ARTICLE VI. THE PRACTICE OF SPRAYING TO PREVENT INSECT INJURY.

The introduction of the spraying machine into American horticulture marks an advance almost as important as was marked by the advent of the improved cultivators into our agriculture. Before the latter were introduced the weeds that infest the soil were fought by the hand-hoe, but now a single team does the work of many men. In the same way until recently various laborious and partially effective methods were used in fighting noxious insects and destructive fungi; but now many foes of both these classes are fought on a large scale by the force-pump and spray-nozzle, and every season adds others to the list of those against which this method may be successfully used. With a large class of farmers and fruit-growers, spraying has become a recognized part of the season's operations, and therein lies the chief promise of the method. When the belief becomes general that it is as important to save a crop from destruction by its foes as it is to produce it; that fighting noxious worms must take its place as a farm process by the side of that of fighting noxious weeds; that the parasitic plants which absorb the vitality of leaf and fruit are as dangerous to the crop as the plants which dispute with it the possession of the soil—and when along with this recognition there is placed before the farming community a cheap and wholesale method of preventing the injuries of these organisms, then the vast annual loss now suffered because of insects and fungi will be very greatly lessened.
SPRAYING MACHINERY.

Within the last ten years a large number of spraying outfits have been placed upon the market. They are of all shapes and sizes, and suitable for a great many purposes. The main points of a good machine are that the pump shall be durable, work easily and throw a forcible stream; and that the nozzle shall throw a fine spray a considerable distance, and be so constructed that the size and quality of the stream may be regulated at the will of the operator. It is better, and where the copper fungicide solutions are used, is essential, that the parts touched by the liquid be made of brass.

In case only a few trees are to be sprayed a cheap hand pump will frequently do very well. Some form of these can be obtained at almost any hardware store. Of those to which my attention has been called, the following may be mentioned:

A hand pump manufactured and sold by W. M. Johnson, Wilmot, Ohio. Price $2.00 and $2.50.

A similar pump sold by J. K. Compton, Leslie, Michigan, for $2.00.

A combination pump and agricultural syringe, shown at Fig. 1, manufactured by Lewis & Cowles, Catskill, N. Y. Price, $6.00.

A portable brass force pump, shown at Fig. 2, manufactured by the Gould's Manufacturing Company, Seneca Falls, N. Y. Its catalogue price is $9.

A hand force pump, called the Aquaject, shown at Fig. 3, manufactured by Rumsey & Co., Seneca Falls, N. Y. Its catalogue price, with three feet suction hose, three feet discharge hose and rose sprinkler, is $9.00.

Among the best of the larger machines for general orchard work are the following:

The "Perfection" spraying outfit, manufactured by the Field Force Pump Company, Lockport, N. Y., shown in operation at Fig. 4. It con-
consists of a hand force-pump, which is set upon a barrel and has ten feet of discharge hose and a graduated spray-nozzle attached. At one side three feet of return hose is fastened, which connects with the discharge pipe at the lower end, and which runs back into the barrel, so that at every stroke of the pump a small quantity of the liquid is re-discharged, thus keeping the poison well mixed. The price of the outfit, without barrel, is $12.00.

A similar apparatus is the Climax Pump No. 2, manufactured by the Nixon Nozzle and Machine Company, Dayton, Ohio. This outfit is illustrated at Fig 5, and sells for $15.00. It is provided with the excellent Nixon nozzle, and is a good practical machine for orchard work.

Several spraying pumps are also manufactured and sold by the Gould's Manufacturing Co., Seneca Falls, N. Y. A double acting force-pump made by them is shown at Fig 6. It can be attached either to the side or head of the barrel. One of the discharge pipes may advantageously be run back into the barrel to keep the liquid stirred. The price of the pump alone, with the parts made of brass, is $14.00, while with the outer cylinder of iron it is $8.50.

Figure 7 shows a barrel machine manufactured by the Nixon Nozzle and Machine Co., of Dayton, Ohio, which is sold for $35.00. "It is built on runners and can easily be drawn by one horse over any land accessible for cultivation; or it can be placed in a wagon and
used as readily for orchard work as any unmounted tank machine. It has a pendulum agitator arranged for stirring the liquid used as an insecticide.” The “Little Giant” machine made by the same firm for the same price, is much like this, except that the tank is square and is mounted on wheels.

For spraying large orchards it is often desirable to use a machine like the one shown at Fig. 8, which is operated by horse power, the pump being connected with gearing on the wheel. It is manufactured by the Field Force Pump Company, Lockport, New York, and sells for $30.00. The manufacturers claim that it mixes the fluid and keeps it stirred in the tank while in operation, the pump being double acting, and having a double spout which supplies two discharge hose.
The outfit illustrated at Fig. 9 is the new Orchard and Vineyard Cart of the Nixon Nozzle and Machine Co. It is designed to meet all the requirements of spraying.

It is mounted on iron wheels three feet in diameter, and the width of the tread is three feet six inches, and the machine has detachable shafts so that it can be readily shipped. A barrel is mounted on the forward part of the cart frame, the force-pump on the rear at the right side, and central on the frame is the seat of the operator. A pipe leads from the pump to a transverse pipe at the front to which are attached at both ends the spraying nozzles. These are adjustable so that any desired direction may be given to the spray. Union couplings are used so that tubing can be attached to the pump for spraying trees.

Figure 10 is an outline drawing of a home made spraying cart in use by Mr. Ernest Dunbar, of Ashtabula county, Ohio. In a recent letter he describes it as follows:

"My spray cart is forty inches wide between the wheels. The thills cross the axle close to the hubs, and the floor of the cart is so placed on the axle and between the thills as to be horizontal when the thills are raised to the proper height. The tank of galvanized iron is 32 inches in diameter and 26 inches high, and rests on the floor of the cart between the thills and against the cross bar in front to which the whirl-tree is attached. It is held in place by two wooden pins behind it through the floor. It is connected with a pump, which is screwed to the floor behind, by gas-pipe coupling underneath. The pump I use is from the Field Force Pump Co., Lockport, N. Y. The wheels of a grain drill are suitable for this purpose."

"The whole cost was $14.00. For anything but high trees, where much power is needed, one person can throw the lines over his shoulder, pump with one hand and direct the spray with the other, as in potatoes and currants. One tank full will Paris green an acre of potatoes in less time than any other way."

The only fault I see in this machine is the absence of some way to keep the liquid well stirred. London purple could be used in it very well as it settles slowly, but Paris green would be likely to settle too rapidly for good results.

**INSECTICIDES TO BE USED IN SPRAYING.**

A large proportion of the insecticides in use at the present day may be applied with the spraying machine. The most important are the
arsenites—Paris green and London purple—but there are also many others, like hellebore, pyrethrum and keroceine emulsion, which may advantageously be applied in this way.

**Paris Green.**—This well known poison is a chemical combination of arsenic and copper, called arsenite of copper. It contains from fifty-five to sixty per cent of arsenic, and retails at about thirty cents per pound. It is practically insoluble in water. For spraying apple, pear, cherry and the so-called foreign or improved varieties of plums, it may be used in the proportion of one ounce to twelve gallons water, or a quarter of a pound to a fifty-gallon barrel. It may be used against an immense number of insects, such as the Codling Moth, Plum Curculio, Canker Worm, leaf-rollers, Colorado Potato Beetle, shade tree caterpillars, and in fact nearly all biting insects infesting plants to which poisons may safely be applied.

**London Purple.**—This insecticide is a by-product in the manufacture of aniline dyes. It contains about the same per cent of arsenic as Paris green, and is cheaper, retailing at about fifteen cents a pound. It is in finer powder, and consequently remains in suspension in water much longer. By many it is thought to be more liable to injure foliage than Paris green.

**Hellebore**—This is a powder made of the roots of White Hellebore (Veratum album). It is a vegetable poison, but much less dangerous than the mineral arsenical poisons, and it kills both by contact and by being eaten. It may be applied in water mixture in the proportion of an ounce to three gallons, or a pound to a barrel. It is especially valuable for destroying the Imported Currant Worm, the Cherry Tree Slug, and the Rose Slug. It usually costs at retail about twenty-five cents a pound.

**Pyrethrum** is an insecticide of recent introduction, made from the powdered flowers of plants of the genus *Pyrethrum*. There are three principal brands upon the market, known as Persian insect powder, Dalmatian insect powder, and Buhach—the latter being a California product. The greatest obstacle to the use of pyrethrum has been the difficulty of obtaining the pure, fresh article. If exposed to the air the poisonous principle volatilizes and the powder is worthless. Hence dealers should purchase a fresh supply each season, and should keep it in air-tight vessels. Pyrethrum is used mainly either as a dry powder or in water (one ounce to three gallons): but may also be used in the form of a tea, or a decoction, a fume, or an alcoholic extract diluted. For use as a dry powder it may advantageously be diluted with six or eight parts of flour. It is especially excellent for clearing rooms of flies and mosqui-
Kerosene Emulsion is made by adding two parts of kerosene to one part of a solution made by dissolving half a pound of hard soap in one gallon of boiling water, and churning the mixture through a force pump with a rather small nozzle until the whole forms a creamy mass which will thicken into a jelly-like substance on cooling. The soap solution should be hot when the kerosene is added, but of course must not be near a fire. The emulsion thus made is to be diluted, before using, with nine parts cold water. This substance destroys a large number of insects, such as the chinch bug, cabbage worm, and white grub; and is a comparatively cheap and effective insecticide.

THE CROPS TO SPRAY.

Among the more important crops which may advantageously be sprayed to prevent insect injury are the following:

**Apple.**—Spray for the Codling Moth and Curculio soon after the blossoms fall—when the apples are from the size of a pea to that of a hickory nut—with London purple or Paris green, 1 oz. to 12 gal. water.

**Plum.**—To destroy the Plum Curculio spray foreign varieties (Lombard, Yellow Gage, etc.), soon after blossoms have fallen with Paris green or London purple, 1 oz. to 12 gal. water. Repeat the application once or twice at intervals of ten days. Varieties of the wild goose class are almost as tender as the peach, and should be sprayed carefully and with a weak solution, if at all.

**Cherry.**—Spray Early Richmond, and other varieties similar in foliage, with Paris green or London purple (1 oz. to 12 gal. water), soon after blossoms have fallen. Repeat the application a week or ten days later.

**Peach.**—If sprayed at all this fruit should be treated very carefully. Use Paris green in preference to London purple on this crop, seeing that it is kept constantly stirred; and do not make the mixture stronger than one ounce to fifteen gallons water. Spray late in the afternoon, or on cloudy days, rather than in the hot sunshine.

**Currant and Gooseberry.**—To destroy the Currant Worm, spray with hellebore—an ounce to three gallons, or a pound to a barrel—soon after the foliage appears and as soon as small circular holes are to be found in the lower leaves. Repeat application a week or ten days later.

**Cabbage.**—To destroy the cabbage worm spray with pyrethrum—in the proportion of an ounce to three gallons water—or kerosene emulsion, at intervals of ten days from the time the worms appear until the crop is ready to gather.
Potato.—Spray for first brood of potato beetles soon after the plants are up, with Paris green or London purple, 1 oz. to 10 gals. water. Repeat application when necessary.

**THE PHILOSOPHY OF SPRAYING.**

Spraying is simply an easy and practical way of applying insecticides, or the substances by which insects are destroyed. These substances may act in either, or in some cases both, of two ways: (1) By poisoning the insect when eaten by it; and (2) by closing the breathing pores of the insect, or acting as an external irritant. Paris green and London purple are examples of the first class of insecticides, and pyrethrum and kerosene emulsion of the second class, while hellebore acts in both ways.

Substances of the first class have simply to be distributed in small particles over the foliage or fruit of the infested plant, where the insect in biting will swallow it with the food eaten. Thus in the case of the Colorado Potato Beetle, the potato leaves are coated with minute particles of Paris green or London purple, and the insects take some of these particles with their food and are destroyed. So also in the case of the Codling Moth or Apple Worm. The parent moth, represented resting on an apple at $f$, Fig. 11, deposits an egg in the blossom end of the apple, at $b$ of the figure, and this egg hatches into a worm or caterpillar that eats its way into the fruit. By spraying the trees with Paris green or London purple in water, when the apples are small, some particles will be lodged in this blossom end of the fruit, and the worm in attempting to enter will eat part of these and be killed. Thus, in this case, the spraying takes effect, not on the moth by which the eggs are laid, but rather upon the larva which hatches from the egg.

With the Plum Curculio the case is different. Here the spraying takes effect by destroying the parent beetle before the eggs are laid. The beetles gnaw the fruit and foliage for food, and so when these are coated with poison they are exposed to injury.

In spraying an insecticide which kills by contact the aim is simply to get it distributed where it will reach as many insects as possible; and generally the more forcibly it is applied the more effective it will be.
PRECAUTIONS TO BE TAKEN.

The greatest drawback that has heretofore been experienced by those who sprayed with the arsenites is the danger of injuring the foliage—"scorching" or "burning" it as is generally said. This may be guarded against by using weak mixtures, keeping the liquid well stirred and applying evenly; and it is pretty well proven that it is safer to apply on a cloudy day or late in the afternoon than during the hot sunshine of mid-day. Of course especial care must be taken to keep all poisons out of the reach of children and stock.

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ARTICLE VII.—THE BARK-LICE OF THE APPLE AND PEAR.

During the past few years two species of bark-lice have so increased in many parts of Ohio that they are now above the danger line, and in consequence are attracting the anxious attention of a large number of fruit growers. Both are old and well-known pests that have, at occasional intervals, in years past done great damage in various parts of the country. They are known respectively as the Oyster-Shell Bark-louse (Mytilaspis pomorum), which especially infests the apple, and the Scurfy Bark-louse (Chionaspis furfurus), which occurs upon both the apple and pear.

THE OYSTER-SHELL BARK-LOUSE.

A piece of bark covered with the scales of this insect is shown at Fig. 12. These scales are about one-sixth of an inch long, and similar in color to the bark. "Under each of these scales will be found a mass of eggs varying from fifteen or twenty to one hundred or more. These, during the winter or early spring will be found to be white in color, but before hatching they change to a yellowish hue, soon after which the young insects appear. This usually occurs late in May or early in June. (In southern Ohio the lice will probably hatch early in May, and in the central and northern portions of the State from the middle to the last of May.) If the weather is cool the young lice will remain several days under the scales before dispersing over the tree. As it becomes warmer they leave their shelter, and may be seen running all over the twigs looking for suitable locations to which to attach themselves. They then, under a magnifying glass, present the appearance shown at 2, Fig. 13, their actual length being only about one one-hundredth of an inch; to the unaided eye they appear as mere specks. A large proportion of them soon become fixed
around the base of the side-shoots of the terminal twigs, where, inserting
their tiny sharp beaks they subsist upon the sap of the tree. In a few
days a fringe of delicate waxy threads issues from their bodies,
when they have the appearance shown at 3. Gradually the insect
assumes the form shown at 4; 5 and 6 represent the louse as it approaches maturity and when detached from the scale; 1 shows the egg highly magnified; and 8 one of the antennae of the young louse, also much enlarged. Before the end of the season the louse has secreted for itself the scaly covering shown at 7, in which it lives and matures. The scale is figured as it appears from the underside when raised and with the louse in it. By the middle of August the female louse has become little else than a bag of eggs, and the process of depositing these now begins, the body of the parent shrinking day by day, until finally, when this work is completed, it becomes a mere atom at the narrow end of the scale, and is scarcely noticeable."

The infested trees should be carefully watched during May, and as soon as thousands of little white specks are seen crawling over the bark the tree should be sprayed with kerosene emulsion as directed below.

**The Scurfy Bark Louse.**

This species is at once distinguished from the other by the scales, which are white instead of gray or brown. An infested twig is repre-

Fig. 14. Scurfy Bark-lice on Twig.

sented at Fig. 14, while Fig. 15 illustrates a single female scale magnified,

WEED—THE BARK LICE.

the natural size being indicated by the small figure at the lower right-hand corner. Beneath these scales are found, during the winter and spring, numbers of small purple eggs. These hatch in May into purple lice that crawl about over the bark for a few days, when they insert their beaks and undergo a development similar to that of the oyster-shell species described above.

There are various natural enemies of both these bark-lice which do a great deal towards keeping them in check. Among the most important of these are a small, eight-legged mite, which feeds upon the eggs, and the young or larva of certain lady-bird beetles.

REMEDIES.

During the winter and early spring as many of the scales should be scraped off the trunk and larger branches as possible. On large trees this may be done by first scraping with some instrument like a hoe, and then thoroughly scrubbing with a scrub-brush or broom, dipped in a solution made as follows: Add one part of crude carbolic acid to seven parts of a solution made by dissolving one quart of soft soap, or one-fourth of a pound of hard soap, in two quarts of boiling water. The scraping is especially desirable for the Oyster-shell species, and on large trees. The bark of young trees is so tender that they must be scraped carefully, if at all. A scrub-brush is the best thing to use for applying the soap mixture, as the bristles remove many scales which a cloth would slide over. Then in May or June soon after the young lice have hatched, the trees should be sprayed with kerosene emulsion, made as directed on page 125 of this Bulletin. The emulsion must be thoroughly mixed, with none of the kerosene floating separately, or it is liable to injure the foliage. When the lice are young they are very readily destroyed by the emulsion. To spray it effectively some of the spraying outfits described on a previous page are necessary.

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ARTICLE VIII.—THE BUFFALO TREE HOPPER.

During February of the present year Mr. J. O. Libis, of Portage county, Ohio, wrote the Station as follows:

I send with this letter twigs cut from my young apple trees. Can you tell me what is working in the bark, and a remedy for them? I have a small orchard of about twenty young apple trees. They have been set about six years, and have grown nicely, but the bark is rough on them, and upon examination I find something eating into the bark and wood. It has worked on last year's growth. I think they have been affected for a year or more. I thought it would not injure them, but they looked so bad this spring that I examined them. They are all budded nicely. Will you please write me the cause and a remedy for it, as I am very anxious to save them if possible.

About the same time the following letter was received from Mr. C. C. Kenyon, of Medina county, Ohio:

The small twigs of my young apple trees are thickly infested with some kind of an insect, either in the larva or pupa state; I cannot tell which. I enclose some infested twigs for your examination. What are they, and will they do any serious damage to the trees? Is there any remedy?

A month later Mr. D. K. Woodward, of Trumbull county, Ohio, sent examples of the same injury, accompanied by the following letter:

I have a pear orchard of five hundred trees that were put out last spring and the year before. The trees that were put out the first year, and a few of those set last spring, are badly damaged by some insect work that was done last summer. Did not notice it much until fall, though it might have shown before. I mail you a package of the twigs to-day. The damage is upon the top side of the limbs, and not much upon the last year's growth. Can you tell me what caused it, and what to do for it? Will it be necessary to remove the damaged limbs? On many trees it would take nearly all the present top. I think you will find insects now in the bark. There are some young peach trees in the orchard, but they are not damaged much. Forty young apple trees that stand in the same orchard are also as much injured as are the pear trees.

All of the specimens accompanying these letters exhibited a peculiar injury, represented at c, Fig. 16, which was recognized as due to the egg punctures of the Buffalo Tree-Hopper (Ceresa bubalus.) This insect has only lately attracted special attention because of its injuries, but the

![Fig. 16. Buffalo Tree-Hopper. a, Back view; b, side view, both slightly magnified; c, apple twig showing egg punctures. (Original.)](image-url)
above accounts indicate that it may become a foe to be dreaded by the horticulturist.

The Buffalo Tree-Hopper is a small greenish or yellowish insect, about one-third of an inch long, which is generally rather common during the late summer and early autumn months. A fair idea of its form, which has been compared to that of a beechnut, may be obtained from a and b, Fig. 16. Its mouth consists of a sharp beak, which it inserts into the bark and sucks the sap. The eggs are laid in the upper part of the twigs of apple, pear, maple and various other fruit and shade trees, mostly during the late summer or early autumn months. They hatch the following May into small, active, greenish hoppers, somewhat like the adults in appearance, which insert their tiny beaks in the tender bark and suck out the sap. They become full-grown about midsummer, and feed, in both the young and adult states, on a great variety of plants.

THE PROCESS OF EGG-LAYING.

The scars caused by the insect in depositing eggs are shown at c, Fig. 16. The way in which these punctures are made and the eggs are laid, has been described by Prof. E. A. Popenoe, as follows:

Standing parallel to the twig, the female thrusts the ovipositor obliquely into the bark, and working backwards cuts a slightly curved slit. Beginning at the posterior end of the slit, the insect now thrusts the ovipositor its full length into the cambium between the bark and wood and an egg is placed. The ovipositor is now drawn forward, a second egg is laid, and so on until the anterior end of the slit is reached. A second slit is then made, a little to one side, its concave side facing that of the slit first made, and a second row of eggs is laid. The number of eggs is usually from seven to twelve in each slit, and the entire operation requires about half an hour for its completion. In the completed wound it may be seen that the eggs in either row were introduced from the slit on the opposite side. A narrow line of bark is thus cut entirely loose from the wood beneath it and soon dies, leaving on the growing twig an irregularly circular dead spot.

THE AMOUNT OF DAMAGE.

The chief injury done by the Buffalo Tree Hopper is that done in the process of egg-deposition just described. On old trees it is not likely to be very serious, but on young trees considerable damage may be done. Professor Popenoe, in describing the work of the insect in a young apple orchard in Kansas, says:

The effect of these punctures in the bark and wood was shown in the unhealthy and unsymmetrical appearance of the twigs, and in the young apple trees mentioned, in the lack of vigor of the tree itself.

It is always more difficult to prevent the injuries of an insect that feeds upon a large variety of plants, both wild and cultivated, than one which is confined for food to the single crop injured. As a rule it is also more difficult to fight those insects which get their food by sucking, than those which bite. The Buffalo Tree Hopper combines both of these characteristics, so that from the nature of the case we may expect it to be a difficult insect to overcome.

Professor Wm. Saunders, in his excellent treatise on Insects Injurious to Fruits, says of this species:

In the larval state, before the power of flight is acquired, the insect is easily caught and destroyed; but it is not easy to suggest a remedy for so active a creature as the perfect insect is. It cannot be killed by any poisonous application, as it feeds only on sap. It has been suggested that where they are so numerous as to injure fruit-trees they may be frightened away by frequently shaking the trees, as they are very shy and timorous.

Professor Popenoe, in the article already referred to, also says:

On account of their very general distribution, their shyness and great activity, no satisfactory method of destruction has been so far found.

It seems to me that the insects might be successfully fought, just after hatching from the eggs, by spraying with kerosene emulsion. With this end in view the infested trees should be carefully watched during May, and as soon as most of the eggs are hatched the trees should be sprayed with the kerosene emulsion described in Article VI of this Bulletin. In those cases where the trees are infested by bark-lice, as well as the present pest, the same spraying may be made to kill both. By destroying the progeny of the eggs in this way, the crop of egg-laying specimens will be reduced, but it will not necessarily prevent the hoppers which develop in neighboring localities from invading the orchard to deposit eggs.

The suggestion contained in the above extract from Prof. Saunders' treatise, of frightening away the insects during the season of egg deposition by frequently shaking the trees, also seems worthy of trial.

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ARTICLE IX.—INSECTS AFFECTING CORN IN SOUTHERN OHIO.

The purpose of the present article is to call attention to certain insects injurious to corn in southern Ohio, which appear to be to a large extent either overlooked, or confounded with one another. There are three species to be discussed. The first is the well-known "grub worm," or white grub; the second, the young or larva of the common Twelve-spotted Cucumber Beetle; and the third, the corn root louse.

All of these insects are present in many of the southern counties of the State, and have done very serious damage during the last few years. As I have already noted, in the annual report of this Station for 1889 (Bulletin, Dec., 1889, Vol. II, p. 48), there is good reason for believing that much of the injury attributed to the white grub has really been due either to the root worm or root louse.

THE WHITE GRUB.

This notorious pest is the young or larva of the common May beetle or June bug. Its life history may be briefly summarized as follows: The brown beetles, shown at 3 and 4, Fig. 17, appear during May and June, and feed at night upon the foliage of various fruit and shade trees. They deposit small whitish eggs about the roots of grass. These eggs hatch into small, brown-headed grubs, that feed upon the roots about them. They continue feeding for three seasons, when they are full-grown and resemble 2, Fig. 17. They then form an oval cell in the soil and change to the pupa state, and soon after again change to adult beetles. The change to the pupa and beetle state often occurs in fall, so that the beetles may be turned up during late fall or early spring plowing, but generally it does not occur until spring.
This insect is one of the most difficult pests to fight of its class. It breeds especially in grass lands, and often ruins pastures and meadows, while crops on sod land are very frequently destroyed. There is much evidence to prove that with high farming and short rotations its injuries may largely be prevented; and experiments made for this Station in Butler county, Ohio, last summer, by Mr. Benj. H. Brown, convinced that gentleman "that by high cultivation and high fertilizing we can overcome the ravages of the white grub."

**THE TWELVE-SPOTTED CUCUMBER BEETLE.**

There is good reason for believing that the young, or larva, of this insect does serious damage to corn in southern Ohio. Some of these reasons were mentioned in the 1889 Report already referred to.

The Twelve-spotted Cucumber Beetle (*Diabrotica 12-punctata*), is a small yellow beetle, one-fourth of an inch in length, with twelve black spots on its back. It is represented, somewhat enlarged, at Fig. 18, the straight line at the right indicating its natural size. It is a very common insect, often occurring abundantly in connection with the common Striped Cucumber Beetle, represented at Fig. 19. It feeds upon squashes, cucumbers and melons; and occasionally upon the leaves of corn and other plants. No full description of its life-history has yet been published; but it is known that it passes the winter in the adult state; that its eggs are deposited about the roots of the corn; and that these eggs hatch into slender, cylindrical whitish worms, or larvae, that burrow into the lower part of the growing corn. Corn plants so affected appear sickly and stunted, and make little or no growth. By splitting open the lower part of the plant the larva can generally be found. It is very much smaller and more slender than the white grub, and the two are not at all likely to be confounded, though if one judges only by the effect on the plant the work of the one might easily be confused with that of the other.

This insect, at least in the adult state, is quite different from the Corn Root Worm of Illinois and other states west of us. The adult of that species is of a uniform green color. It does not occur in this State so far as we have observed, and its eggs are deposited in fall about the roots of the standing corn, so that rotation is a simple and effective pre-
ventive; while with our species the eggs appear to be laid in the spring, so that rotation is likely to be of very little assistance in this respect. With our present knowledge it is difficult to suggest a practical remedy. Possibly advantage may be taken of the fondness of the beetles for squashes and pumpkins, these to be planted in the fields as a lure to the beetles, which might deposit their eggs about the vines in preference to corn. The squash or pumpkin plants could then be destroyed, and the young worms hatching from the eggs would die of starvation. To a certain extent the beetles might also be killed by applying Paris green or London purple to the squash or pumpkin plants.

**The Corn Root Louse.**

This is a small, bluish green louse which occurs on the roots of corn, from the time it comes up in spring until it is cut in autumn. Its general form when magnified is well shown at Fig. 20, which represents a closely related species, the Apple Plant Louse. There are two forms found upon the roots, one having wings and the other not, the latter being much the commonest. Both forms are always attended by the common, small brown ant (Lasius alienus) which cares for them as tenderly as it does for the eggs and young of its own species. For our knowledge of the life-history of this insect we are largely indebted to Professor S. A. Forbes, State Entomologist of Illinois, who has made it a special study for several years. In his recently issued Fourth Report (p. 6), he says of the winter history of this species:

The eggs are collected from the ground in autumn by the common brown ant (Lasius alienus). Early in spring, before corn is planted, the young lice as they hatch are placed on the roots of pigeon-grass (Setaria), smartweed (Polygonum), and possibly some other weeds, and are reared there until the field is planted to corn—if this be done—when they attack the corn roots or subterranean part of the stem. If the field is planted to some other crop, the young lice mature on the grass roots, and produce a second brood, many of which acquire wings about the middle of May and then disperse. Later they seem to abandon the grasses entirely.

The presence of these lice can be easily determined by carefully pulling or digging up plants supposed to be injured. When the lice are present they will be seen crowding the roots as small bluish-green particles. By means of a sharp pointed beak they suck the sap from the roots. The effect upon the plants is much the same as in the case
of the root-worm described above. They appear yellow and sickly, and grow slowly or not at all.

No effective method of preventing the injuries of this pest has yet been discovered.

I would be glad to learn of any injuries done by either of these corn insects, or of any observations which farmers in the infested region may make upon them.

CLARENCE M. WEED.
Entomologist and Botanist.

ARTICLE X.—THE OX WARBLE FLY OR BOT-FLY.

A recent careful estimate from statistics gathered by the Farmers' Review, of Chicago, Illinois, indicates that fifty-six per cent. of the cattle in Ohio are attacked by the Ox Warble or Bot fly (Hypoderma bovis), and that the average loss on the hides due to the injuries of this insect amounts to one-third their total value, while the added loss due to the injury to the beef for food amounts to an average of $1 per animal. Statistics gathered from ten of the principal stock-raising States of the Mississippi Valley, showed the lowest per cent. of infestation to be thirty-three in Wisconsin, and the highest seventy-three, in Illinois. The loss indicated by these results has been summarized by the editors of Insect Life, as follows:

The amount of this loss can be better appreciated by reproducing, in condensed form, the approximate estimate of the loss on the hides of cattle received at the Union Stock-Yards, of Chicago, during the grubby season, which includes the months from January to June. Using the reports by States above given as a basis it is estimated that fifty per cent. of the cattle received are grubby. The average value of a hide is put at $3.90; and while from the report referred to, one-third value is the usual deduction for grubby hides, in this estimate but $1 is deducted, or less than one third. The number of cattle received in 1889 for the six months indicated was 1,335,026, giving a loss on the 50 per cent. of grubby animals of $687,613. When to this is added the loss from depreciated value and lessened quantity of the beef, the amount for each infested animal is put at $5, indicating a total loss on these animals from the attack of the fly of $3,337,565.

In the State of Ohio a very large proportion of this loss could easily be prevented; and the purpose of this article is to call attention to the injury, the life-history of the insect, and the remedies.

LIFE-HISTORY OF THE FLY.

During the spring or early summer one may often find along the middle of the backs of cattle, just beneath the skin, a hard lump,
WEED—THE OX WARBLE FLY OR BOT-FLY.

usually having in the center an opening, which sometimes is more or less a of running sore. These are the "warbles," and the lump is caused by the presence of a whitish or grayish maggot of the form represented at \( c \), Fig. 21. Early in summer these maggots wriggle out of the warbles, tail foremost, through the opening represented at \( b \), Fig. 21, and fall to the ground, where, under such protection as may be at hand, they shorten for pupation, as shown at \( d \), and soon change to the pupa or chrysalis state, represented at \( e \). About a month later they emerge as adult flies, one of which is represented, natural size, at \( a \). These flies pair, and the females deposit eggs on the backs of cattle. The eggs hatch into grubs that work their way into the skin, where they form the warble cells. Their mouth parts irritate the flesh, causing an ulceration, which not only is distressing to the animal, but injures the hide and beef, and, in the case of dairy animals, lessens the quantity of milk produced.

The beef beneath these warbles has a peculiar, diseased, sickening appearance, and is commonly called "licked beef." Such beef always commands a lower price than that which is unaffected.

The subject of warble attack has been carefully investigated for several years in England by Miss Eleanor A. Ormerod, Consulting Entomologist to the Royal Agricultural Society, who deserves great credit for the way in which she has brought the matter to the attention of the public. In a recent pamphlet she says:

It is sometimes said that this loss does not matter to the farmer;—but IT DOES! Every one of those warbled hides is a sign of so much out of the farmer's pocket for the food he spent in feeding grubs in his cattle's backs, which should have gone to form meat and milk, instead of being wasted in foul maggot-sores; and the quantities of hides of dead beasts brought in with their backs "in a mass of jelly," show there IS loss going on to an extent that no farmer would allow to go on if he did but know the cause, and the easy cure.

The aggregate amount of this loss is something enormous. As I have previously noted elsewhere, this is variously estimated, by different practical men, as being from two to seven millions pounds sterling, at the least, per annum. Mr. R. Stratton, of the Duffryn, Newport, Monmouthshire, who has devoted special attention to warble loss.
writes me:—"I am sure it cannot be less than £1 per head of horned stock, and it is probably much more."

From the cattle owner's point of view, we have to consider the direct injury to health and fattening powers so quietly borne that its existence is often not recognized, and (even in cases where the attack is completed by death) it may happen that it is not until the riddled hide is lifted from the jellied back that the reason of the trouble is made known, which a quarter of an hour's care, and outlay of a few pence earlier in the year, would have quite prevented. Besides this is the well-known damage in dairies and other herds from loss of milk and harm to the cows, and loss of flesh to fattening beasts by tearing about (to use again the words of Mr Stratton) "at as good a pace as can be got out of them."

**REMEDIES.**

Every warble maggot destroyed in spring before it escapes to the ground to pupate means that one less fly will be present to lay eggs for the coming brood. This should be carefully borne in mind, for from it the conclusion is obvious that if all the maggots now present in the backs of the cattle of a given neighborhood are killed, the egg-laying brood of flies will be exterminated and there will be no injury next season. There is perhaps no other important injurious insect whose numbers can be so readily controlled, and the experience of English farmers, as published in Miss Ormerod's report, shows that by concerted action and continuation of the treatment the amount of Warble attacks may be very rapidly lessened.

Perhaps the simplest remedy to use during spring and early summer is to squeeze the maggots out of the warbles. When they are nearly full grown this can be done with little trouble; and when smaller the opening can be enlarged with a pen knife so as to let them out. A pair of medium sized forceps are often helpful in removing them.

Another simple remedy is to apply to the opening a little oil or grease, which closes the breathing pores of the maggot, thus causing it to die. Kerosene applied to the warbles either in autumn, winter or spring also destroys them, as does indeed the application of almost any oily or fatty substance. Train oil or fish oil is especially commended in England. Dr. C. V. Riley says that smearing the animals' backs with this substance "is the simplest and easiest method of destroying the warbles, which it does by closing the breathing pores on the posterior end of the body. The destruction of the larvae in this way may be effected by one or two applications in autumn, and is the most satisfactory method of controlling the pest."

As to remedies, Miss Ormerod writes:

With regard to methods of remedy, there does not appear to be any difficulty of getting rid of the Warble-maggot easily and cheaply, when the Warble has "ripened"—that is, opened so far that the black end of the tail is visible. Then it may be destroyed cheaply and quickly. From special observations, taken during the last three years, it
has been found that where the Warble-maggots have been destroyed before they drop from the cattle, there is little if any summer attack of Warble-flies. Consequently the cattle can rest in peace, and, as there is very little egg-laying on them, there are scarcely any Warbles in the following spring.

Squeezing out the maggots is a sure method of getting rid of them, but they may be destroyed easily and without risk by dressing the Warble with a little of McDougall's smear or dip, or by a little cart-grease and sulphur, applied well on the opening of the Warble. Mercurial ointment answers, if carefully used—that is, in very small quantity, and only applied once as a small touch on the Warble; but where there is any risk of careless application it should not be used. Any thick greasy matter that will choke the breathing-pores of the maggot, or poison it by running down into the cell in which it lies and feeds, will answer well; and lard or rancid butter mixed with a little sulphur has also been found to answer. Tar answers if carefully placed, so as to be absolutely on the hole into the Warble.

It is also frequently recommended to smear the backs of the cattle during summer with fish oil, kerosene emulsion or some similar substance to prevent the flies from depositing eggs, but this is a much less practical method than that of destroying the maggots, because the flies are present nearly all summer, making it necessary that the application be frequently renewed.

CLARENCE M. WEED,
Entomologist and Botanist.

ARTICLE XI.—FUNGOUS DISEASES OF PLANTS AND THEIR REMEDIES.

Investigations and experiments made within the last few years upon the various rots, smuts, blights, mildews and other affections of plants caused by fungi, have already given us practical remedies for many of these pests, and there is good reason to hope that many others will soon be brought under control. On account of the great interest in the subject now felt by many fruit-growers it has been thought desirable to present in this Bulletin a general discussion of the subject, together with formulas for the preparation of the several fungicides now in use.

To give the reader a clearer idea of what is meant by a fungous disease, I cannot do better than to quote the following discussion by Dr. Roland Thaxter, of the Connecticut Experiment Station:

Fungus or fungous disease, that is a disease caused by a fungus or fungi, is the term properly applied to a majority of the ailments among plants which are commonly and loosely designated by such names as blast, blight, mildew, mould, rot, rust, scab, scald and smut, all of which convey to the mind a more or less confused and inaccurate idea of what they are intended to distinguish. Such diseases are accurately known only by the scientific names which have been given to the fungi which cause them.
ple, the onion smut in Connecticut is known as *Urocystis Cepis*; *Urocystis* being the generic or group name given to all smuts having the special characters found in the onion smut, while *Cepis*, which notes the fact that it is found on small cultivated onions, is the specific name applied to the particular species mentioned.

Whatever different names we may decide to give them, or rather to their visible effects or products, their nature is practically the same in all cases. That is, the injury is caused by certain lowly organized plants, living on or in the tissues of the plant which harbors them and is conveniently called their *host* or *host-plant*. Their vegetative portion consists of an indefinite growth of thread-like tubes, which usually branch in growing on or through the tissues of the host, and absorb from them their contained nutrient. Such thread-like tubes are called *hyphae*, and from them are produced the reproductive bodies of the fungus, usually in the form of what are called *spores*. The spores, which correspond in many cases to the seed of higher plants, and perform the same function, are very various in their size, shape, color, and markings. Many are simple, composed of a single cell, and others are compound and divided by partitions into two to some times very many cells. They are usually very minute and invisible to the naked eye, except in the case of the spores of onions, in which a single cell, tacked over the bottom of the host of the fungus, or on small affected plants, can be seen with the magnifying glass.

Thus it will be seen that these diseases are caused by plants developing from spores. Hence, if these spores can be destroyed, or if unaffected host-plants can be casted with something which will prevent the development of the spores, the injury will be stopped. To this fact is due the important practical results recently reached in fighting plant-diseases.

The substances used for destroying these spores, or preventing the development of the fungi are called, *fungicides*, or killers of fungi. The most important fungicides now in use are the compounds of copper, especially the sulphate of copper or blue vitriol, and the carbonate of copper. From these substances two of the leading fungicide solutions are made, the Bordeaux Mixture, and the Ammoniacal Carbonate of Copper. Dr. Thaxter gives the following directions for making the first named:

**BORDEAUX MIXTURE.**

<table>
<thead>
<tr>
<th>Substance</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphate of copper</td>
<td>6 lbs.</td>
</tr>
<tr>
<td>Quick lime</td>
<td>4 lbs.</td>
</tr>
<tr>
<td>Water</td>
<td>22 gals.</td>
</tr>
</tbody>
</table>

Dissolve the sulphate of copper in two gallons of hot water to hasten the solution, which is also facilitated if the sulphate is pulverized. Dilute this solution with fourteen gallons of water. Slake the lime, *which must be fresh* (i.e. not partly air-slaked), slowly, with six gallons of water, stirring the mixture while so doing to a smooth paste. After this is slightly cooled, pour it slowly into the copper solution, stirring the whole rapidly at the same time.

For use this mixture must be stirred and strained through fine brass or copper gauze. A small piece of the latter, tacked over the bottom of a salt or strawberry box,
is sufficient for the purpose, and the straining is easily and rapidly done if the mixture is poured slowly upon the grueze from a slight elevation (two or three feet), which avoids clogging the meshes of the strainer. Mixing, etc., should be done in wooden vessels, since the substances corrode iron or tin.

In the Potato Blight experiments, conducted by this Station last summer, I used with apparent success a modified Bordeaux mixture containing only about half as much copper sulphate as is ordinarily recommended, using six pounds copper sulphate and four pounds lime to fifty gallons water instead of twenty two gallons. We usually made it by filling our Nixon barrel machine, which holds fifty gallons, nearly full of water, and then adding three or four gallons of hot water in which the six pounds of copper sulphate crystals had been dissolved. The freshly slaked lime was then poured in, and after a thorough stirring the mixture was ready for use. Sometimes instead of the crystals we used powdered copper sulphate, in which case it was not necessary to heat water to dissolve it, the powder being simply put in the barrel of clear water and was soon dissolved.

**AMONIACAL CARBONATE OF COPPER.**

The formula for this is as follows:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbonate of copper</td>
<td>3 oz.</td>
</tr>
<tr>
<td>Commercial ammonia (22°)</td>
<td>1 qt.</td>
</tr>
<tr>
<td>Water</td>
<td>22 gals.</td>
</tr>
</tbody>
</table>

Add the ammonia to the carbonate and when dissolved dilute to twenty-two gallons with water, forming a clear solution.

The carbonate of copper should be purchased in the precipitated form when possible.

**EAU CELESTE.**

This fungicide is made by dissolving 1 pound of sulphate of copper in 2 gallons hot water; when completely dissolved, and the water has cooled add 1½ pints commercial ammonia; when ready to use dilute with water to 22 gallons.

These fungicides should be sprayed upon the crops to which they are applied. The spraying pump used should have the parts touched by the solution made of brass, as many of the copper mixtures corrode iron or tin; a fact which must be borne in mind when preparing them. The Nixon pumps we have found to do very well for fungicides; and the Gould’s Manufacturing Company also make pumps of brass. These will be found described in Article X of this Bulletin.

Among the more important plant diseases which our present
knowledge indicates may be controlled by the use of fungicides are the following:

POTATO BLIGHT OR ROT.

This is the disease which so generally causes the blighting of the potato tops sometime before the crop is mature. Experiments at this Station last year, as well as some in New Jersey, indicated that the disease may be prevented by the Bordeaux mixture. For early potatoes the first application should be made early in June. It should be repeated two or three times at intervals of a week or ten days, as the growth of the plants or the washing off of the mixture by rains may necessitate. Care must be taken that the spraying is thoroughly done, both surfaces of the leaves being coated as far as possible. London purple may be added to the mixture whenever the presence of potato beetles indicates the necessity of using it.

APPLE SCAB.

Experiments made last year by the U. S. Department of Agriculture indicated that this disease also may be prevented by the copper compounds, especially the ammoniacal solution of copper carbonate. Our experiments at this Station showed that it is not safe to use the Bordeaux mixture, as it injures the apples. But the carbonate solution, if properly applied, appears to be a safe and effective remedy. Professor E. S. Goff, who conducted the Wisconsin experiments referred to, gives the following directions for treating the trees:

The experience of the past season would lead us to recommend using, as a convenient formula, a solution composed of one ounce of carbonate of copper dissolved in one quart of aqua-ammonia (strength 22 Baume), diluted with 100 quarts of water. One and one-half gallons of the diluted solution are sufficient to thoroughly spray a tree of medium size, and two gallons for one of large size. It follows, therefore, that four ounces of carbonate of copper and one gallon of ammonia will make 100 gallons of the diluted solution, which is sufficient to spray 50 large or about 75 medium trees once.

The ammonia should be procured in a glass or earthen vessel, and be kept tightly corked with a rubber stopper. To this add the precipitated carbonate of copper at the rate of one ounce to one quart of ammonia, in which it dissolves, forming a very clear, deep blue liquid. When ready to commence the application, add this solution to the water used for spraying at the rate of one quart to twenty-five gallons of water. The bottle containing the solution should be kept tightly corked, otherwise the ammonia will waste by evaporation.

The number of applications it is necessary to make to secure the greatest benefit is yet to be determined. The adhesive power of the carbonate of copper is very great, and it is possible that a smaller number of treatments than the seven made in our experiment would have answered as well. I would recommend at least three or four treatments, and it is probable that one application, made just after the leaves expand and before the flowers have opened, would add to the efficiency of the treatment, as the fungus commences its growth quite early in the season.
PEAR LEAF BLIGHT.

This is not the ordinary pear blight, but is a disease affecting the leaves, causing them to become spotted and to fall off. It is especially destructive in nurseries. Experiments made last year by the Department of Agriculture on a large scale showed that the disease may be prevented by the Bordeaux mixture. The first application should be made early in June and three or four others should follow at intervals of ten days.

POWDERY MILDEW OF APPLE AND CHERRY.

This, too, is a disease especially injurious in nurseries, which may be prevented by fungicides. Mr. B. T Galloway, of the Department of Agriculture, last year conducted extensive experiments in a large nursery near Washington, D. C., using the ammoniacal carbonate of copper solution. He says:

The first application of this solution was begun on May 24th, and it required two men four days to spray the entire 390,000 trees. One block of 200,000, most of which were budded stocks, was sprayed twice at a total cost of $8 00. Two other blocks, containing 15,000 and 40,000 stocks, respectively, were sprayed six times at a cost of $22 80. It will be seen from these figures that the total cost of each application, per 1,000 trees, was about two cents. An examination of the treated trees on August 11 revealed the fact that nearly all of them were in good condition.

PLUM FRUIT ROT.

It is yet to be determined whether this disease can be prevented by the use of fungicides, but our last year's experiments were sufficiently encouraging to warrant their continuation. In our experiments this year we shall spray the trees soon after the blossoms fall with a simple mixture of London purple and water (about a pound to 200 gallons) to destroy the Curculios; then ten days later we shall spray with a combination of London purple and the Bordeaux mixture, using one ounce London purple to ten or 12 gallons of the mixture; and again in about two weeks with the ammoniacal solution of carbonate of copper.

The dead plums on the trees should be picked off early in the season, and the rotting plums on the trees removed as much as possible.

COMBINING INSECTICIDES AND FUNGICIDES.

This can often be done to advantage but care must be taken. The Bordeaux mixture and London purple or Paris green can be used together very well, but this is not true with the ammoniacal carbonate of copper, as the ammonia renders the arsenic soluble, thus endangering the foliage.
So far as opportunity offers the experiments with these various diseases will be conducted by the Station this season; and I shall be glad to give further information to applicants at any time.

Clarence M. Weed,
Entomologist and Botanist.

ARTICLE XII.—DIRECTIONS FOR COLLECTING, PRESERVING AND STUDYING PLANTS.

I. COLLECTING PLANTS.

The apparatus necessary for collecting plants is neither elaborate nor costly. The most important essentials are something with which to dig up the roots of the plants; something to carry them in from the field to the house; a hand magnifier and a notebook.

For digging the roots of plants either a small trowel, a good sized jack knife or an old carving knife will do very well.

For carrying the plants a good sized tin box with a tight closing cover is excellent. The vasesums described in the botanies are very good, but a cheaper substitute can often be found in the tin canisters and boxes at the grocery stores.

Instead of a tin box many collectors use some form of portfolio containing a quantity of what are known as specimen-sheets. These are simply sheets of paper folded once, in which the specimens are placed. They can easily be made of newspapers. The usual size of the folded sheet is 12 by 18 inches. One form of these portfolios is represented at Fig. 22, which, with the following description is taken from the Botanical Collector's Hand Book.

Many use an ordinary portfolio of lunder's boards, either united at the back by leather, as in a book, or left so far separate as to allow pressure to be applied by means of the two straps which pass around it near the ends free or attached to one side only. They should be covered or bound with strong cloth, cloth well sewed in every place, in a black and varnished, making it as nearly water proof and as durable as possible.

It should be thick enough to hold four or five quires of the specimen-paper and it is well to have it a little larger than the latter, say 12½ by 19 inches, for otherwise when laying in the plants the sheets will almost certainly slide more or less on one another and the edges will project and be torn or welled.

* This is the second of a series of articles intended to aid the farmers' boys and girls of the State in getting correctly started in the study of the natural objects about them. The first, concern-
Put on the upper side and on each end a stout strap and buckle to close the portfolio tightly, so that the plants may not fall out in carrying.

It two other buckles or flaps be attached through which a strap is passed to suspend the portfolio over the shoulders, the trouble of carrying will be greatly diminished.

There is also a combination of the vacuolum and portfolio, the invention of which is credited to Prof. G. L. Goodale, of Harvard University. It is shown at Fig. 23, which is taken from the Botanical Collector's Handbook, in which the following description occurs:

The portfolio is of the ordinary form, but the pressure straps are permanently attached to the back of the inner cover where also the bell is fastened. The buckles of the pressure straps must be arranged to come above the center of the portfolio in order to prevent the knapsack from being turned out when carried upon the shoulders. The two straps are fastened to the portfolio in the proper position to go over the shoulder and bring the knapsack just below the shoulder blades. The bellows extension is made of enameled cloth, and the outer side must be made stiff with a pressed board the same size as the frame of the portfolio. The flap to the bellows should be made large enough to cover the opening when fully extended and may be kept in place by means of rings on elastic straps which go over buttons placed at intervals down the outside.

The more delicate or desirable specimens may be pressed at once and the less perishable ones carried in the extension, which is in reality a flexible vacuolum, and may be used, if desired, for other purposes.

The expense of this apparatus is but trifling, and a collector of an ingenious turn may easily construct one for himself. The collector should provide a piece of thin India rubber or oil-skin cloth large enough to keep his portfolio dry in a storm.

It may be impossible for some to have made or to make either a portfolio or knapsack; then a substitute no doubt available to all has been suggested by Professor Lester F. Ward, of Washington, D.C., who says he has for several years "used nothing but an old book, 16 inches long by 10 wide, with some of the leaves left in, which I carry with my hand upon the front edge, holding the covers together. An India rubber band around both covers is, an excellent auxiliary where any considerable interval elapses between the times of collecting specimens, and it is often very convenient to put one longitudinally around one of the covers and the leaf next to the last specimen collected, which can remain." This book portfolio is open to the objection that it deprives

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*Fig. 23* Collecting Knapsack

[After Bailey]

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the collector of the use of one hand, and if carried for any length of time the hand which holds it will become very cramped.

Then one must have a magnifying glass, carried in a convenient place. A triplet having lenses of one-half, five-eights and three-fourths inches diameter can be obtained in almost every book store. A Coddington magnifier is a somewhat better lens; the focal distances range from one-half to one inch; they are mounted in nickel frames, which are perforated, or provided with a ring, by which they can be attached to the watch chain.

A note book and pencil should always be carried, and notes be taken of the locality and situation in which the plant is found, and date of collecting.

In collecting plants do not content yourself with breaking off the plant so as to get the blossom and merely enough leaves to make it look pretty; whenever possible, and with herbs it usually is so, take the whole plant, root and all, and try to get it at such a time that the fruit, as well as the blossom, is shown; thoroughly wash the roots free from dirt, but do not wet the leaves. Collect grasses in flower. If the plant is very tall, then enough of the upper end to show the leaves, branches and blossoms, and a portion of the lower end of the stem, with the root and root leaves is sufficient. In such cases make a note of the size of the plant. Of trees and shrubs, collect the blossom and enough of the small twigs or branches to show the character and arrangement of the leaves. Then go again later in the season and collect the fruit, and also some of the leaves; for in some cases the leaves which are on the tree when in blossom differ from those which appear later. If the roots, stems and flower-heads are too thick, to lie flat and press well, they can be split without injuring the specimen.

If, in placing a plant in the portfolio, it is found too long for the sheet, but not more than twice that length, bend it once, preferably near the flower end. If it is longer than twice the length of the sheet, two bendings are necessary; make the angles opposite, giving the plant a zigzag direction, so that its parts shall not overlap. Never let any ends project beyond the sheet.

In placing plants in the old book, put them between the leaves that were left in it, then slip the elastic around the cover and the leaf over the plant.

If a vasculum is used for collecting, put the plants in it so that they lie in an even pile, with roots and flowers equally distributed in both ends. To prevent the more delicate specimens from being crushed by the coarser ones, it would be well to put soft paper here and there between them.
II. PRESERVING PLANTS.

After the plants are collected they must be pressed. For this, one needs a supply of the specimen sheets already described, and also of "driers." These driers may be made of newspapers folded to about 12 by 18 inches; but the soft, bibulous carpet-paper, sold at carpet and dry goods stores, is better. This comes in long rolls a yard wide, and usually costs about five cents a yard. It can be cut into driers the desired size, which are excellent for the purpose.

The press consists of two boards a little longer and wider than the sheets and driers. One is put down as a foundation on which to place the plants. If the collecting has been done in a portfolio, the plants are left in the sheet in which they were first laid. Put fresh driers, two are sufficient if the heavy felt-like paper is used, on the board, on this a sheet containing specimens; then two more driers; another specimen sheet, and so on until all the plants have been transferred from the portfolio to the press. On top of the pile put the other board, and on this a weight—good sized flat stones are perhaps the most convenient. The weight must be sufficient to press the plants, but must not crush them.

If the plants have been collected in the vasculum they must be arranged in sheets of paper and then placed in the press. In arranging the plants, show some of the blossoms and leaves from one side and some from another, be careful that they are not creased or folded, and do not let parts of the plant overlap too much. Make the specimen look as natural as possible.

Cut strips of paper somewhat longer than the specimen sheet; on one end write the name of the plant, if you know it, the date of collecting, place where found and collector's name. Lay one such a strip in each specimen sheet, allowing the written end to extend beyond the sheet, so that the writing may be read without opening the sheet. You will have no trouble afterwards in writing labels for the herbarium.

In arranging the press make as even a pile as you can, putting some of the plants on one side of the sheet and some on the other, so that the center is level, else all parts of the plant will not dry evenly.

See that the driers are perfectly dry before using; a good way is to use hot ones, as the object is to dry the plants as quickly as possible in order to retain their colors. When not in use spread the driers in the sunshine or in some place where the wind can blow over them. Change the driers at least once a day—twice is better.

Do not remove the plants from the press until they are thoroughly dry to the touch, so that the stems and leaves are very brittle.
Before mounting specimens for the herbarium they must be poisons to prevent insect attack on them. Dissolve an ounce of corrosive sublimate in a quart of commercial alcohol. Either place this solution in a shallow vessel in which the plants may be immersed, or in a deeper vessel, and apply the solution to the plant with a broad, soft brush, without metal fastenings, as the poison corrodes metal. Be careful not to get any of the poison on the hands, and always keep the bottle distinctly labeled—Potts. Place the saturated plants between fresh driers, put them back in the press and lay a light weight on them. When dry they are ready to be mounted.

The herbarium sheets should be of smooth, stiff, firm white paper, or bristol board, and each sheet should be 16½ by 11½ inches, which is the size adopted in the United States.

A mixture of equal parts gum tragacanth and gum arabic in solution, with a few drops of carbolic acid added to keep it from moulding, is the best glue.

There are two methods of mounting plants—one is to glue the specimen to the sheet, and the other is to fasten it to the paper by means of gummed strips.

If the first method is adopted, the plant is laid face downward on a blotter or piece of newspaper, and the glue is applied to every part with a brush; then take the specimen, turn it over and place it quickly and carefully in its place on the sheet. Don’t move it around after the glue has touched the sheet, as it will make an untidy looking sheet. Do not put too many specimens of one species on a sheet, and never put on more than one species.

If the second method of mounting is used, arrange the specimen on the sheet and fasten it down here and there, where the specimen seems to need it most, with gummed strips. In preparing these gummed strips it is best to coat a sheet of paper with glue, and when it is dry cut it into the desired strips. When wanted they have only to be moistened and applied. White court-plaster cut into narrow strips is a very neat thing to use, as it is so transparent it does not show much.
Both these methods of mounting specimens for the herbarium have of course their good points and their drawbacks. When a plant has been mounted according to the first method it can never be removed from the sheet, if a change is desired, or a mistake has been made, but on the other hand it is so firmly pasted down that it will not become frayed or broken off.

If the specimen is secured only by gummed strips it can be transferred to another sheet, or can be removed for study whenever wanted, but it is very apt to get broken unless handled with extreme care.

In Fig 24 both methods have been used. It is often found necessary to put gummed strips over a root or obstreperous stem of a plant which is pasted to the sheet.

The label should be put on the lower right-hand corner of the herbarium sheet; $3\frac{1}{2}$ by $2\frac{1}{2}$ inches is a good size. It should contain the generic and specific names of the plant. Under this is usually written the common name, in one corner the date and locality, and in the other the name of the collector. A good arrangement is shown in the accompanying cut, which is a copy of the label used in the herbarium of the Ohio Agricultural Experiment Station.

The species of each genus are sorted and put in a folded sheet of stiff brown paper a little larger than the species sheet; this is the genus cover. On the lower right-hand corner of this cover is placed a label containing the name of the genus. Some botanists add a list of the species contained in each cover, by this means one can see what species are in the cover without opening it. The genera are grouped in their respective families.

A very convenient cabinet for an herbarium is shown at Fig. 25, which is taken from the Botanical Collector's Hand Book. The shelves should be 17 inches deep and 12 inches wide, and not more than from 4 to 6 inches apart. Into these compartments the genus covers slip readily.
Each family, if not too large, can be put on a shelf, and each shelf labeled with the name of the family. Instead of pasting these labels on the edge of the shelf, make tacks by pinching off common pins a short distance below the head, and tack the labels on the front margin of the shelf with these. The labels being tacked on can be removed at any time, which would be impossible with pasted labels.

Always collect and preserve more than one specimen of each species, and keep these duplicates for study, exchange and the like. The duplicates are not mounted, but are left in the sheets in which they were pressed. The labels that were put in the sheets in the press are left in them. The species of each genus are grouped in genera covers, and in fact are treated just as the mounted specimens were, only are kept in a place by themselves. So if one of these is wanted it will be no more difficult to find than is a mounted specimen.

### III. Studying Plants.

Much can be learned of plants by studying them wherever we find them, but the more careful and extended study must be done at home.

For such work some sort of dissecting microscope will be of great use. It need not be elaborate, but there must be a stage or platform on which the part of the plant to be examined can be laid, and some contrivance by which the lens is held above it, so that both hands are free. Such a simple dissecting microscope can be obtained for a small price of any dealer in natural history supplies. Or it can be made at home by taking a smooth block of wood for the stage, and fastening into this a metal rod or nicely rounded and smoothed stick, over which the perforation in the lens just fits. You then have an instrument which, though crude, is very useful.

Several needles are also necessary for teasing out and separating parts of plants. These are easily made by inserting the eye end of a cambric needle into an old penholder or any rounded stick. It is best to have at least four or five of these. A pair of small curved scissors and a pair of tweezers are also useful.

After the specimens, lens and needles are in hand the next essential is a good botany. The series of text books by Professor Gray are adapted to the wants of beginners as well as those farther advanced. Gray’s Manual of North American Plants, a sixth edition of which has just been published, is indispensable, as by it one can determine specimens easily. The series of botanies by Prof. Chas. E. Bessey, are also excellent; as are the Class Book of Botany and Botanist and Florist, by Alphonso Wood. These may be purchased through any book dealer, as
can also the following books, which will be found very useful to any botanical student

Talks Afield about Plants and the Science of Plants, by L. H. Bailey.


Plant Analysis, Professor Kellerman.

There are also two journals devoted to botany which contain much valuable matter. The first is the Botanical Gazette, published at Crawfordsville, Indiana, and the second the Bulletin of the Torrey Botanical Club, of New York City. Much information may also be gleaned from the bulletins and reports of the U. S. Department of Agriculture, the various experiment stations, the Illinois State Laboratory of Natural History, and various other institutions.

SENDING PLANTS TO BE NAMED.

When sending plants to any botanist for identification do not send just the blossoms with a few adjacent leaves. Nothing is more annoying than to be asked to name a plant and find only a few dried-up scraps to identify it by. Send the whole plant, if possible, for each part of it has a character of its own. If too large send enough of the stem near the top to show the arrangement of the branches, leaves and blossoms, and a portion of the lower part of the stem, with the root and root leaves. If possible send both fruit and blossoms. Make a note of the size of the plant and locality where found.

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