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Russian Willows and Poplars — Descriptions and Value for Minnesota.
Insects Affecting Willows and Poplars.

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RUSSIAN WILLOWS AND POPLARS — DESCRIPTIONS AND VALUE FOR MINNESOTA.

SAMUEL B. GREEN.

The following report on the characteristics of the Asiatic and European Poplars and Willows is made to supply information regarding their value, and also to aid in furnishing some means for the identification of the different species. The kinds mentioned in the following pages have all been grown for at least five years in this state, and while in limiting the report to these only, a few varieties may have been overlooked which are of value, yet I think it safe to only report on those which have been tried this length of time. It is very evident to those who have experimented with these varieties that many of them have much intrinsic value and are especially adapted to many useful purposes in the prairie districts of this state. Among the uses to which these Poplars are adapted may be mentioned the following: Wind-breaks. For this purpose most of them are as hardy as the Cottonwood, more rapid growers and are freer from diseases of the foliage. For timber some of them are of much value, almost equaling the Pine for general purposes. Others make a good quality of fuel. For ornamental purposes some of them have beautiful foliage and symetrical habits, and many of them are superior shade trees. There is such wide difference in the form and color of the leaves as well as in manner of growth that with a little forethought and management the varieties can be so arranged that they come in contrast and make a very pleasing appearance.

Among the Willows are those which are especially adapted for such purposes as wind-breaks, for which they have a growth that is remarkably dense, tough and vigorous. Some of them are largely used for basket and tying purposes in Europe and others are valuable for timber. It is well known that white Willow wood is highly prized as being light, tough, elastic and tenacious of nails. It is valuable for lining wagon bodies, for wooden trays, etc. Some of the Russian Willows are said to possess these desirable qualities in a remarkable degree. In the eastern states there are many Willows planted for the purpose of making charcoal for gunpowder works, for which no other wood is so valuable. Plantations made for charring have paid well.

Were this a bulletin on the general subject of forests I should encourage the planting of Evergreens, and especially the Scotch Pine and

white Spruce as furnishing most admirable wind-breaks, but they are of slow growth and in many places will not grow at all until protected from the severe winds. These Willows and Poplars, besides furnishing wind-breaks, afford the protection needed in growing other varieties of trees.

POPLARS.

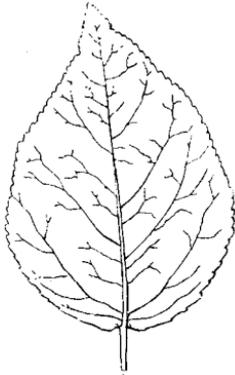
Populus certinensis. This is a very fast growing Asiatic poplar, received from Prof. Budd, who in turn got it from Prof. Sargent's collection. It is perfectly hardy with us and promises to be very valuable for exposed situations. Its foliage is much healthier than that of the cottonwood, and is not affected with rust, while its timber is said to be valuable for building purposes. It roots readily from cuttings. It is of an upright form, with thick leathery leaves, and an exceedingly rapid grower. Leaves broadly, oval pointed, (*ovate-acuminate*), nearly flat, though wavy on the edge. The new wood is colored and strongly marked with five ridges. (See plate for diagram of leaf.)

Populus Fastigata. This is the Russian form of the Lombardy Poplar, and it may prove a much better tree. We do not think it of any great value, and mention it simply to give its characteristics. Form very upright; of medium size; leaves broadly heart-shaped, (*deltoid*) thick and very smooth; petioles long and pliable; edges irregular; growth rapid; young wood round, smooth, without ridges and shiny. It seems to be a good stock on which to graft the white foliated Poplars. It has shown a tendency to sucker in our nursery rows.

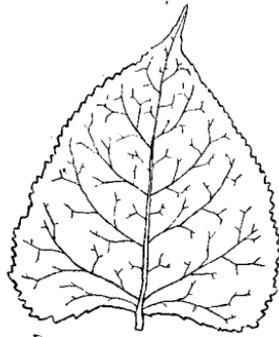
Populus Petrousiki. This is so much like *Certinensis* in foliage and growth that I cannot distinguish the difference when they are planted side by side. It may develop a different habit when older. Like the *Certinensis* it is a vigorous, upright grower, and a valuable timber tree. Prof. Budd says "that it is especially adapted to a dry soil and a cold climate, and that the timber does not warp, shrink or crack like that of our native Cottonwood." Foliage thick and leathery, with stiff petioles; new growth strongly ridged; leaves oval-pointed, (*ovate-acuminate*), fluted on the edge when growing rapidly. (*For form of leaf see diagram of P. certinensis, to which it is similar.*)

Populus bereolensis. This is similar to *P. certinensis*, and a valuable timber Poplar, with large leathery foliage and vigorous, upright habit. Leaves oval-pointed; quite broad at the base; serrated, and

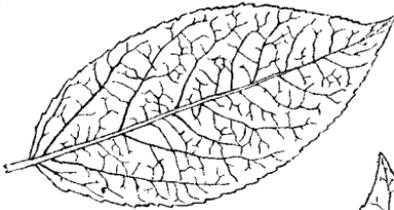
NOTE.—The plate on opposite page shows the different forms of leaves of the several types of Poplars described. These figures were obtained by blue-printing the leaves, tracing them with ink and then bleaching out the blue color with soda. *P. monilifera* is our common Cottonwood which is well known and is given simply for comparison. *P. balsamifera* is similar in form of leaf to *P. laurifolia* and *P. Siberica pyramidalis*. The leaf of *Populus certinensis* (the specific name is spelled wrong in the plate) as given in the plate is also typical of the leaf of *P. Petrousiki* and *P. bereolensis*.



P. wobsky



P. monilifera



P. balsamifera



P. certnensis



P. betulifolia



P. holleana



P. alba

fluted on the edge when growing rapidly; new growth quite angular. *See diagram of leaf of P. certinensis to which it is similar.*

Laurel Leaved Poplar, (*Populus Laurifolia*.) This is a little slower grower than *P. Certinensis* but has a foliage which is hard, healthy and vigorous. In speaking of this poplar, Prof. Budd says, "that it is a common park or street tree in Northern Europe. As a timber tree it is superior to the Cottonwood for either lumber or fuel. Its thick leaves will withstand the hottest and driest air of the West, either standing alone or in shelter-belts. The lumber is much like that of the White Poplar in strength and closeness of texture." Leaves oval and silvery smooth-white on the under side; flat, though sometimes folded; buds rather conspicuous, without ridges. (*Similar in form of leaf to that of P. balsamifera, for which see plate.*)

Populus Siberica Pyramidalis.—This is a very promising Poplar. Prof. Budd says of it: "Still another thick leaved Poplar of the largest size, as valuable as our Cottonwoods in quality of timber, it will attain great size where the Cottonwoods will fail in twelve or fifteen years." The growth is moderate in the nursery and in small trees of upright rather pretty close habit. The new wood is smooth, without ridges and of a reddish color. Foliage, oval-pointed, flat finely serrate, dark green on upper, but white on lower side, with a conspicuous veining. (*Similar in form of leaf to P. balsamifera, for which see plate.*)

Populus Dudleyi.—This we have sent out as 15 Vor. Its number should be 115 Vor. It is supposed to be the European form of *Populus Angulata*. The growth is only moderate, upright when young, but somewhat pendulous when old. It has been badly attacked with leaf rust on our older specimens and we do not consider it of much value. The leaf is broadly lanceolate, very wavy on the edge and often folded, serrate. The bark of the young growth is marked with five very distinct prominent ridges.

Populus Wobsky.—This we have sent out as 40 Riga, and we consider it one of the most distinct and valuable Poplars in our collection. Prof. Budd says of it: "That on account of its regular form and large shining leaves, it is a favorite for ornamental planting, yet it is an upright and rapid grower as a timber tree." We find it to be perfectly hardy and easily propagated from cuttings. The leaves are large, ovate heart-shaped (ovate-cordate), stiff, very flat, shiny blue-green on upper and light green on lower side; petioles $1\frac{1}{2}$ inches long; buds large and sticky; young wood very slightly ridged. *See plate for form of leaf.*

Populus betulifolia.—This Poplar is very conspicuous and of a much different habit from any other in our collection. The foliage is large and distinct, while the tree is rather open in habit and inclines to having a straight trunk with the branches coming out at right angles. It has retained its foliage bright and fresh in dry sod land. It is perfectly hardy, easily propagated and is a rapid grower. In referring to

this variety, Prof. Budd says: "Not specially valuable for timber, but interesting for wind-breaks and for effect on timber borders." The leaves are very large, deltoid in shape, very broad and thick with a sharp point; much larger and broader in form than the Cottonwood leaf. (*See plate for form of leaf.*)

Populus balsamifera of Asia. This we have sent out as 116 vor. Mr. Charles Gibbs says he saw a specimen of it in the Botanical Garden at Kazan, 50 feet in height and two feet in diameter; that although the tree when young is like *P. Siberica* it is said to grow into a different shaped tree; easily propagated, vigorous and healthy; leaves somewhat folded so that the almost pure white under side shows plainly; dark green on upper side; stiff, very thick, on short stiff petioles, broadly oval; new bark smooth without ridges and of a reddish color. (*See plate.*)

Populus alba. This is the true White European Poplar. It is upright in form, with downy, silvery foliage, resembling the *abele*. It is said to be superior to the *abele* in that it does not sprout to any serious extent, and it has a better form. We have found it rather difficult to propagate, except by grafting. Perfectly hardy. (*See plate for form of leaf.*)

Populus Bolleana. When Prof. Sargent saw this Poplar in Europe he pronounced it to be one of the finest ornamental trees of the temperate zone. Prof. Budd writes that "it is difficult to realize the beauty of a well grown specimen without seeing it when its silvery cut leaves are moved by the summer breeze." It is very conspicuous and entirely different from the ordinary silver Poplar which it resembles in its downy, white foliage. The growth is nearly as upright as the Lombardy Poplar but the resemblance stops with this, for it is a long lived tree, of excellent habit, perfectly hardy in the most trying situations, and does not sucker; rather difficult to propagate as it roots poorly from cuttings, but it may be grafted or budded on several varieties of Poplar. Those which have given us the best results for a stock are *P. fastigata* and *P. laurifolia*. Prof. Budd says it buds well on *P. nostlei*. Small green wood cuttings made in the summer and kept moist in a frame will root. It is of quite moderate growth on its own roots, but when budded or grafted on some of the fast growing varieties, such as *P. Wobsky* or *P. laurifolia*, it makes a very rapid growth. It is a variety which will be much sought after for ornamental planting when it is better known. In general appearance the bark and foliage resembles the common Silver Poplar, the leaves are cut however much like those of the Soft-maple and are of a very rich dark green color on the upper, while on the lower side they are white and downy; form upright and close. (*See plate for form of leaf.*)

WILLOWS.

Salix acutifolia.—This is a very valuable Willow for wind-breaks or for single specimen trees and-for tying material. It is conspicuous from its bright green healthy foliage. Referring to this tree, Prof. Budd writes: "This will be especially valuable in the far west and north-west, where the summer and winter air is dry and the rainfall light. The timber is less valuable than that of the Red Willow, but it is better than that of any of the common kinds." Mr. Charles Gibbs writes that in Mantchooria in the woods it is a large timber tree with a trunk often four feet in diameter, used by the natives for canoes. In cold, open exposures it is a mere shrub. It is the best weeper in the botanical gardens at St. Petersburg. It is planted in the sandy wastes of southeast Russia to fix the drifting sands." F. B. Hough puts this variety in the list of those most desirable for osiers. Its foliage is bright green on the upper with a faint bluish bloom on the under side, very tough, thick, shiny and somewhat curled; the bark two years old is covered with a blue bloom which has very much the appearance of the bloom on Concord grapes; this with the yellowish green twigs gives it a peculiarly distinct and pretty appearance. The whole tree appears elastic and tough as the branches move easily in the wind with a graceful, swaying motion. It grows very thick from the bottom when cut back; perfectly hardy. (See plate for form of leaf.)

Salix fragilis.—This we have sent out as Red Willow. It is perfectly hardy and a free grower, propagating easily from cuttings. We consider it valuable for its pretty appearance when young, and also for its lumber, which is well known in Europe as being the most valuable of that from any Willow. The twigs make good tying material and the bark is used for tanning the valuable Russian leather, which is highly prized in all civilized countries. We quote from Prof. Budd: "If the manufacturers of fine leather can afford to import the bark of this Willow, we can afford to grow it on our western plains, more especially as the trunks make far better fuel than our common kinds. It has been used in Europe for building fast sailing yachts." In Hough's Elements of Forestry this Willow is put down as having light, tough, durable wood, but when old as being liable to die at the top. The specific name is given from the facility with which the twigs used for basket work break from the tree, although the twigs themselves are tough and pliable. Loudon says it produces timber superior to that of any Willow. Leaves broadly lanceolate and finely serrate, acuminate. (See form of leaf in plate.)

Salix laurifolia (Laurel-leaved Willow).—This variety, without doubt, has the handsomest foliage of any Willow in cultivation. Its habit is good and it easily takes on a tree form with straight trunk. It is a very rapid grower when young and is especially fitted for the lawn, where its bright, healthy appearance, even in the driest weather, renders it an object of beauty. It makes a pretty, though not a large

tree, and must not be confounded with the *S. laurifolia* of the French nurseries, which is seldom more than a large shrub. Prof. Budd says; "In dry climates this rarely beautiful round-topped Willow reaches its height of beauty. It is difficult for one who has not before seen it to realize that its large, laurel-like leaves can belong to a Willow. Fine specimens were seen as far north as St. Petersburg." The foliage is large (often 4x1½ inches on the young growth), broadly acuminate, with large, round stipules at the base, finely serrate and slightly curved; the

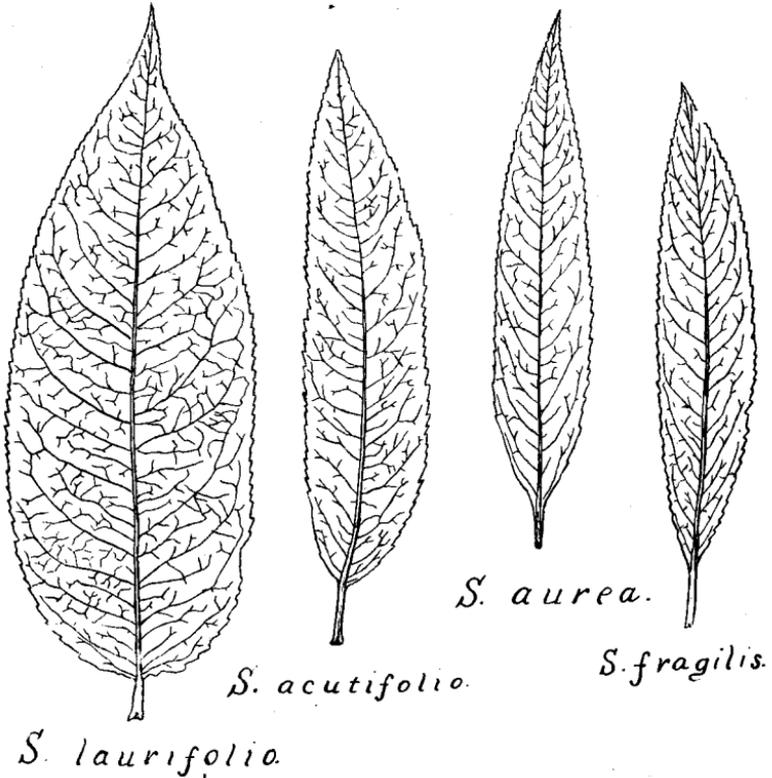


Plate showing the typical form of the leaves of four important Willows. (Reduced ¼.)

mid-rib shows as a light stripe through the center of the leaf; petiole short, with many glands. The whole foliage appears as if varnished and is rarely attacked by insects; new growth a shiny light green color and close jointed; easily propagated and perfectly hardy. (See plate for form of leaf.)

Salix aurea (Golden Willow).—This Willow we have sent out as 123 Vor. It is very ornamental and makes a good wind-break, becoming a large tree with age; of clean, rapid growth and good foliage, but its chief beauty lies in its golden back, which is pretty in the sum-

mer, but in the winter is especially conspicuous from the brighter golden color it then assumes,—very pleasing in contrast with dark colored Willows and in brightening up the landscape. Perfectly hardy and easily takes on the tree form; leaves lanceolate, with tapering point. (*See plate for form of leaf.*)

Salix Napoleonis.—This is a very pretty dwarf prostrate Willow with fine twigs and a drooping habit, lying naturally quite flat on the ground. If kept cut close it makes a very ornamental low shrub or hedge. When “worked” on some tree Willow five feet from the ground it forms a very pretty weeping tree. For this purpose the *Salix Aurea* affords a good stock. We have found some of the new wood killed back after severe winters where much exposed. Growth not strong. New growth small, dark colored and covered sparingly with small, bluish, linear foliage.

Salix rosmarinifolia.—This we have sent out as 122 Vor. Prof. Budd says it is not the same as *S. rosmarinifolia* from the west of Europe, but is the type from Asia. It is of moderate growth, straggling form and is better adapted to the purposes of an ornamental shrub than a tree. The foliage is clean and pretty and of an attractive bluish-green color; leaves oblong linear, acute, very blue on under side; healthy and easily propagated. A much more vigorous plant than *Salix Napoleonis* and hardier.

RUSSIAN POPLARS AND WILLOWS FROM CUTTINGS.

The soil used for this purpose, had for several years, been cultivated in garden and nursery crops, and was what might be called a fertile clayey loam, with a tendency to be a little muddy in moist weather. At the time the cuttings were set it worked rather heavy, but was planted while in this condition in order to have the cuttings in the ground before their buds burst. The cuttings were made in the spring of 1888 from well ripened wood of the preceding season's growth, which wintered over fully exposed to the weather of the winter of 1887-1888. It was cut about the last of April into lengths of about nine inches and tied in bundles which were set on their butts, with a little soil thrown around them to keep them from drying out. As soon as the soil could be worked they were planted out into rows three feet apart and at intervals of four inches in the rows. The method of planting was as follows: The land was plowed and leveled. A garden line was stretched where the rows were to come, and carefully walked, by this means the mark of the line was left wherever the feet pressed. The line was then removed and a subsoil plow, set seven inches deep, was drawn by a pair of horses following the mark left by the line. The cuttings were then placed six inches deep in the earth thus loosened, and were firmed into place by pressing with the ball of the foot on two sides of each cutting. The line was stretched again just where it was at first, and the cuttings were firmed the second

time, considerable care being used to push into the straight row any cuttings that were a little out of the way.

The only further cultivation given was to keep them clear of weeds and the soil loose. Most of the varieties rooted well. One variety, *Populus alba*, entirely failed, which was on a par with our previous success in rooting it from hardwood cuttings. The growth made consisted of from three to five shoots about three feet high. Of the cuttings planted, all varieties, except three, rooted over eighty per cent. Those rooting less than eighty per cent. were *P. alba*, of which none rooted. *P. Bolleana*, two per cent. rooted. *P. Wobsky*, 65 per cent. rooted. All the cuttings of many varieties grew and made a strong growth.

STGGESTIONS TO THOSE ABOUT TO PLANT CUTTINGS.

Take cuttings from healthy, vigorous trees. Cuttings from such trees root easiest. It is generally best to make cuttings in the Fall after the growth stops, and winter them over buried in well drained soil, or plant out at once. Cuttings of Willows and Poplars may be also successfully rooted if made early in the Spring before growth starts. Select clean two year old wood, or strong, well ripened one year old wood for cuttings. Make cuttings from eight to ten inches long and as near to one-half inch in diameter as economical cutting will allow. Larger cuttings root nearly as well but are more bulky to handle. See that the cuts are made smooth with a sharp knife. Have the land for cuttings thoroughly cultivated and the ground mellow. Plant at least eight inches deep, in rows three feet apart, and press the soil close around the base of the cuttings. Do not tramp them in hard if the land is wet. If the land is dry they cannot be too firmly placed in the soil. Keep well ahead of the weeds by running a horse cultivator between the rows very often.

INSECTS AFFECTING POPLARS AND WILLOWS.

OTTO LUGGER.

A large part of our beautiful State is composed of prairie land without timber of any kind. Even in prairies with a more undulating surface trees are rarely found, nor can they always be easily grown. Yet trees, no matter how poor a quality of wood they may furnish, are in many ways of the very greatest importance to the farmer and to his animals, and wherever it is possible small groves should be grown, if only as a windbreak against the cold blasts of winter. It is remarkable what a grateful effect a few trees will produce during a driving storm from the north or northwest. As soon as we enter their protection, bare of foliage as they are at that season, we feel that we have escaped from the penetrating wind and found refuge and comfort.

We should also recollect that trees surrounding a house do not alone protect the same against the storms, but beautify it as well. Many farmers are too apt in their struggle for existence to utilize their houses simply as staying places; they do not attempt to transform them into homes. "Home, sweet home" is not always the strong sentiment it ought to be. How can farmers expect their children to love the place of their birth, if it reminds them only of an endless round of toil and drudgery, but not of the pleasures and comfort and the refining influence found only in a true home?

Growing trees for a grove or a windbreak is not always a very easy matter, as some of our severe winters are only too apt to kill the plants. Numerous injurious insects also take immediate possession of the table we so liberally spread for them. The most useful trees set out for the purpose of forming a windbreak are Poplars and Willows, because both plants are hardy and of very rapid growth, so that a few years suffice to produce at least some shelter for man and beast. To prevent the killing by frost of the young trees, both plants must be grown in rows, and naturally close together; thus they offer food and shelter to a number of insects, which under natural and normal conditions would not usually occur in such vast numbers. As it is not possible at this time to treat of all the injurious insects that occur in such localities, only the most important ones will be discussed in this bulletin. As will be seen, they do not all belong to one order of insects, but to many. In most cases the insects are very familiar to a number

of the readers, and the illustrations will go far to give an idea of their appearance to others, so that a detailed description is unnecessary.

THE LARGE WILLOW SAW-FLY (*Cimbex americana* Leach).

The popular name, SAW-FLY, is misleading, as the insect has no resemblance whatever to any but is a wasp, distinguished from the

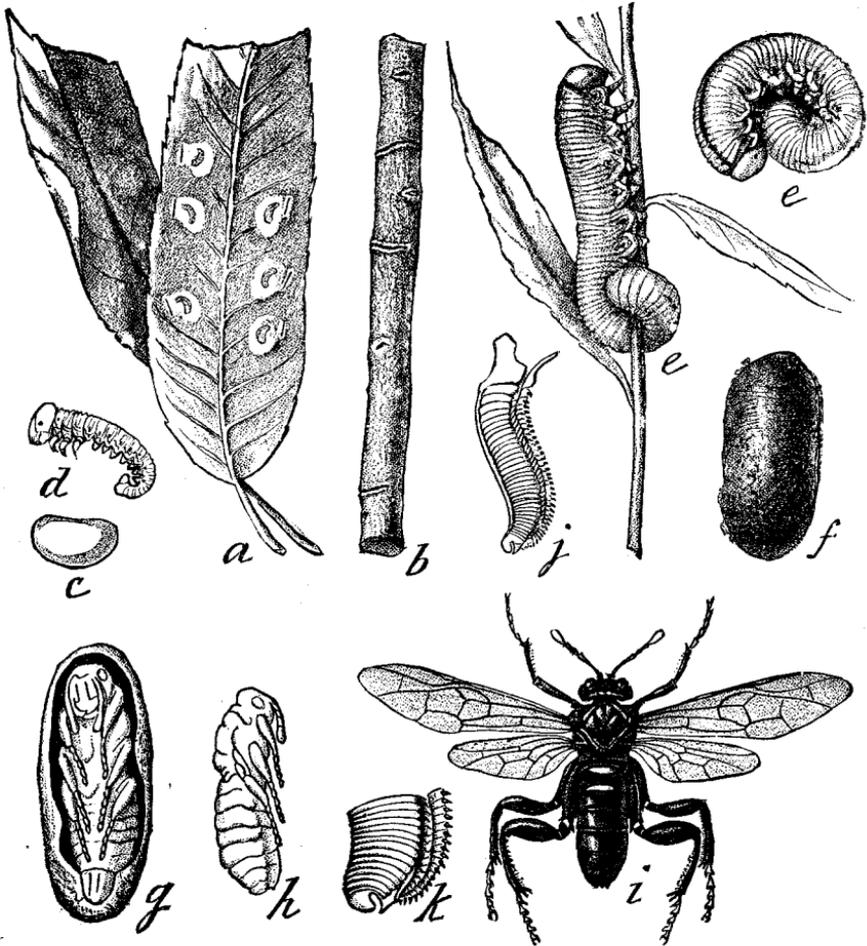


FIG. 1.—*Cimbex americana*: a, willow leaves showing egg-blisters from above and below; b, twig showing girdlings; c, egg; d, newly-hatched larva; e, e, full-grown larva; f, cocoon; g, cocoon cut open, with pupa; h, pupa, side view; i, female fly; j, her saw detached, side view; k, tip of saw.—c, d, j, k, enlarged, the rest natural size. (After Riley.)

true wasps by various characters. Its common name should be changed to SAW-WASP. The larvæ of all saw-wasps are true plant-feeders, and look in the great majority of cases like real caterpillars, in consequence of which they are usually called *false caterpillars*.

Most of these false caterpillars live upon the lower or upper surface of their food-plant, are brightly colored, and are distinguished from real caterpillars with sixteen prolegs by possessing from twenty to twenty-two such organs. The larvæ are usually found together in company. When resting they curl up like snails; when feeding they fasten themselves upon the edge of the leaf, framing the same in a very peculiar manner. Frequently they elevate the front part of their body, forming an α , and move upwards and downwards in unison. This peculiar motion is evidently produced with the intention to scare away parasitic insects; we can force the larvæ to perform it by gently blowing upon them.

The WILLOW SAW-FLY (*Cimbex americana*) is the largest of our American species, and looks somewhat like a bulky hornet. Head and thorax of female are polished black; the oval abdomen is steel-blue or deep violet above, with three or four yellow spots on each side, which unite above in continuous bands; the antennæ end in buff-colored, egg-shaped knobs; legs blue-black; feet yellow; wings semi-transparent, smoky brown. The male (Fig. 1, *i*) differs greatly from the female by having a longer and narrower body, with white, almost obsolete, spots on the sides; the hind legs are very thick, the shins bowed, and hairy within.

The larvæ (Fig. 1, *e, e*) are rather thick, nearly cylindrical, with a rough, pale greenish-yellow skin, covered with numerous transverse wrinkles; a black stripe, composed of two narrow black lines, extends from the head to the tail along the top of the back. The larvæ have twenty-two legs, or a pair to every ring except the fourth. When disturbed the larva ejects a watery fluid from pores situated just above the black spiracles. This fluid can be thrown to some distance, and is no doubt a protection against such enemies as parasitic wasps and flies.

Early in June the eggs are deposited by means of a saw-like ovipositor (Fig. 1, *j, k*) between the epidermis and parenchyma of the leaf. The place of oviposition is hardly perceptible from above, looking like slight blisters; these are plainly visible from below (Fig. 1, *a*), as they are paler than the other parts of the leaf, and when older possess also a reddish color. As a general rule a number of such blisters occur close together in one or two longitudinal rows, and as many as twelve can frequently be counted; in every instance, however, the individual eggs are separated by the ribs of the leaf. The opening made by the saw in inserting these eggs is always plainly visible. The mature egg (Fig. 1, *c*) is oblong-oval, somewhat flattened, and is enclosed in an exceedingly thin and pliable, hyaline shell. When the young bluish-gray larva (Fig. 1, *d*) hatches, it does not leave the blister at once, but remains for some time within it; eventually it leaves by an irregular slit, and attains its full size towards the last of July. It now enters the ground to a very slight depth, barely covering itself, and spins a

tough, coarse, silken cocoon (Fig. 1, *f*), inside of which it changes towards spring to a pupa (Fig. 1, *g, h*). During the month of May of the following season it transforms into a winged insect, and starts a new generation.

This giant among our saw-flies seems to have but few enemies. Yet it is not without them, and I have at this time a number of pupæ of a Tachina-fly in the breeding cages. As many as six eggs of this useful insect were found upon one larva. Large numbers of eggs had also been destroyed by some unknown parasite. Moles, shrews, mice and other animals eat the pupæ, and search for them even under snow. Hens, ducks and other birds do not seem to like the worms, and hogs cannot safely be allowed to grub in the windbreaks, at least not as long as the trees are still young. Yet there is no excuse to allow these insects, which have but one annual generation, to increase as they do. The worms are so large, and drop so readily to the ground when shaking the tree, that hand picking is a very effective remedy. Children, during their vacation, could be engaged in this work. Nor is it difficult to gather the large cocoons, or the winged insects when engaged in laying their eggs, or early in the morning when still torpid. In many cases the rows of young Willows and Poplars are protected by mulching, and all the worms invariably seek such places to form their cocoons. Large numbers of them can thus be gathered during the autumn and early spring, when the ground is not covered with snow, or still better, the straw used for mulching can be collected in heaps and burned. Of course the usual arsenical poisons, such as London purple and Paris green might be employed in case of necessity, and will prove of great value, as their use would also kill a number of other injurious insects not so easily kept in check. Such poisonous materials must be used with great caution, and not so strong as to injure the foliage.

This insect is not alone confined to the White Willow, but attacks the other species as well, and feeds also upon Poplars, Linden, Elm and Birch.

Prof. RileY mentions a peculiar habit of these large saw-flies. The perfect insect gnaws very fine but deep transverse incisions in the bark (Fig. 1, *b*), almost girdling the twig, and thus killing the same. This habit has as yet not been observed to any great extent in this State.

THE YELLOW-SPOTTED WILLOW-SLUG. (*Nematus ventralis* Say.)

This is another species of a saw-fly, very much smaller in size than the Cimbex already described, but equally injurious to Willows, and in some extreme cases to young Poplars as well. In some seasons it may prove even more destructive than its larger relative, as it produces annually from four to five broods in this State. In the more Central and Southern States six, and even seven broods, are not unusual. All kinds of low willows, but chiefly the various varieties of

White Willows, are eaten by these slugs. Evidently, however, the younger plants are preferred and consequently suffer most.

The rather large eggs are deposited in the usual manner by means of two saws situated under the posterior part of the abdomen, and produce little blister-like swellings, which give the leaf a crumpled appearance, as may be seen in the lower leaf illustrated in Fig. 2. The eggs themselves are oval, whitish, increase in size after being laid, and are only partly inserted into little pockets in the under surface of the

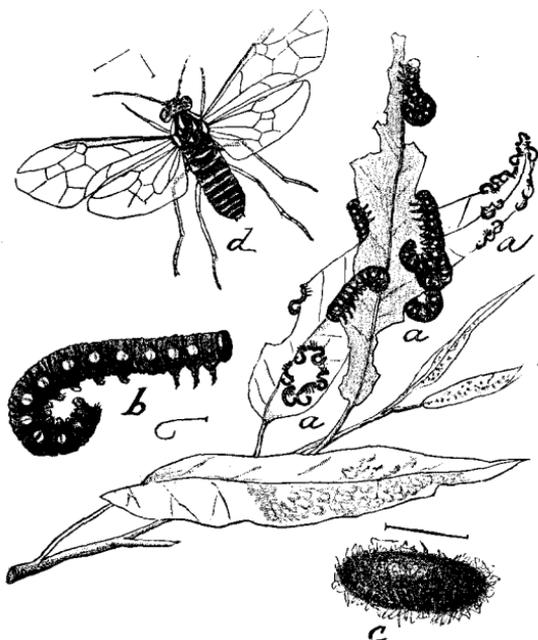


FIG. 2.—*Nematus ventralis*: a, a, a, different sizes of young larvæ; b, full-grown larva; c, cocoon; d, adult; all slightly enlarged. (After Riley).

leaf. As soon as the young slugs hatch, they gnaw minute holes, which increase in size in the same ratio as the slugs themselves grow. The slugs feed in company and their presence soon becomes painfully visible, they being of a slimy black color, and covered and surrounded by their filthy and moist excrement. When they grow larger, they devour the whole leaf, leaving only the tougher ribs of it untouched. At first white, with a small blackish spot on each side of the head, they soon change to a shiny black, ornamented with yellow spots; a slimy matter covers their entire body. After their last molt the characteristic and conspicuous markings (Fig. 2, b.) of ten large yellow spots becomes very prominent; their heads are perpendicular, free, and polished black. Besides the three pairs of long and black true legs, the slugs possess six pairs of light blue prolegs, and a seventh very imperfect pair of anal ones. The slugs, owing to their con-

spicuous colors and markings, are readily seen upon the plants. Like most larvæ of this kind, they assume, when at rest, the peculiar curved position of an interrogation mark. In the course of ten days to three weeks they molt four times, and reach their full size, indicated by a line under Fig 2, *b*. They now enter the ground and form shiny, glue-like cocoons (Fig. 2, *c*), of a dark, almost bronze color. Within this cocoon, which consists of a rough outside layer and a smooth and tough inner one, they change to a yellow pupa, which in the course of a week may give forth the winged insect.

The mature insect (Fig. 2, *d*), is very sluggish in all its motions, and the female, while engaged in sawing slits in the leaves for the reception of eggs, can be handled without greatly disturbing it. Both sexes are black; the female has the venter, tibiæ, palpi, and the base of the wings bluish-green, the edges of the abdomen and some obsolete bands between the segments pale yellowish. The same parts in the male, as well as part of the upper surface of the abdomen, are yellowish-brown or orange colored.

Like the LARGE SAW-FLY OF THE WILLOW this insect seems to have but few enemies. The eggs are frequently destroyed in the Eastern States by a very small Chalcid parasite, which very likely occurs here as well, as indicated by the conditions of some eggs evidently destroyed by this or a similar parasite. No insect is more readily combated by arsenical solutions than this YELLOW-SPOTTED WILLOW-SLUG, and willows devoured by it are a disgrace to the owner, indicating gross negligence or ignorance on his part.

THE STREAKED COTTONWOOD LEAF-BEETLE. (*Lina scripta* Fab.)

This beetle, brightly colored with yellow and black, is remarkable by varying greatly in coloration and markings, as shown in Fig. 3. It is by no means confined to the Cottonwood, but is equally injurious to all kinds of Willow and Poplar. Wherever it occurs in large numbers it is extremely injurious to all the trees mentioned above, and forms no small obstacle to the successful planting and growing of groves and windbreaks.

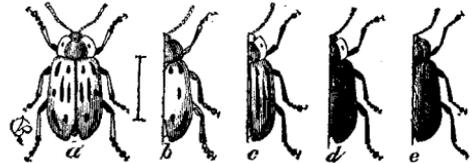


FIG. 3.—*Lina scripta*: *a*, beetle, normal form; *b, c, d, e*, showing variations. Natural size. (After Riley.)

Whenever the young trees are neglected for some years they are doomed to perish from the constant defoliation by this insect. The selection of the above popular name was a good one, however, because this beetle seems to have acquired of late a great liking for Cottonwood, and vast groves have been utterly destroyed by it in the treeless portions of Minnesota, Nebraska, Dakota and Kansas. The perfect insect (Fig. 3, *a-e*) hibernates in sheltered positions under all sorts of rubbish. As soon as the leaves of Cottonwood, Poplar or

Willow commence to unfold the beetles leave their winter quarters mate, and the females deposit their eggs. (Fig. 4, a, b.) These eggs



FIG. 4.—*Lina scripta*: a, eggs; b, one enlarged; c, newly hatched larvæ; d, d, larvæ of different sizes; e, pupa—natural size; f, one of the middle joints of body of larva from above, showing tubercles—enlarged. (After Riley.)

are elongate-oval, pale yellowish-white, soft, and about 0.5 mm. long (Fig. 4, b); they are laid in large numbers together, from ten to one hundred (Fig. 4, a), upon the young leaves. The larvæ soon hatch, and grow very rapidly. At first they are black and gregarious, and skeletonize the leaves near their place of birth, as shown in above illustration. As they grow larger and pass through several molts, they become lighter in color, separate more and more, and now eat large holes in the leaves. As soon as fully developed, which requires but a few weeks, they fasten their hind legs securely to the surface of the leaf, and partially throwing off their last larval skin, they transform to pupæ (Fig. 4, e). As there are at least three broods every year, they can rapidly increase in any grove of Cottonwood. Like all the species forming the genus *Lina* these larvæ emit a milky and more or less pungent fluid from the tips of tuberculous spines clothing their body (Fig. 4, f). This fluid can be re-absorbed if not removed by coming in contact with some foreign body. Of course this pungent fluid forms such a very good protection against parasitic insects that none have been discovered as yet. Even birds do not like this addition to the food, and only the larvæ of the carnivorous lady-bugs relish and consume the younger larvæ of this insect-pest.

All the transformations of this insect take place upon the leaves infested by it, and consequently spraying with any arsenical solution will be effective. London purple seems to injure the trees less than Paris green, and as it is cheaper and diffuses better in water, it will be best to use it in preference. One-half pound London purple, three-quarts flour, and forty gallons water is a very excellent mixture, and

can be readily and cheaply applied by any of the many spraying machines now in the market. As the effects of such arsenical poisons do not appear at once impatient parties are very apt to make another application on the second or third day, thus injuring the plants.

Two other and nearly allied species occur also in large numbers in this State, and occasion more or less damage. The larva of *Lina tremulæ* Fab. (Fig. 5) can be readily distinguished by its darker color,

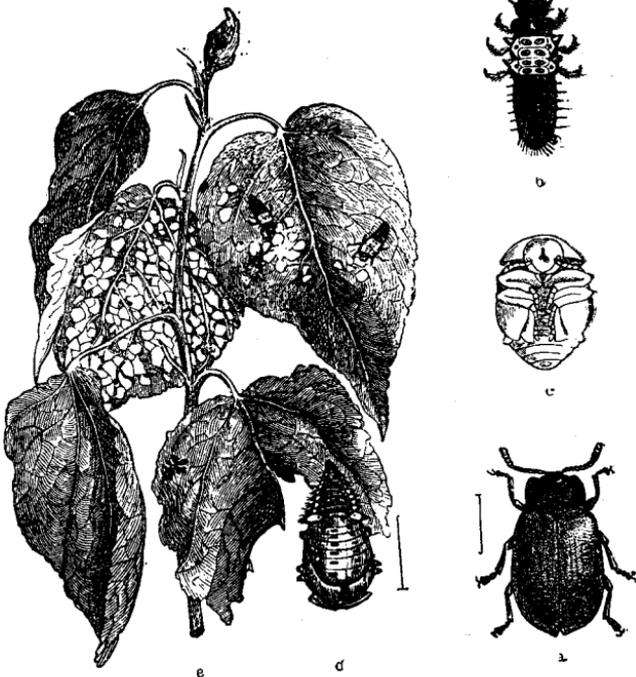


FIG. 5.—*Lina tremulæ*: a, beetle; b, larva; c, pupa, front view; d, pupa, dorsal view, showing old larvæ skin—all enlarged; e, showing work and larvæ—natural size. (After Taschenberg.)

by the spots being larger and broader, but chiefly by a distinct whitish spot on the second and third joints, as indicated in Fig. 5, b. In Europe this insect shows a decided preference to Poplars, but here it seems to be more partial to low Willows.

Lina lapponica Linn (Fig. 6) is a spotted, not striped beetle. In its larval stage it cannot be distinguished from *Lina scripta*. The larva, however, seems to be able to emit the milky fluid much more freely.

THE POPLAR BORER. (*Saperda calcarata*, Say.)

This large bluish-gray beetle, finely punctured with brown, with four ochre-yellow lines on the head and three on the top of the thorax, with a ochre-yellow scutel and several irregular lines and spots of the



FIG. 6—*Lina lapponica*.

same color on the wing-covers, measures nearly $1\frac{1}{2}$ inches in length. It is one of the most destructive insects in the Western States



FIG. 7.—*Saperda carcharias*, and the burrows made by its larva in Poplar. (After Taschenberg.)

to the Cottonwood, Poplar, and even Willows. The beetle (Fig. 7) is found in August, usually resting on the trunks or branches of the various trees infested by it; it is, however, quite active during the night, and sometimes enters open windows, attracted by a burning light. The injury done to the trees is caused by its larva, which is illustrated in Fig. 8.

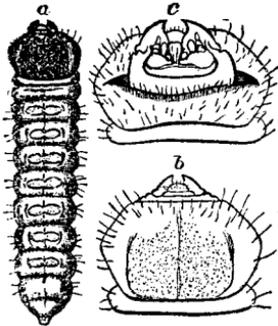


FIG. 8.—Larva of *Saperda calcarata*: *a*, natural size; *b*, upper and *c*, under side of head and first thoracic segments—enlarged. (After Packard.)

This larva is a yellowish-white grub, without any legs. It bores into the solid wood of the infested tree as illustrated in Fig. 7.

THE POPLAR GIRDLER (*Saperda concolor* Lec.)

This is a very much smaller beetle of uniformly gray color, with no spots, with black antennae stained with gray at the joints. Its larva

is very injurious to sapling poplars, and by mining around the trunk forms large, gall-like swellings, which in course of time decay, thus killing the plant. Fig. 9 shows the work of this beetle, and also the cocoon of a parasite. Frequently the tree is killed by the larva girdling the trunk.



FIG. 9.—Work of *Saperda concolor*, showing gall-like swellings on Poplar: *a*, gall; *b*, the same, cut open; *c*, parasitic cocoon in burrow; *d*, burrow with frass; *e*, holes of exit. (Original.)

deposited their eggs. The presence of larvæ is also easily discovered by a discolored blotch upon the bark, and by the little heaps of saw-dust that are pushed out by them during their boring operations. The larvæ can be killed by means of a wire, or can be removed with a pruning knife. Perfectly healthy trees but seldom harbor these borers, and taking pains to have thrifty trees is the best prevention.

Quite a number of different species of parasitic Ichneumonidæ assist us in our war against these noxious borers.

THE ANTIOPA BUTTERFLY (*Vanessa antiopa* Linn).

This beautiful butterfly (Fig. 10) has velvety wings, which are purplish-brown above, with a broad buff-yellow margin, and near the

The females of both insects deposit their eggs in cracks and depressions of the trunk, and the young larvæ feed at first below the bark. After hibernation they penetrate into the solid wood, forming irregular channels filled with their excrement looking like saw-dust. It seems to require two years for the larvæ to mature, as we always find larvæ of two sizes in the same tree. When full grown the larva makes a hole leading to the open air, fills it with chips and saw-dust, and retreats to the interior of the burrow, where it changes to a pupa, which in due time transforms into a winged insect, which leaves the tree by the hole prepared by its larva.

The beetles are very sluggish during the day and can be gathered in large numbers. Painting from time to time the trunks of the trees with a mixture of soft soap and Paris green prevents the females from depositing their eggs. The presence of larvæ is also easily discovered by a discolored blotch upon the bark, and by the little heaps of saw-dust that are pushed out by them during their boring operations. The larvæ can be killed by means of a wire, or can be removed with a pruning knife. Perfectly healthy trees but seldom harbor these borers, and taking pains to have thrifty trees is the best prevention.

inner edges a row of pale blue spots. It expands three inches and more. Passing the winter in some sheltered spot in a partially torpid

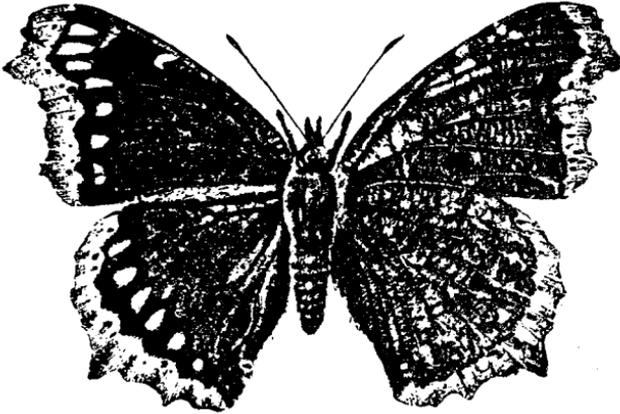


FIG. 10.—*Vanessa antiopa*—natural size. (After Harris.)

state, it frequently may be seen in early spring flying leisurely about in sunny spots. Its beauty has paled, however, and the gaudy wings

look faded, so that the yellow margin is now almost white. The female deposits numerous eggs upon the swelling leaf-buds of the food-plants, and these eggs soon hatch. The full-grown caterpillar (Fig. 11) is covered with stout spines, has a black body spotted minutely with white, with a row of eight dark brick-red spots on the back, and prolegs of the same red color. While growing the caterpillars are gregarious, but when their full size has



FIG. 11.—*Vanessa antiopa*—caterpillar (after Harris).

been reached they scatter, and transform into dark brown chrysalis (Fig. 12), with large tawny spots around the tubercles on the back.

The butterfly flies from March till June, and again from the middle of August until late autumn.



FIG. 12.—*Vanessa antiopa*—chrysalis (after Harris).

The caterpillars are very injurious and sometimes denude whole rows of Willows and Poplars. They are still more fond of the leaves of Elms, and I have seen them so numerous upon those trees in Michigan that branches four inches in diameter were broken by their weight. As they are so readily seen, and live in societies, there is no excuse to allow them to multiply unduly. Branches containing such colonies ought to be cut off and the insects destroyed. If the trees are very tall, spraying with arsenical solutions will soon put an end to their further injuries. The caterpillars, as well as the chrysalis, harbor

many parasites, which are very apt to assist us when this denuder of our trees becomes very numerous.

THE FALL WEB-WORM (*Hypantria cunea*, Drury.)

This insect, like the Antiopa Butterfly, belongs to the Order of *Lepidoptera*, but to another Family, to the *Spinners*. This name was given because the caterpillars as a general rule form silken coc-

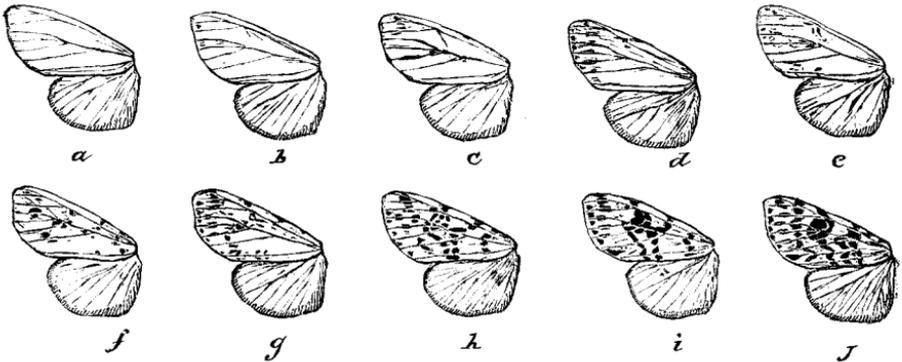


FIG. 13.—*Hypantria cunea*: a-j, varieties of markings of wings. (After Riley.)

oons, frequently intermixed with their own hair, around their pupæ, thus protecting them more or less effectually against the influence of unfavorable weather and parasitic insects. The Fall Web-worm (Fig. 13, 14, 15) is a well-known insect in some parts of the Union, and very frequently causes great injuries to fruit and shade trees, but chiefly so

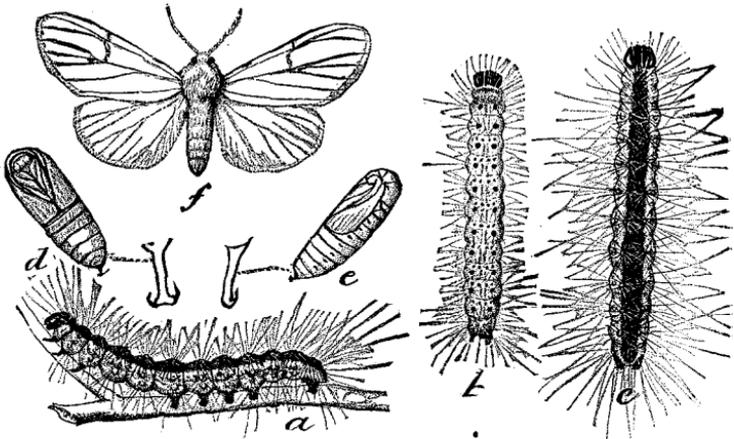


FIG. 14.—*Hypantria cunea*: a, dark larva from side; b, light larva from above; c, dark larva from above; d, pupa, ventral view; e, pupa from side; f, adult—all slightly enlarged. (After Riley.)

where it is double-brooded, as in the more southern states. Here in Minnesota it appears during August, and the observant grower of trees will soon perceive why it is called the Fall Web-worm. The

young caterpillars, immediately after hatching, spin a small silken web, which soon becomes large and dense enough to become plainly visible upon the trees. The caterpillars (Fig. 14, *a, b, c*) feed in company under this web, and as they grow they enlarge the same, so that soon it is quite a bulky affair. Nor do the caterpillars leave it until they reach maturity, which requires about one month; full-grown they scatter and wander about in search for a suitable shelter, in which to spin their cocoons, which are thin, almost transparent, composed of

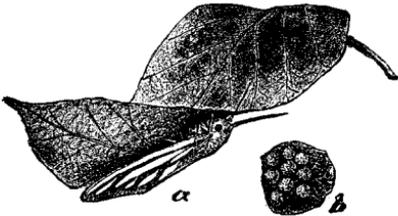


FIG. 15.—*Hypantria cunea*: *a*, moth, ovipositing upon a leaf—natural size; *b*, a few eggs in *situ*—enlarged. (After Riley.)

silk and hairs. These cocoons are frequently slightly imbedded in the earth, providing this was friable enough to enable the caterpillars to penetrate its surface. The very dark brown pupa (Fig. 14, *d, e*) is smooth and polished. As shown in Fig. 15 the bright golden-yellow globular eggs are deposited most frequently upon the upper surface of the leaf near the end of a branch. Each cluster of eggs contains from 300 to 500 eggs, and if the winged insects were at all numerous enough caterpillars can be produced to ruin most of our shade trees. The moth is very variable, as shown in Fig. 13, but the usual color is white, with tawny-yellow front thighs and black feet. The caterpillars also vary greatly in markings and coloration, but are generally pale yellowish or greenish, with a broad dusky stripe along the back, and a yellow stripe along the sides; they are covered with whitish hairs, which start from orange-yellow or black warts. Caterpillars, pupæ and moths are illustrated in natural size in the above illustrations.

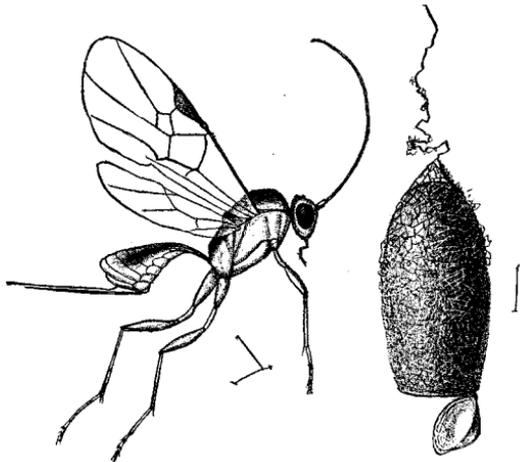


FIG. 16.—*Meteorus hyphantriae*: *a*, adult; *b*, cocoon—enlarged. (After Riley.)

A large number of parasites infest this insect whenever it occurs in unusual numbers for several seasons in succession. In the entomological report for 1886, published in the Report of the Commissioner of Agriculture in Washington, may be found a very instructive account

of these parasites. Fig. 16 shows the form of the principal parasite and its cocoon. This Web-worm attacks many species of trees, but is very partial to Box-elder, Poplars and Willows.

Owing to the fact that the webs of this insect are so large and plainly visible, the remedies are simple and easily applied. Pruning the infested twig, and burning immediately the web with its inhabitants, is a very good remedy. If the webs are within easy reach in the tree, they can be soaked with kerosene oil and burned *in situ*. Such remedies should be applied as soon as possible, or as soon as the webs are noticed. Arsenical poisons in the proportion already given are very effective.

THE COTTONWOOD DAGGER (*Acronyeta lepusculina*, Gn.).

The various kinds of Poplars growing in the nursery of the Experiment Station were badly infested by a curious caterpillar, which,

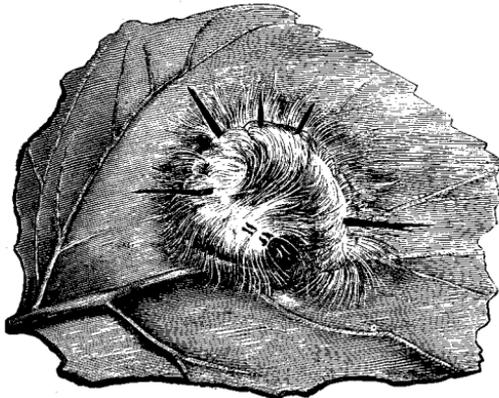


FIG. 17.—*Acronyeta lepusculina*: larva. (After Riley.)

not feeding, was curled up like a snail, and rested freely exposed upon the upper surface of a leaf, as shown in Fig. 17. Its body is covered with long, soft, bright yellow hairs; the head is shiny black, and black spots occur on the top of joints 1 and 2, and black brushes on top of joints 4, 6, 7, 8 and 11. The insect is double brooded, the caterpillar of the second brood hiding in some sheltered spots under rubbish, where they pass the winter as pupæ. These latter are dark shiny brown, ending in obtuse points armed with several hooked bristles; they are enclosed in pale yellow cocoons, made of silk and the hairs of the caterpillars. The beautiful moth, illustrated in Fig. 18, is pale gray or white, marked with black.

Although very numerous and destructive early in the season, the second brood was almost destroyed by a number of parasites, but chiefly by a *Tachina*-fly. The young caterpillars are more or less gregarious, and as they are readily seen, and are also very lazy, hand-picking is an excellent method to destroy them upon the younger



FIG. 18.—*Acronyeta lepusculina*: moth. (After Riley.)

plants of Poplars. In case that larger trees are affected, spraying with arsenical solutions has to be resorted to.

THE CECROPIA MOTH (*Platysamia Cecropia*, Linn) AND THE AMERICAN SILK-WORM (*Telea Polyphemus*, Linn).

The caterpillars of these two insects are sometimes very injurious to our Poplars and Willows. They are the largest caterpillars found in Minnesota, and are correspondingly voracious. But when at all numerous they are usually so badly infested with parasites that they need cause no alarm. The cocoons of the former moth are very large, and remain in the trees all through the cold season, and can readily be gathered. The heavier ones, containing living pupæ of the moth, should be burned; the lighter ones contain very often parasites, and should therefore not be burned, but should be kept in a perforated box, with one-half inch holes to allow the parasites to escape and to keep out the mice, which are very fond of such delicate morsels. The second species spins an oval cocoon among the leaves, which drops to the ground in autumn.

All the insects mentioned thus far are distinguished by being able to obtain their food by means of powerful jaws: they are all *biting or chewing insects*. But there are numerous other insects, and some of them very injurious, that lack such jaws; their mouth-parts are so modified as to form a beak, by means of which they *suck* the sap of plants upon which they live. This beak is situated on the under side of the head, and can in most cases be folded close to the body between the legs when not in use.

The *Aphidæ*, or PLANT-LICE, are soft-bodied insects, and occur usually in vast numbers together. The summer of 1889 was remarkable for the immense numbers of such insects, and hardly a single plant was exempt from their attacks. Naturally such large numbers of even minute insects, constantly engaged in absorbing the sap intended for the use of the plant, must injure it. Plant-lice abound by reason of their wonderful fertility, the young being brought forth alive. As there are as many as nine or ten generations, a single plant-louse can become the parent of millions of children and grand-children in a single season. (Those interested in the study of such plant-lice ought to consult the excellent "Synopsis of the Aphidæ of Minnesota," prepared by Prof. O. W. Oestlund, in Bulletin 4 of the Geological and Natural History Survey of Minnesota.) Some of these plant-lice form peculiar galls upon Poplars; others live free upon stems and leaves of this tree and Willows. All galls should be removed as soon as found, and should be burned or buried in the ground. Free living plant-lice are also easily controlled by means of kerosene emulsions, or by the repeated use of soft soap. The same machines employed for spraying arsenical solutions can be used for emulsions and soaps.

The *Coccidæ* or BARK-LICE do not move when once fastened to their food-plant. They have also received the name SCALE-INSECTS

from the habits and shape of the females, which have bodies resembling scales; these are usually flattened, scale-like, or rounded and hemispherical. The females insert their long and slender beak into the bark and leaves of plants, drawing in the sap. They lay their very numerous eggs beneath the end of their bodies, and the species increase rapidly if not controlled. As the insects are so well protected

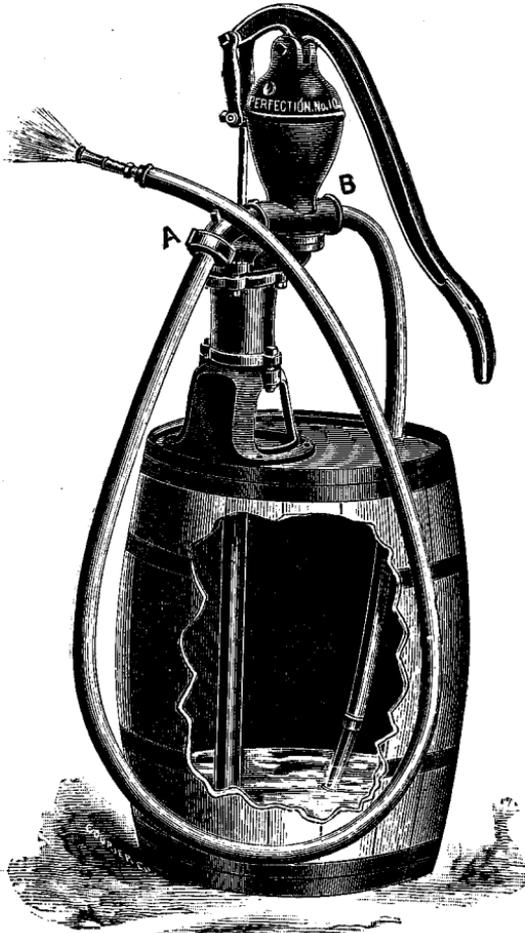


FIG. 19.—“Perfection” spraying outfit.

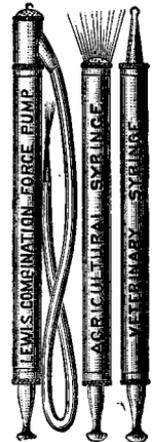


FIG. 20.—“Lewis’ Combination Force Pump.”

by this scale, which is frequently covered with a peculiar white substance that sheds rain and other fluids, some penetrating insecticide must be used repeatedly to reach and kill them. Kerosene-emulsion seems to be the best substance yet discovered for this purpose.

Numerous inventions for applying the various insecticides on a

large scale are in the market, and are fully described and illustrated in the Annual Reports of the Department of Agriculture in Washington. It would take too much space to even enumerate the most important ones. Here at the Station we have successfully used the "Perfection" spraying outfit, manufactured by the Field Force Pump Co., Lockport, N. Y. It is illustrated in Fig. 19. It has three feet of return hose, which keeps the poison well mixed while the pump is in use, and is furnished with the "Graduating Spray Nozzle" with which the amount and fineness of the spray may be regulated. The price without barrel, is \$12.00. Of course any other nozzle can be used with this machine. As it can throw quite a stream of water, it is also a very efficient fire extinguisher.

Another smaller and still cheaper spraying machine (\$6.00) is made by Lewis & Cowles, Catskill, N. Y. It is called the "Lewis's Combination Force Pump." It has been found very useful, and in many different ways. Fig 20. shows the construction of this very handy instrument.

I repeat here the formula for an excellent Kerosene-emulsion. It is called "Hubbard's solution." It is composed as follows :

Kerosene, 2 gallons.....	67 per cent.
Common soap or whale oil soap, $\frac{1}{2}$ pound, {	33 " "
Water, 1 gallon.....	{

"Heat the solution of soap and add it boiling hot to the kerosene. Churn the mixture by means of a force pump and spray nozzle for five or ten minutes. The emulsion, if perfect, forms a cream which thickens on cooling, and should adhere without oiliness to the surface of glass. Dilute before using one part of the emulsion with nine parts of water. The above formula gives three gallons of emulsion and makes, when diluted, thirty gallons of wash.

The above formidable list of twelve very injurious insects, all infesting Poplars and Willows, should not induce the farmers to give up the planting of such trees for groves and windbreaks. The insects become only injurious when the trees are neglected. By paying as much attention to them as to his other crops, by carefully inspecting them from time to time, he can keep all these insects out of them, or at all events he can keep the intruders in check.

The insects described in this bulletin are the most injurious ones infesting our Poplars and Willows. But there are numerous other insects, which under favorable conditions may become equally injurious; they will be considered in future bulletins.