface of the swellings, and especially between them in the numerous crevices that the larger excrescences contain. The roots thus attacked, distorted and swollen soon begin to decompose; saprophytic fungi and bacteria enter the dead and decaying portions and help to hasten the work, and soon that portion of the root perishes. Sometimes the root seems to be killed outright by the vast number of aphis sucking the sap and causing the abnormal growth, so that the attacked portion perishes before decomposition has fairly set in. But in either case the aphids perish or leave the dead root and seek living roots upon which they can feed, and hence when one examines a root that has been dead for only a short time even, the aphis may not be found there, and this has led many to attribute the death of the root to other causes, especially to "root rot." As the wooly-aphis attacks in immense numbers the main roots at or near the trunk, and as these roots are usually eventually killed and then rapidly decay, the tree loses its support and falls with the first wind.

It is remarkable how long an apple tree will manage to live after its main roots have been killed by the wooly-aphis. It puts forth numerous small rootlets that nourish the tree enough to keep it alive with about half the usual number of leaves, but these rootlets are not sufficient to hold the tree upright.

No variety of apple tree in Missouri appears to be exempt from the attack of the wooly-aphis, nor does the age of the tree appear to make any difference. It attacks and injures alike, seedlings, nursery stock, young and old bearing trees, but very old trees appear to withstand this pest much better than young ones.

This insect is well known to all fruit growers in Missouri, and it needs no scientific description. A very brief statement of its life history may, however, be useful. The adult insects are found in two forms as can be seen by carefully examining a colony late in the summer. One form has wings and does not excrete the downy matter (see Fig. 2, A), while the other and more numerous form has no wings and excretes from

the pores of its abdomen the bluish-white downy or cottony matter that covers the insect and renders it so conspicuous (see Fig. 2, C). If this downy substance be touched, it will be easily removed from the insect which will immediately excrete more. Figure 2, A, represents a winged form which is an agamic female; B, a wingless or apterous form with the downy matter removed; and C, one with a small amount attached. Both B and C are apterous, agamic females. All three of these figures represent the insects magnified sixteen diameters, while the hair lines under the wingless and between the wingless forms represent the natural size of each respectively.

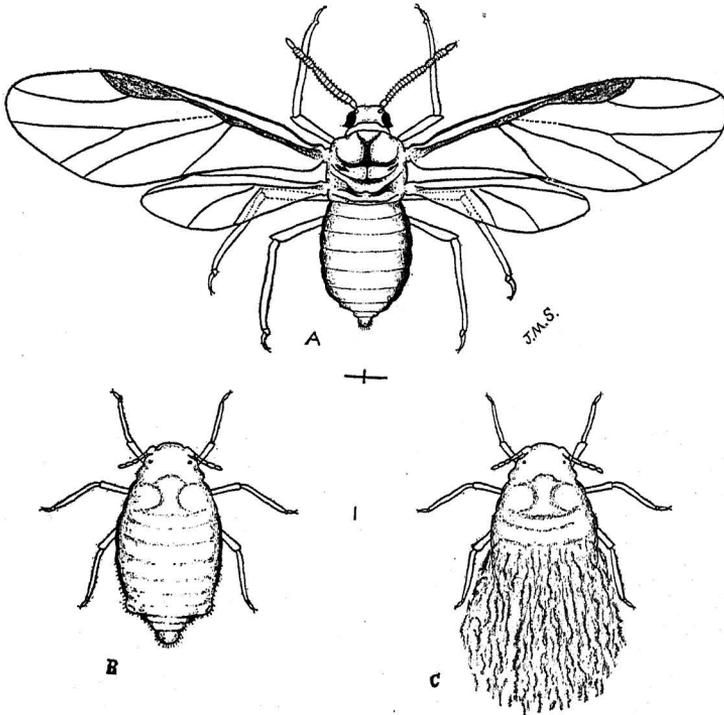


Fig. 2.—The Apple-Root Woolly-Aphis, *Schizoneura lanigera* (Hausm.) magnified sixteen diameters. A, winged agamic female, B, C, apterous or wingless agamic females. (Original.)

The solitary eggs of this woolly-aphis may be found during the winter in the crevices of the bark at or near the base of the tree, where they are

usually seen completely enveloped in the dead skin of the mother who lays a single egg. In the spring these eggs hatch into wingless, agamic females like the ones figured at B and C in Fig. 2. These females then bring forth living young rapidly and without males—parthenogenetically. These young are also always wingless, agamic females. Their offspring do likewise. This is continued during the summer, each generation being apterous agamic females only. Toward the latter part of summer winged, agamic females are developed (Fig. 2, A). Some of the winged forms leave the infested tree and fly to other trees, where they establish another colony by bringing forth living young. Late in the fall, toward the approach of cold weather, some of the agamic females bring forth living, wingless, and mouthless true males and females. These pair and the females each develop a single fertilized egg and perish.

Each aphid, whether winged or wingless, is independent, and derives its nourishment by piercing the bark with its long beak or mouthparts and sucking the sap below.

In the northern part of Missouri most of the woolly-aphid perish during the severe cold of winter, and the eggs are frequently the only means of continuing the species the following summer. In the southern half of the state, however, the aphids, themselves, are usually able to hibernate in large numbers, and hence it is that we find this pest so much more numerous in that section. One may easily verify this statement by examining the lower roots, near the base of the infested tree, during the winter. I have seen hundreds of them alive and active in such places every month in the year; but they appear to feed very little, if at all, during the winter, beginning to feed at the first approach of warm weather in the spring. Each hibernating aphid commences to bring forth living apterous, agamic females just as soon as warm weather is established; and as hundreds of them may hibernate on the roots of a single tree, it is readily understood why this insect is so numerous in South Missouri.

REMEDIES.

The experiments with remedies to kill and control the woolly-aphid of the apple tree were conducted in the laboratory and in the field. It is not necessary to discuss the laboratory methods, since the field experiments

are final and were conducted in order to check and prove the value of those carried on in the laboratory.

The aerial form of the woolly-aphis can be easily killed by one or two thorough sprayings with strong kerosene emulsion. If the aphids are on the trunk only, as frequently happens when the wooden wrappers are used as a protection against the attack of borers, they can be killed by washing the trunk with the emulsion by means of a whitewash brush.

Kerosene emulsion is made as follows: Dissolve one-half pound of hard soap in one gallon of boiling water. Rain or soft water should be used for this purpose, otherwise "break" the water by adding washing soda. Remove the water from the fire and add two gallons of kerosene. Churn this mixture for ten minutes by means of a force pump—pump a solid stream of the mixture back into itself. The liquid will assume a milky appearance, increase about one-third in bulk, and become thick and creamy. Be sure to churn for ten minutes, otherwise the mixture may appear to be perfectly emulsified, when it is not, and the kerosene will separate and rise and the material and labor will be lost. This emulsion should keep indefinitely in this concentrated form. When it is to be used, add nineteen gallons of water to the above, mix thoroughly, and apply as stated.

It is the root inhabiting form that is difficult to manage, but it is believed that we can now control this pest cheaply and easily. Undoubtedly the root form can be killed by saturating the ground with kerosene emulsion, but this is extremely troublesome, difficult, expensive, and in most localities impossible to accomplish on account of extensive orchards and the scarcity of water; then again it is practically impossible to reach all the aphids under the large roots around the base of the tree where they are protected. Pure kerosene should never be used for this purpose.

From what has been determined by actual experiments in the laboratory and in orchards and nurseries, it is certain that carbon bisulphide and especially finely powdered tobacco or tobacco dust, as it is called, are the two great remedies to be used against the root inhabiting form of the woolly-aphis. Uground tobacco stems or coarse tobacco will not answer; it must be finely powdered.

In the case of apple seedlings and common apple nursery stock I should not advise the use of carbon bisulphide. Unless extremely cautious, there is too much danger of killing the trees. In these cases the young trees can be kept free from the woolly-aphis by the liberal use of

finely powdered tobacco. Small trenches should be dug and filled with a liberal supply of the tobacco dust covered with a little earth, and the plants grown in these.

The tobacco dust will leach down with every rain and more or less saturate the earth about the apple tree with nicotine, which will not only kill every aphid that may be there, but will prevent others from entering, and at the same time act as a strong fertilizer to the tree. Tobacco dust is worth what it now costs—one cent per pound—as a fertilizer, and is worth much more as an insecticide against the woolly-aphid.

Since the woolly-aphid damages nursery stock and causes a financial loss principally from the fact that the young trees that are badly infested have distorted, swollen, and knotty roots, and are not merchantable, it is far better to prevent the aphid from ever attacking the trees than it is to kill them after they have caused this characteristic condition of the roots, for the real damage is then done and can not be cured. If the trees that are being sold or put in cold storage are infested in the least—and this can be detected not only by the character of the roots, but also by the presence of the bluish-white downy or cottony matter—the roots should at once be cleaned by shaking and then thoroughly dipped for a minute in strong kerosene emulsion. This will kill the aphids; and it should be practiced not only by every nurseryman, but also by every person setting out apple orchards, even though the trees may have been so treated by the nurseryman.

From the experiments it is evident that there is great danger of injuring the trees in using carbon bisulphide unless one is careful to make the injection at least one and preferably two feet away from the trunk. However, by the use of an injector that will inject one fluid ounce, and by injecting two feet from the trunk on two sides of the tree, one can readily kill the woolly-aphid and not injure the tree. The injection should always be made when the earth is dry. If it be at all wet, the fumes of the carbon bisulphide will not penetrate the earth to any extent, but will be lost. Carbon bisulphide evaporates very rapidly and the fumes are heavier than the air, and in a dry soil they will penetrate and kill all the aphids for a considerable distance from the point of injection. In inserting the injector it will occasionally strike a large root just below the surface of the ground; in such cases, remove it and make the injection to the right or left so as not to allow the liquid to touch a main root. The depth to

inject varies from six inches to one foot according to the size of the tree and the condition of the soil.

Carbon bisulphide can be purchased in bulk for ten cents per pound, and, if used as above directed, it will cost one and one fourth cents for the material to treat one tree. It must be understood, however, that the carbon bisulphide only kills those aphids that are there at the time the injection is made; its work is done in a short time, and the fumes soon disappear, and there is then no reason why other colonies should not establish themselves on these same roots. To prevent this, one should apply, as above directed, about two pounds of tobacco dust to each tree either just before or within a few days after the injection of the carbon bisulphide.

The use of the carbon bisulphide is not advised except in bearing orchards or in extreme cases such as where the trees are very badly infested and it is very desirable to kill the aphids at once. The use of tobacco dust is always necessary in order to prevent the aphids from again establishing themselves, and since this is the case, it is no more trouble to apply a larger quantity of tobacco dust and kill the aphids all with one operation. The tobacco dust works slower than the carbon bisulphide, but it not only kills the aphids, but it also remains about the tree, and prevents other colonies from forming. It costs from three to five cents per tree to kill the aphids by means of tobacco dust, but it will cost only about one half that amount each succeeding year to keep them away. If we take into account the cost of the material and the trouble of making the injection of carbon bisulphide and the cost of the tobacco and trouble of applying in order to keep the aphids away, we shall find that the cost and trouble of applying only the tobacco dust in the beginning is about the same. Hence I would advise the use of finely powdered tobacco or tobacco dust as a means of killing the root inhabiting forms of the woolly-aphis on apple trees, and would urge its use every spring as a preventive. Always apply the tobacco dust, as above directed, by removing the earth from around the trunk of the tree for a distance of two feet and from four to six inches in depth, and evenly distribute the tobacco in this excavation, taking care to place it close to the trunk also, and then cover it with the earth.

Judging from the experiments, it is believed that the liberal use of tobacco dust, applied as stated, will cheaply and effectually kill and hold in check the woolly-aphis and prevent serious injury from this pest. The

experiments with tobacco dust as a means of controlling this insect will be continued for several years by using a definite quantity each spring about the roots of the same trees in order to ascertain its full value.

In planting an apple orchard in newly cleared timber land, it is advisable to cultivate the land in some other crop such as corn for two years before the apple trees are set out. This will kill the wooly-aphis that may be on the roots of the wild crab and allied trees, which would otherwise infest in great numbers and seriously injure the young apple trees.

In all cases it is advisable to thoroughly drench the roots of apple stock in strong kerosene emulsion by placing them in the mixture for a minute in order to kill what aphis may be there. This should be done by the nurseryman when the trees are first dug, or by the orchardist just before planting them. While planting, each young apple tree should have a liberal supply of tobacco dust placed about and over the roots and close up to the body, and a little earth covered over this tobacco. Then every spring, just as soon as settled warm weather appears, each tree should receive a quantity of tobacco dust applied in the manner previously stated. The amount should be about one pound the first spring, and should be increased each spring until the tree receives about three pounds when six years old, after which the amount need not be increased unless found to be necessary. If the above directions be followed, I do not think the wooly-aphis will damage an apple orchard.

The experiments above described seem to me to prove that the wooly-aphis infesting the roots of apple trees is as cheaply and as easily controlled as most other injurious insects.

Tobacco dust can be obtained from the Hill-Settle Tobacco Co., of St. Louis, Mo., or from the A. B. Mayer Manufacturing Co., of St. Louis, Mo. Carbon bisulphide can be obtained from the manufacturer, Mr. E. R. Taylor, Cleveland, Ohio, for ten cents per pound, in fifty pound cans.

The station is indebted to the Kansas City, Fort Scott & Memphis Railroad Company for numerous courtesies and material assistance in conducting these experiments.