U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF FORESTRY—BULLETIN No. 46.
GIFFORD PINCHOT, Forester.

THE BASKET WILLOW.

BY

WILLIAM F. HUBBARD,
FOREST ASSISTANT, BUREAU OF FORESTRY.

WITH A CHAPTER ON

INSECTS INJURIOUS TO THE BASKET WILLOW,

BY

F. H. CHITTENDEN,
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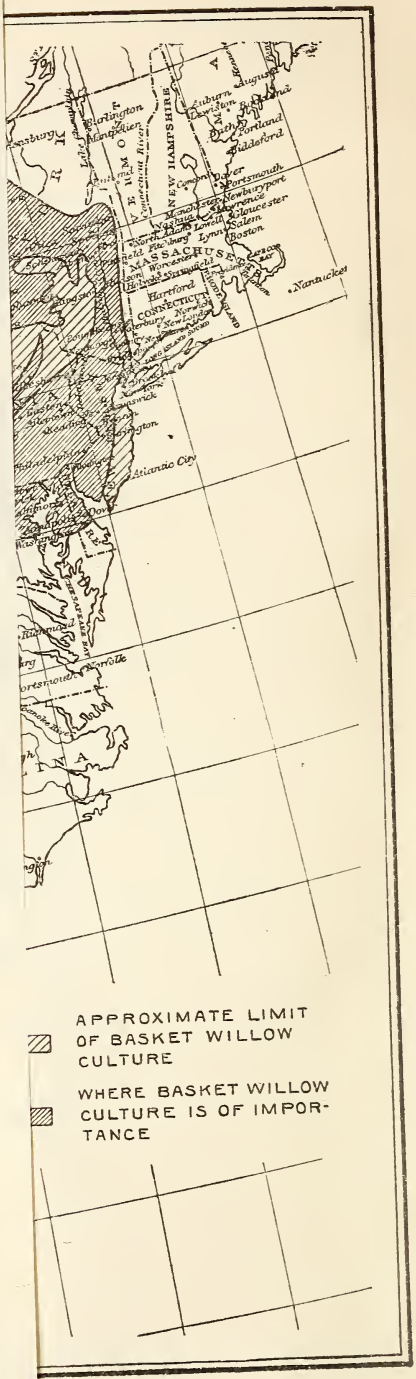

AND PROBABLE LIMITS.

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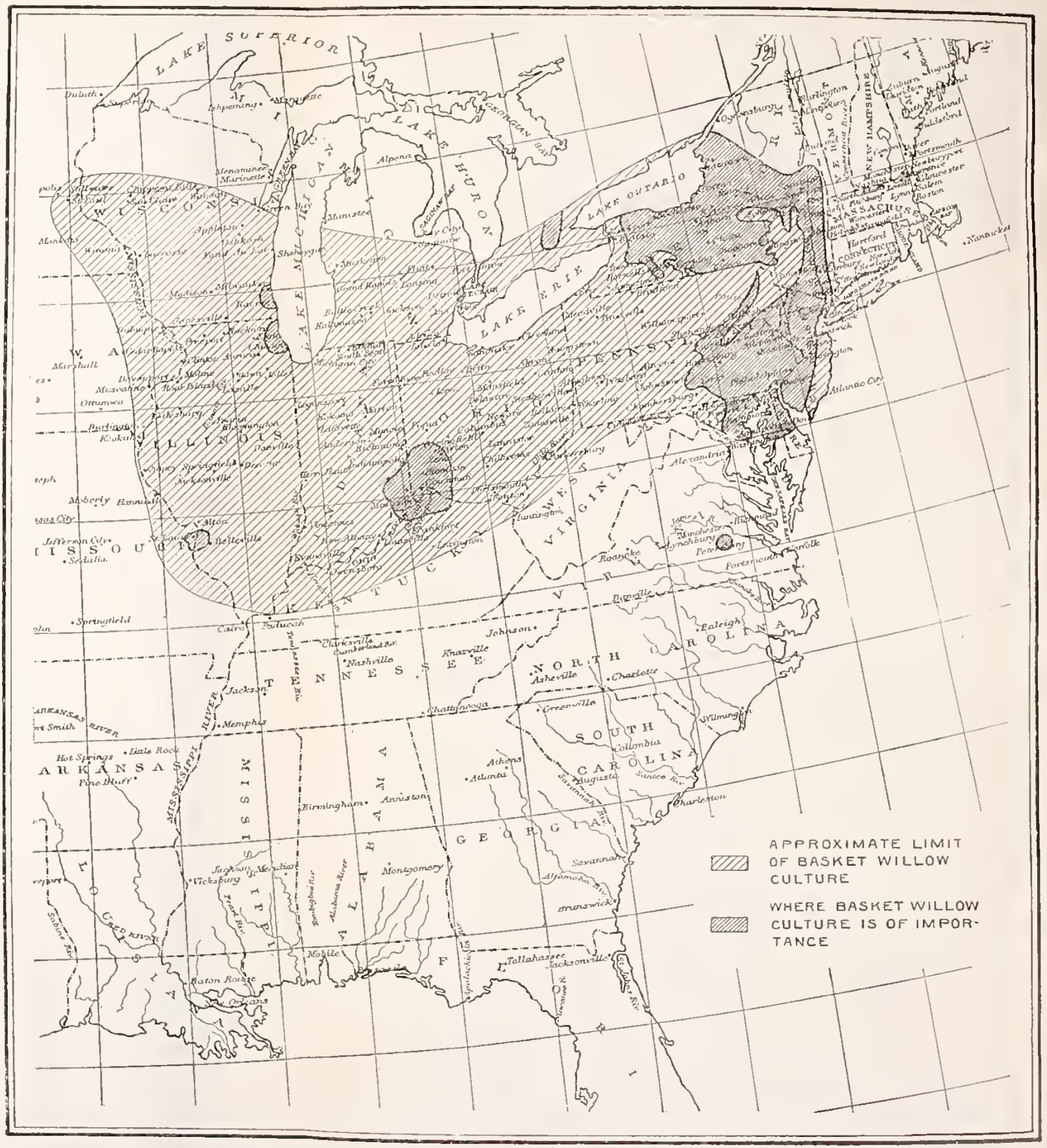

PRINCIPAL KNOWN AREAS OF BASKET WILLOW CULTURE IN NORTH AMERICA AND PROBABLE LIMITS.

LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Forestry,
Washington, D. C., June 29, 1903.

Sir: I have the honor to transmit herewith a report entitled "The Basket Willow," by William F. Hubbard, Forest Assistant in the Bureau of Forestry, with a chapter on "Insects Injurious to the Basket Willow," by F. H. Chittenden, Entomologist in charge of Breeding Experiments, Bureau of Entomology, and to recommend its publication as Bulletin No. 46 of the Bureau of Forestry.

The map, seven plates, and twenty-seven text figures accompanying this bulletin are necessary for its proper illustration.

Very respectfully,

Gifford Pinchot, *Forester.*

Hon. James Wilson,
Secretary of Agriculture.

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THE BASKET WILLOW.

INTRODUCTION.

THE GENERAL HISTORY OF WILLOW CULTURE.

The cultivation of the basket willow began very early. Among the ancient Romans, who brought every branch of horticulture to a high state of perfection, the willow was regarded as one of the most useful trees cultivated. The shoots were used for the manufacture of beehives and baskets, for garden and vineyard fences, and for binding grapevines, and the wood, covered with hide and bossed with brass, was made into shields, for which purpose its elasticity and lightness peculiarly fitted it. Among the species mentioned by Pliny are *Salix fragilis*, *purpurea*, *amygdalina*, and *viminalis*, all of which are at present used as basket willows. During the Middle Ages willows were commonly used for basket ware, and in France, and later in Germany, the basket makers' guilds were of considerable importance. The seventeenth and eighteenth centuries, however, saw these organizations sunk into insignificance and the basket makers generally seeking a precarious living by wandering from town to town.

It was not until the development of a factory system that the weaving of basket ware began to rise once more to the dignity of an industry. As soon as manufacturers began to ship to a large national market, the need for packages became very great. Where these could be made out of willow ware one factory would use more baskets and crates in a year than a village in ten times that period. This, together with the development of transportation facilities by which far-off city communities could be cheaply supplied with basket ware for household use, tended once more to raise the basket maker to some prosperity. But, since basket making precludes any considerable division of labor and demands hard, patient work at low wages, its first development was naturally where industry throve through a large class of independent master workmen and small factories, rather than where it immediately tended to great division of labor in large establishments using power engines. Accordingly, the European continent,

rather than England, became the motherland of the modern willow and basket industries. In France, the Low Countries, and, to a less extent, in Germany, we hear of systematic willow culture early in the eighteenth century. (See pp. 35–36.) Germany, however, was at this time too distracted by war and political strife to develop industrially far enough to demand basket ware for any but local use. Of late years, however, this branch of manufacture has followed the wonderful industrial progress of the German Empire.

Willow culture in England was among the many forms of industry which were temporarily or permanently stimulated by Napoleon's embargo act. Great Britain had imported her osiers and baskets from Holland until her exclusion from the Continent led to the formation of plantations at home. The Society of Arts directed their attention to the subject, and gave premiums for the establishment of willow plantations. The willow is still considerably grown in England, where the principal cultivator of late years was William Scaling, and such districts as Nottingham and the fens of Cambridgeshire produce osiers of the highest quality; but general labor conditions and the ease with which willow is imported from other countries have prevented it from being widely cultivated or manufactured. France, Italy, the islands of Sicily and Madeira, Belgium, Holland, Germany, Austria, and Russia are all large growers of willow, and have a good export trade of osier rods and basket ware. In all these thickly peopled countries, which abound in cheap labor, willow growing and basket making have followed the development of other manufactures to a very marked degree.

In the United States the conditions are altogether different from those on the continent of Europe. Here raw material is cheap in comparison with the cost of labor, and nearly every branch of manufacture tends to concentrate in large establishments with a great number of labor-saving devices. Such an industrial condition has relegated basket making to a very small position in the general world of manufacture. Yet it may well be questioned whether there is not a profitable opening for its more general practice. A comparatively small part of our population is made up of highly paid skilled laborers; the great bulk of the people is scattered in the agricultural districts, doing more or less independent hand labor. It has been observed in all countries that willow growing gives an uncommonly high margin of profit. A large demand for willow is now supplied by import, and as American-grown osiers are of good quality when proper care is taken in their culture, there is no reason why the further development of the industry should not be possible, if more American farmers can be convinced of its practicability.

Viewed as a whole, there is no doubt that the willow growing and basket industries are in a state of decline. The last census shows a

great falling off since 1899, as does the import of both rods and basket ware. Yet a further analysis of the figures brings many circumstances to light which justify hopeful conclusions. The manufacture of willow furniture, which is lost in the total figures, when separately considered shows a most promising condition. Of late years willow furniture has sprung into fashion, and to-day no minor industry is more prosperous than that devoted to its supply. The wages are good, and the manufacturers demand a steady supply of superior willow. This is now almost entirely received from France at a price which will give the entire trade to the American if he can equal the quality. In basket ware proper the decline seems to have reached bed rock. Experience has proved that no stock is equal to willow when durable baskets are demanded. The high-class basket has made a place for itself in the market even under present circumstances, and the entire decline in the trade has been in the low-priced basket, which competes with the foreign willow product or the American-made wooden basket. To put a low-priced basket on the market with raw willow at its present price, the wages must be cut lower than the normal standard in America. For this reason the trade is almost entirely in the hands of immigrant basket makers, who know no other trade, and who are seldom or never reenforced by native workmen.

The remedy lies in a reduction in the cost of the raw material. The cheaper the willow (when good in quality), the better the wages which can be paid to produce a low-priced basket, and a low-priced basket of good quality will find an almost unlimited market. On this point the entire trade agrees.

Thus the problem has but one solution. A good grade of willow must be produced at a low cost. To do this, better and more scientific methods must be introduced. At present the willow is grown in the rudest manner possible, and several inferior varieties are planted. After a more detailed discussion of present conditions the following pages will show how the yield per acre may be increased and the quality of stock bettered. The price will then fall, but with a corresponding gain to the grower in the lessened cost of production. On this depends the future success of basket making in America. An incentive to improvement should be the fact that even under present conditions the American willow tends to displace the foreign in the home market.

DISTRIBUTION AND CHARACTERISTICS OF THE WILLOW.

DISTRIBUTION.

Willows are adapted to a wide range of soils and climatic conditions, and are therefore among the most widely distributed of trees and shrubs. The genus Salix, to which these plants belong, contains a large number of species, ranging from large trees to a small, low

plant. From 160 to 170 species are known, inhabiting all regions from the low grounds and river banks of temperate climates and warm countries to the arid Alpine slopes of mountains and to the boreal regions of both hemispheres.[a] They occur in America from the Arctic Circle to the West Indies and the mountains of Chile. In the Old World they range from northern Europe and Asia to Madagascar and South Africa, and to the islands of Java and Sumatra.

True to the characteristics of the genus, the basket willow also has a wide distribution over varying climatic conditions. In Europe *Salix viminalis*, *amygdalina*, *purpurea*, etc., are successfully grown from Russia, Sweden, and Norway, far down into Italy and the Mediterranean islands. In America it is difficult to decide positively just how far the commercial range of the European basket willow coincides with the boundaries within which it is at present grown. Although it has been cultivated in this country with more or less success for many years, willow growing is at present confined to the areas marked on the accompanying map (frontispiece). How far these can be extended can be found only by actual experience; yet there is every reason to believe that suitable places for willow growing exist throughout the entire United States. There is continual record of small imports of willow from the West Indian islands; and it is quite certain that northern willows suffer quite as much from insect pests as those on the southern boundary of the present willow-growing section. For these reasons it would seem that the South has a good future for this industry, if favorable positions are sought for the holts. In the last session of Congress $5,000 was set apart for the introduction of the willow industry among Indian tribes and on Indian reservations. This is a wise step, and there is no climatic reason why the willow should not thereby be introduced into Western States where its culture is now unknown. On the Pacific Coast also, the high transportation rates which must be paid for the foreign or eastern article should give willow growing a chance to become an economic industry. A start has already been made in California.

CHARACTERISTICS.

In a genus with such a wide range it is but natural that the wood should answer many needs. Both in Europe and, to a lesser degree, in America the wood is used for many purposes. In this report, however, only the basket willow will be considered.

Although the willow is one of the most widespread and accommodating of plants, and shows such an endless variety of strains, the

[a] There are at least 92 varieties, hybrids, and crosses of the osier willow enumerated in the dealers' catalogues.

varieties used in basket making will by no means flourish commercially on all kinds of soil. It is a mistaken idea, however, that it will thrive only on marshy land, though it is true that a fresh soil is needed. That the willow is nevertheless characteristically found in wet places when growing wild is due less to its demands than to its adaptability.

The distribution of species in a natural forest is not determined solely by the requirements of each tree, but depends also on their ability to compete with one another for the favorable positions or to support life on the unfavorable. The willow, having a poor height growth, and being also intolerant of shade, finds its only chance for life in its capacity for soil adaptation. It is not at all sensitive to moisture, and hence is forced to grow on river banks and lowlands. This is further necessitated by the fact that its seeds can not sprout save on soft, open soil which is free of weeds, and lose their powers of germination in a few days. Such seeds, when left to nature's conditions, find their most favorable bed on the soft alluvial deposits of river banks.

The whole structure of the tree goes to show that it is not a water plant. It has none of the softness, succulence, and loose texture of an aquatic species. On the contrary, it has a very highly developed root system, which can absorb every atom of moisture from the soil, a thick, heavy bark, which hinders evaporation from the stem, a large leaf area—an indication that it absorbs carbon dioxid from the air and not from the water—and thin leaves, with waxy epidermis, which evaporate no more water than those of other forest trees growing under normal conditions.

When grown as an article of commerce, the willow is removed from all natural competition, and therefore should be put in a position suited for its development. Both European and American experience have shown that rods grown on moist, rich, well-drained bottomland are more flexible, tougher, and less branchy than those grown on undrained marsh land. This does not mean that valuable fields should be given over to the willow. The most exacting of trees is far less sensitive to soil conditions than any farm crop, and willows thrive on soil which produces even a very poor quality of grass. But the fact remains that the swamp is not the favorite home of the basket willow, and, if a high grade of osier rod is wanted, land permanently saturated with water should be avoided. Ground which is often overflowed grows willow of a high quality, but it must be well drained. Long-continued inundation is fatal to all species (Pl. I, fig. 1). Nor should its excessive intolerance of shade be forgotten. Weeds and undergrowth of any kind prevent its luxuriant development.

WILLOW GROWING IN THE UNITED STATES.

HISTORY.

The culture of the basket willow was introduced into America by German immigrants in the period between 1840 and 1850. The first attempts were made in western New York and Pennsylvania, where German basket makers had tried to ply their trade by using wild willows. When this was found to be impracticable, European species were introduced—principally the purple or Welsh willow. As the demand for willow ware throughout the country had begun to take on good proportions, osier growing succeeded from the first, and rapidly spread throughout the German settlements of the Middle West. As early as 1851 records of willow culture may be found in the Report on Agriculture of the Commissioner of Patents, and in 1860 cuttings of Welsh or purple willow were distributed throughout the country by the Government.

After the civil war the industry began to assume large proportions, and reached its maximum between 1870 and 1875. In the next ten years more effective methods were introduced into modern wooden basket making, and as a consequence the cheap willow basket was forced out of a large part of its market, where it had to contend also with the increased importation of abnormally cheap willow ware from Europe, which in the eighties and early nineties did incalculable harm to the home industry.

To these troubles were added others. The Germans who introduced willow growing came from their native country before scientific methods had generally been adopted. In consequence they planted the willows very far apart, and used only the most extensive methods of cultivation. As they received very high prices at first for the raw material—often as high as $50 per ton[a]—they received ample returns under this system, and were satisfied to make no improvements. In the meantime wages and the cost of living were continually rising, and when the increased competition came, the price of willow became inordinately high. As there seemed no way to reduce the cost of the raw material, wages in basket making could not rise in proportion to those of other trades, and in the decline of the industry the grower began to suffer.

In western New York there are no skilled workmen, but whole colonies of basket makers who are occupied in turning out cheap hampers and market and clothes baskets. Further to reduce the cost of the raw material, steam peeling is resorted to. Since steam-peeled rods have a dark color, they can not be used for fine baskets. Consequently, as cheap basket making has declined, willow growing in that district

[a] See Patent Office Report, Agriculture, 1851, p. 47.

has suffered with it. To make matters worse, at the time when competition was still severest the willows were terribly attacked by the cottonwood leaf-beetle, which, in the early nineties, destroyed acre upon acre of the New York willows. To this unfavorable combination of circumstances is due the present lack of prosperity in the willow-growing section of New York.

Throughout the Middle West much the same methods of growing were used as in New York, but the willows are almost always hand peeled. For this reason they supply the demand of the high-grade basket, and, in this direction, are still doing well. As far as the poorer baskets are concerned, however, the demand is falling off, and in certain districts, such as Indiana and Kentucky, the whole willow-growing interest is on the brink of annihilation through a new and terribly destructive sawfly (pp. 68–70).

The district about Baltimore was not one of the early centers of willow growing, but various circumstances have tended to make the industry singularly successful there. Not that the cultivation practiced is any more intensive here than elsewhere—rather the contrary—but the happy choice of good varieties and an advantageous position on bottomland seem to have worked very much in favor of this locality. To this must also be added the fact that in Baltimore there exists a steady and growing demand for good willows to be used in high-grade basket ware.

Apart from the Welsh or purple willow (Pl. II, fig. 1, and fig. 6, p. 26), which is in common use throughout the country, the growers about Baltimore introduced the "Lemley" (fig. 7, p. 27), a hybrid from this species known as the "patent Lemley," and the almond or "American green" (Pl. I, fig. 2, and fig. 8, p. 28). These have proved very successful under American conditions.

From Maryland these last-named willows have been introduced with the best results into Pennsylvania and Virginia, and the use of the American green has spread through the Middle West as far as Wadsworth, Ill.

THE PRESENT CULTURE OF WILLOWS IN AMERICA.

GENERAL.

Although introduced so long ago, willow growing in America occurs only in restricted localities throughout a relatively small portion of the country. (See map, frontispiece.) Because the growers are thus isolated into small groups with little or no connection and because these growers are very seldom in touch with the basket makers, there has been little chance for general improvement. It is true that in western New York basket maker and grower are in close communication, but there the trade demands only the cheapest grade of the

steamed willow—a condition which, far from being an advantage to the grower, has been his greatest handicap.

Because of these conditions, and, further, because the system of culture, like American agriculture in general, has lacked intensiveness, little or no advance has been made on the method introduced fifty years or more ago.

POSITION OF THE HOLT, OR WILLOW PLANTATION.

Although the idea is common that willows grow only on swampy ground, it takes but little experience to explode this fallacy (Pl. I, fig. 1). Hence all serious attempts at osier culture are made on well-drained soil, even though it be of poor quality. In many places willows are grown on ordinary corn land, but generally they are planted in low-lying fields subject to occasional inundation (Pl. I, fig. 2; Pl. II, and Pl. III, fig. 1), or in the swales and low places of grain fields, subject to the overflow or drainage of sudden rain storms. When planted on high ground the land chosen is deep and heavy, but when the holt (or willow bed) is subject to inundation the land may be of poorer quality.

PRELIMINARY CULTIVATION.

In most parts of the country the ground is prepared for willows exactly as it would be for corn or wheat. The work is generally done in the preceding autumn, occasionally in the spring. Often where the willows are to be planted on waste bottomland subject to inundation, the wild growth is simply cut down and burned on the field, and the willows are planted either with preliminary cultivation or in the raw soil.

PLANTING.

Almost without exception throughout the country willows are planted from 9 inches to a foot apart, in rows 2½ feet to a yard distant from one another, or from about 14,000 to 23,000 per acre. Here and there occasional growers plant in closer order—even 18 by 8 inches—but they are the decided exception. This method of wide planting is followed for several reasons. It is undoubtedly cheaper to plant fewer cuttings, and the cost of cultivation is much reduced, as a plow may be run through the wide rows. It is also a generally held opinion that the more shoots from a stool (or stump), the greater the yield. Finally, the practice is continued because those who introduced the industry planted in this manner.

The sets (or cuttings) are cut from one-year shoots into sections about 10 inches to a foot in length, and are generally planted with about an inch and a half out of the ground. (See p. 40.)

WEEDING AND CULTIVATION.

The care of a holt depends so much on the character of the ground that two systems must be separately discussed.

FIG. 1.—PURPLE OR WELSH WILLOW (SALIX PURPUREA), PART OF WHICH HAS BEEN KILLED BY STANDING WATER. NEW YORK, JULY, 1902.

FIG. 2.—ALMOND OR AMERICAN GREEN WILLOW (SALIX AMYGDALINA), ON WELL-DRAINED BOTTOM LAND; RODS 7 TO 8 FEET HIGH. MARYLAND, SEPTEMBER, 1902.

FIG. 1.—PURPLE OR WELSH WILLOW (SALIX PURPUREA) PLANTED 3 FEET BY 1 FOOT. MARYLAND, SEPTEMBER, 1902.

Holt two years planted. Rows too far apart. Height, 4 to 5 feet.

FIG. 2.—TYPICAL WILLOW BOTTOM LAND. MARYLAND.

FIG. 1.—WILLOWS ON DRAINED LAND; CUT AND SUBSEQUENTLY INUNDATED. MARYLAND, MARCH, 1903.

The stools are covered with a layer of mud. Rows too far apart.

FIG. 2.—EFFECT OF UNDRAINED LAND. MARYLAND, MARCH, 1903.

Planted too far apart. The stools are forced out of the ground by frost. The willows are carelessly cut.

FIG. 1.—DRAFTING (SORTING) WILLOWS.

FIG. 2.—WILLOWS IN THE PIT, SPROUTED AND READY FOR PEELING.

Willows on meadow or corn land.—In the first year the rows are hoed about three times, and later run through occasionally with a light plow. In subsequent years only the plow is used, several times in the season.

Willows on bottomland.—In the first year these are sometimes cultivated once, but as a general thing they are only thoroughly grassed with a sickle. This is done twice in the first season, and subsequently but once. As the land is inundated every spring a heavy coat of mud is deposited, and fertilization and cultivation is not necessary (Pl. III, fig. 1). This advantage, however, is partially offset by the stimulated growth of weeds, which are very difficult to keep suppressed.

CUTTING.

Unless the holt has been very well tended, the first-year rods may be of little value. They are, nevertheless, cut. As a general rule, however, they are not cut very close, and the projecting head of the set is allowed to stay (Pl. III, fig. 2). This makes the stool branchy and knotty from the first—a very serious fault (see p. 23). In the second year the rods of a carefully cultivated holt should have at least half the value of a full crop, and from the second or third year the holt should yield at least twelve good paying crops. Only a few growers realize the value of an occasional rest (see p. 47). As a rule the holt is cut annually until exhausted. Where steam peeling is practiced the willows are generally cut as soon as the leaves have fallen in November, so that they may be stripped in the winter. In districts where sap peeling is common the rods are allowed to stand on the stump until March, when they are cut and immediately drafted (Pl. IV, fig. 1), tied into bundles, and put into the pit (Pl. IV, fig. 2).

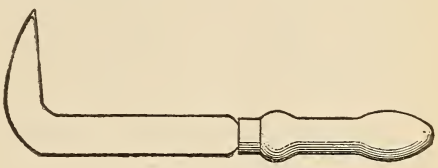

FIG. 1.—Knife for cutting rods.

By letting the willows stand all winter and cutting them early in the spring, any trouble in housing the rods is saved. In some districts, however, it is customary to wait until the sap begins to run. This is most objectionable, as the stools bleed and lose vitality.

The cutting is generally done with a knife somewhat similar to that shown in fig. 1. In almost every district the value of low cutting is fully appreciated, but the work is seldom carefully done in this respect, mainly because of the added expense.

DRAFTING AND PEELING.

After cutting, the rods are immediately sorted into four sizes and bundled. This is called drafting, and is most conveniently done in the

manner shown in Pl. IV, fig. 1. An armful of rods is put into a barrel and sorted according to size with a measuring stick. All rods below A go into the smallest size, those between A and B into the next, those between B and C into the next, and all over C into the largest size. About 40 pounds are put into a bundle, which is firmly bound and taken immediately to the pit (Pl. IV, fig. 2). This pit is a series of shallow ponds of water, not over 2 inches deep, in which the bundles are stood. Racks are arranged at regular intervals to keep the bundles upright and secure, but they should not be too closely packed. After the willows have stood in the water for two or three weeks the rods become almost entirely covered with tender, green foliage, while the submerged end is a mass of rootlets. In this condition they are ready for the peeling, which should begin at once. Peeling is done by a man and two strippers, the latter being either boys or women. The brake used for removing the bark (fig. 2, Nos. 4, 5, 6, and 7) is inserted in a beam at a convenient height, and the rod passed through it, first in one direction and then in the reverse (Pl. V, fig. 1). This loosens the bark; the strippers then peel it off, either with the fingers or with a dogwood or metallic hand brake (fig. 2, Nos. 1 and 2), and carry the rods to the drying racks (Pl. V, fig. 2), where they are laid in the sun to dry, care being taken to keep the rods in the four sizes arranged in the drafting. After they are sufficiently dry they are tightly bundled by a machine (Pl. VI, fig. 1), and in this form shipped to the manufacturer. The machine here illustrated is not in common use, but from its simplicity and efficiency should be more generally introduced. It can be made by hand on the place with the aid of a blacksmith. The main feature is the binding-strap, which is so crossed on the axle that by turning the latter the pressure is exerted on the rods, not only from the top, but also from the sides and underneath. A cog and ratchet attachment on the axle holds the tension while the bundle is being tied; the necessary cord is held in a reel under the machine.

It does not pay to peel the smallest size of rods with the rest, so they are generally put out to families to peel at a given rate per pound, women and children doing the work. The grower makes little or no profit on these rods, but the basket maker's demand for a certain amount of small stuff makes it necessary to have such stock on hand.

SUGGESTED IMPROVEMENTS IN CULTURE.

The following suggestions concerning willow culture in America have been prepared after a careful study on the ground of actual conditions both here and in Europe. While the introduction of any new system in a particular locality calls for a consideration of questions of labor, market transportation, etc., all of which can not be taken into account in a general discussion, there is room for many improvements

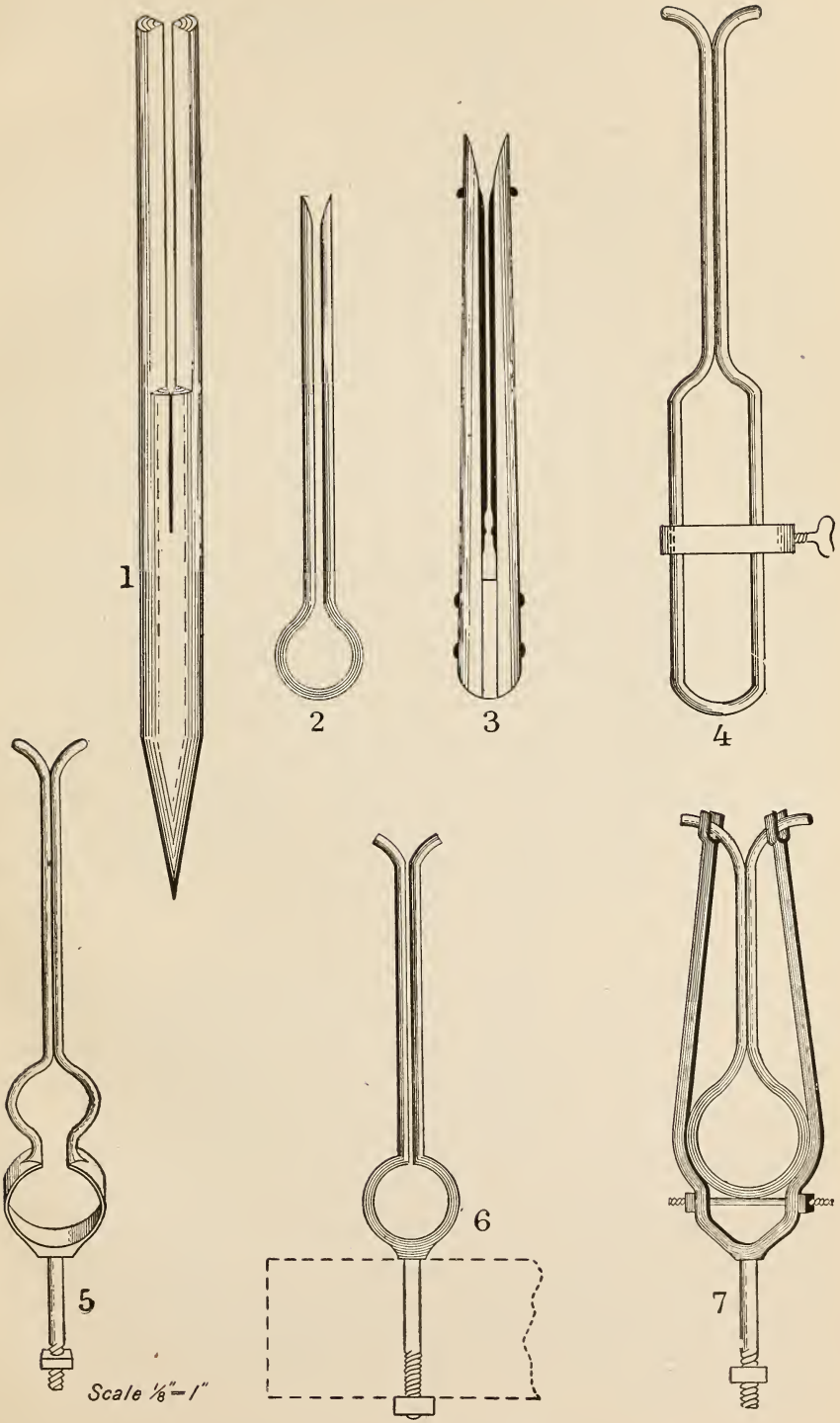

FIG. 2.—Seven types of brake.

on present methods, and the intelligent application by the individual grower of the information here given should enable him in most cases decidedly to increase his profits.

CHOICE OF LAND AND PRELIMINARY CULTIVATION.

Any extra expense incurred in the preliminary cultivation of the soil will be repaid in the increased yield. The land should be plowed and harrowed exactly as for any field crop, and should be fertilized with lime or wood ashes if calcareous constituents are lacking. Even fields subject to inundation should be well cultivated before planting.

If the holt is to be planted on land which is never flooded, the soil should be deep and moist, but not necessarily rich. If the land is subject to inundation in the spring, it should be thoroughly drained. Not only are the rods brittle and of poor quality on swampy soil, but the winter frost forces the stools out of the ground, making large heads above the surface and neutralizing the effect of good cutting (Pl. III, fig. 2).

There is no doubt that land subject to inundation is the best for osier growing. If it can be perfectly drained and the flooding regulated, ideal conditions are present for the production of high-grade stock. The flooding does away with any need for fertilizer, and the layer of deposit keeps the stools well covered (Pl. III, fig. 1), while if the water stands long enough the larvæ of insects are likely to be killed. All these advantages counteract the additional danger from weeds, which can be kept under if attacked early enough in the season. In a suitable location flooding can be inexpensively provided for by the construction of a weir dam. This would easily pay for itself in the facility with which the water could be regulated. Fig. 3 shows a good location for willow growing on inundated land.

PLANTING.

By planting from 34,000 to 81,000 sets per acre, or at distances from 20 by 9 inches to 16 by 6 inches, both a much heavier yield and longer, more even-sized, and better rods are obtained—straighter, less branchy, and less tapering. (See p. 24.) The main objections to close planting are the increased initial cost, the greater amount of cultivation necessary, and the more rapid exhaustion of the holt. But the average yield from a holt planted 3 feet by 1 foot after the second year is 4 tons green per acre for about twelve years, while that from an acre planted 20 by 9 inches should not be less than 6 tons green for ten years. This gives the close-planted holt an excess yield of 12 tons over the one planted 3 feet by 1 foot, to say nothing of the extra yield in the first and second years. In Tables I and II the expenditure and return under both systems of planting are given in detail. (See pp. 29–33.)

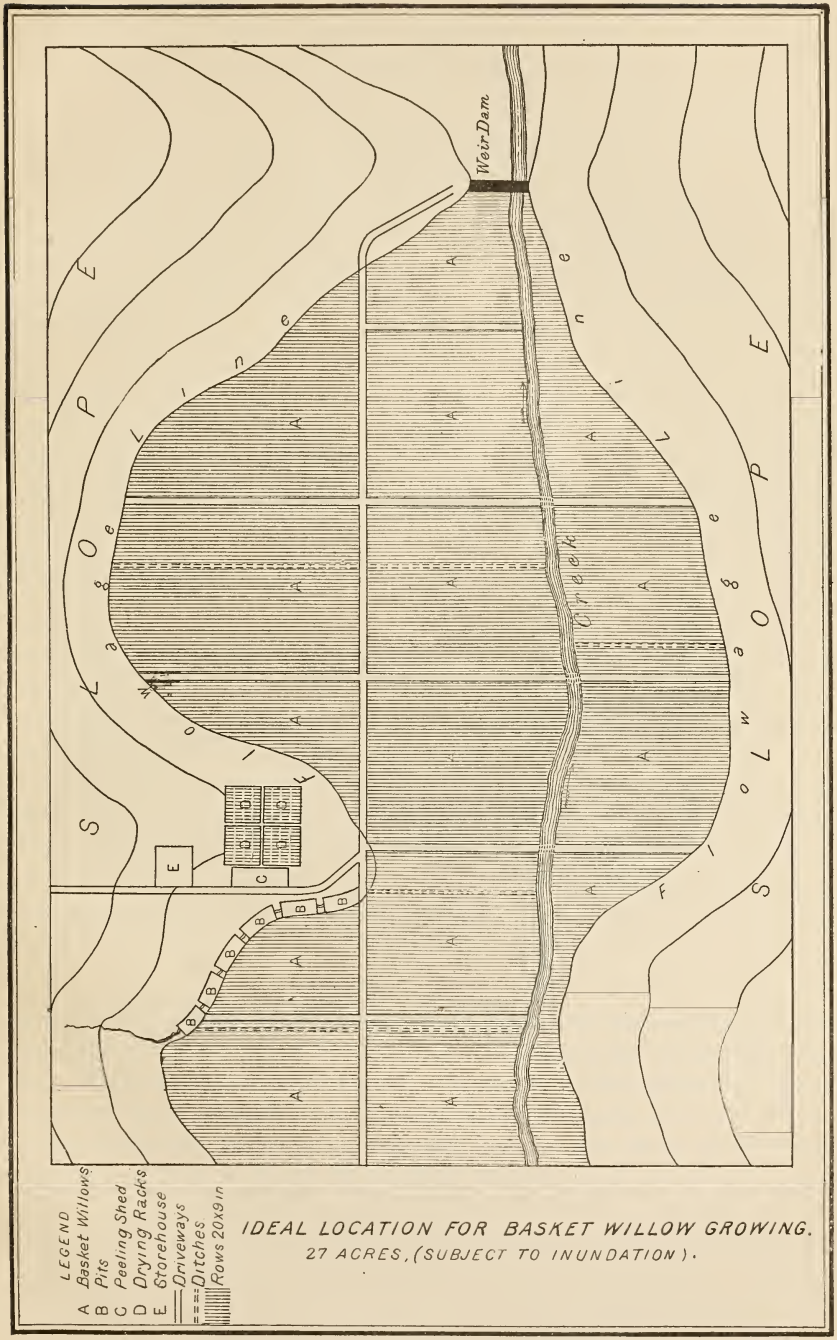

FIG. 3.—Ideal location for basket willow growing.

These estimates, however, take no account either of the improved quality of the entire crop or of interest on the larger profits secured. With these reckoned in, a much larger balance in favor of close planting would be obtained.

Of course the conditions which determine the application of different methods of willow growing are purely local, and the price of labor and the market for the stock must fix the method of culture, but if labor can be obtained and the market is thoroughly known, a willow holt will pay as much as any field crop, and possibly more. While in many instances it would not be advisable to change the present method of cultivation, there are places where close planting and careful cultivation would undoubtedly pay handsome returns. For American conditions, 20 by 9 inches, giving about 34,000 plants per acre, would probably be the best distance. Care should be taken that the sets are 12 inches long and planted with the buds pointing upward, and that they are put into the ground perpendicularly their whole length. The planting frame shown in fig. 4 may be of help on small areas.

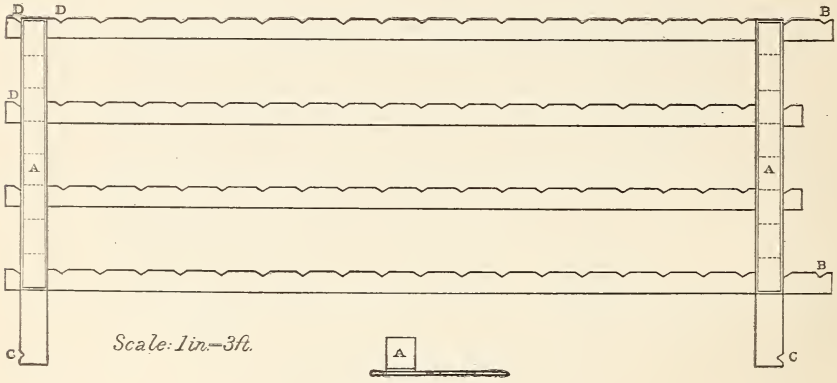

FIG. 4.—Planting frame.

WEEDING AND CULTIVATION.

When willows are close planted, it is absolutely essential that weeds and grass, under all circumstances their arch foes, should be kept out during the early life of the holt. Afterwards, when the stools have become vigorous, they are able from their close rank to shade out other plants if the first cultivation in the spring has given the weeds a setback. But in the first year the cultivation should be so thorough that the weeds get no chance to develop. In normal years three or four hoeings should suffice for this. Two hoeings should be given the second year. After that time one hoeing should be sufficient. The first cultivation should take place very early in the spring, before the stools have begun to sprout, and the soil should be heaped up over the plants. If the ground has been inundated after cutting, the stools will be sufficiently covered, and the first cultivation may be deferred until the weeds begin to start.

Two thorough hoeings under normal circumstances will be found to cost little more than ordinary grassings or other methods of cultivation in vogue, and it is but little more trouble to hoe an acre set with 34,000 plants than one with 14,000.

FERTILIZATION.

On ordinary soil willows should be fertilized every four or five years, beginning with the fifth or sixth. This makes two treatments during the normal life of a close-planted holt. Any ordinary field manure may be used. If the land is flooded in the spring, no other fertilization is necessary.

INSECTS.

Insect ravages vary very much with the year, but it has been generally observed that they are more common on high land than on those fields which are subject to inundation. It is probable that the standing water kills the larvæ, and hence it is of great importance that the flooding be under control, so that the holt can be inundated after cutting.

In combatting the danger from this source, a first requisite is united action by all the growers of one neighborhood. A few uncared-for holts will completely neutralize all the efforts of careful growers. Against the ravages of such insects as the cottonwood leaf-beetle or caterpillars, spraying with poison is generally efficacious if commenced early enough in the season. (See p. 76.)

One of the most terrible willow scourges is the sawfly (see p. 68), which has lately appeared in Indiana, Ohio, and Kentucky. For this there seems no remedy but to cut the willows entirely off immediately after the fly has made its appearance, and to be effective this must be done throughout the whole region, even at the sacrifice of a year's crop.

CUTTING.

When the rods are to be steamed they may be cut any time during the period of rest, but when they are to be sap peeled it saves storage to let them stand on the stools until the spring. Care, however, should be taken to cut them before the sap begins to move.

The necessity for close cutting can not be too much emphasized. The rods should be taken off as close as possible to the stool, even if it is necessary to cut them a little under ground. If a stool be kept close and well below the surface its rods will be straighter and more vigorous, it will be less subject to attack from insects, and its length of life will be greatly increased. Fig. 5 shows the difference between good and bad cutting. A illustrates the growth of the rods from a low-cut, compact stool, and B that from a high-branching one.[a]

[a] Fig. 5 is taken from actual examples.

After the rods have been cut it is well to go over the holt and thoroughly clean the stools, removing all rods that may have been left. If the holt can be flooded the water should be let in, covering the stools with a coat of mud.

One of the most successful ways of increasing the holt's vitality is to let the rods stand occasionally for two years. (See p. 47.) The sixth and the tenth years are good ones for leaving the holt uncut. Many

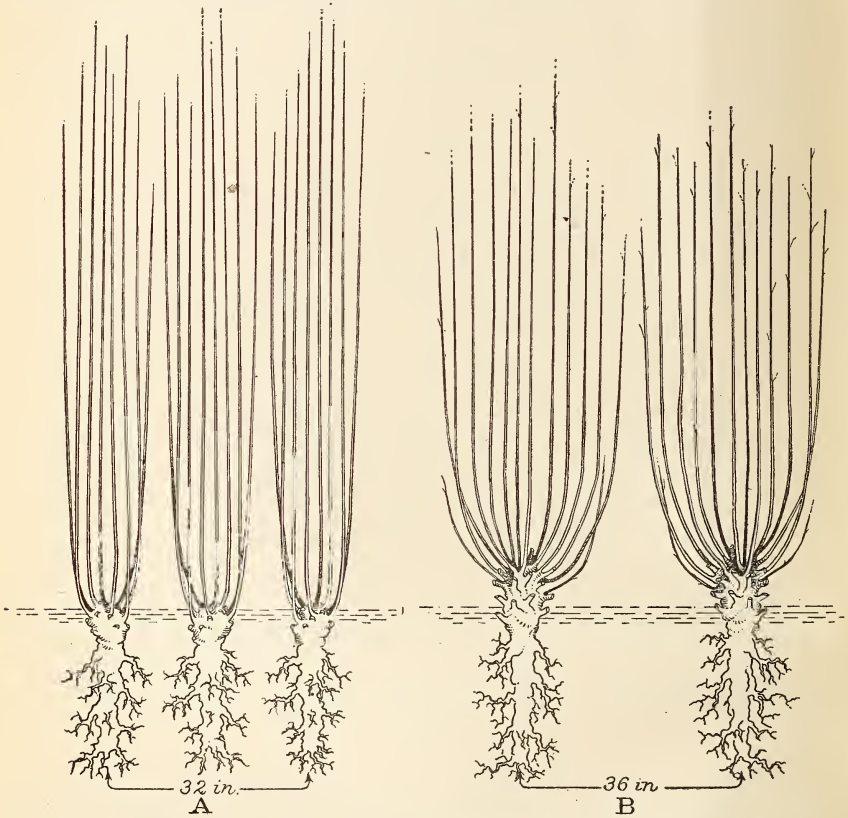

FIG. 5.—Comparison of close planting and good cutting with wide planting and careless cutting.

growers think that such a rest makes the subsequent crops brittle, but there is nothing to substantiate such a theory.

PEELING, SORTING, PACKING, ETC.

The present system of drafting and peeling can not be much improved, but greater care should be taken in sorting. Almost all basket makers complain of the irregularity of American willow. At present the rods are put into four sizes before they are peeled, and are not sorted after they are white. A second drafting when they are put on the drying racks would be no difficult matter, and would undoubtedly pay. The loss of weight in the hands of the manufac-

FIG. 1.—PEELING WILLOWS IN THE SAP.

FIG. 2.—DRYING THE PEELED RODS ON THE RACKS.

The rods should not be piled too deep.

FIG. 1.—MACHINE FOR BUNDLING WILLOWS FOR MARKET.

FIG. 2.—DIFFERENT KINDS OF PEELED AND UNPEELED WILLOW SHIPPING BASKETS ON THE DOCK AT ROTTERDAM, HOLLAND.

turers mentioned on page 53 comes from too early shipment after peeling, and under present conditions is difficult to remedy. Anything which will make his rods of superior quality should be attempted by the grower. It is to his advantage to have his customers know him for his reliability and the superiority of his stock. If he can establish himself in a sufficiently close relation with them to enable him to work with them for the supply of such rods as are likely to be most in demand, so much the better for grower and consumer alike.

WILLOWS GROWN IN AMERICA.

The qualities required to constitute a perfect rod are extreme toughness, elasticity, a level, smooth, and brilliant white surface after peeling, good splitting quality, freedom from branches, great length of shoot in proportion to thickness, and a small pith. The development of a species which will produce such rods and which at the same time is hardy and not liable to ordinary diseases, and a good cropper, is the end for which growers should strive. This demands that the greatest care should be exercised not only in the choice of species but also in methods of culture. Good varieties give no results under careless methods; even inferior kinds will pay if well tended. It should be the object of every grower to lower the price and better the quality of his willow, for on this depends the future success of American osier culture. If rods equal to the French and cheaper in price can be put on the market, there will be an opportunity for a great expansion of basket and furniture manufactures, and the growers will more than make up in larger sales what they lose in price per pound.

Welsh or purple willow (*Salix purpurea*) (Pl. II, fig 1, and fig. 6).—This is the most commonly grown osier in America, although its characteristics do not make it a good willow for peeled rods of a high quality. It is singularly hardy, and crops well, but the yield is small and the rods very hard. It deserves a place in willow culture, but should be put in the damper parts of a plantation, and not made the leading species.

The Lemley and patent Lemley, or Caspian willow (*Salix pruinosa acutifolia and variations of the same*) (fig. 7).—This osier is commonly grown in Maryland and Pennsylvania, and gives good, even-sized rods, which peel well. It should be planted on soil which is perfectly drained and not too rich in quality, or too damp, otherwise it is likely to branch. The white rods have a good color, and are in demand for the better class of basket ware and furniture. As it sends out very few rods from a stool and has a tendency to branch, the Lemley should be planted in close order. Its heavy, dark foliage casts a good shade, which keeps down weeds and undergrowth. On the whole, it can be highly recommended for planting, especially the patent Lemley.

FIG. 6.—Welsh or purple willow (⅛ natural size).

FIG. 7.—Lemley or Caspian willow (⅔ natural size).

American green or almond willow (*Salix amygdalina*) (Pl. I, fig. 2, and fig. 8).—Of all the willows grown in America this most nearly

FIG. 8.—American green or almond willow (⅛ natural size).

reaches the ideal referred to on page 25. It is cultivated in Maryland and Pennsylvania, through Indiana, Ohio, and Kentucky, and as far

as Illinois, and everywhere is in high demand, especially for furniture. Nearly all the main points of the American green given on page 49 hold good for this country. It should be planted on fairly rich soil. If the order be as close as 20 by 9 inches, the very heavy foliage will keep down undergrowth, provided the rods are allowed to get the supremacy in the spring. Most of its varieties have a tendency to branch, which can be overcome by close planting and a careful selection of the best kinds. A large number of holts in every willow plantation should be put to American green.

EXPENDITURE AND RETURNS IN AMERICAN WILLOW CULTURE.

In estimating the expenditure in willow growing, the holts on farm land and those on bottomland subject to inundation should be considered separately.

WILLOWS GROWN ON UPLAND.

In Table I the present and estimated expenditures and returns are given for willows on upland.

TABLE I.—*Willow culture on upland.*

	A.—Steam-peeled rods as grown in New York.			B.—Steam-peeled rods to be grown 20 by 9 inches apart.			C.—Sap-peeled rods to be grown 20 by 9 inches apart.		
	First year.	Second year.	Third to fourteenth years.	First year.	Second year.	Third to twelfth years.	First year.	Seeond year.	Third to twelfth years.
Annual expenses per acre.									
Preparation of land	$10.00	.....	.....	$10.00	.....	.....	$10.00	.....	.....
Sets	[a] 14.00	.....	.....	[a] 35.00	.....	.....	[b] 105.00	.....	.....
Planting	4.50	.....	.....	12.00	.....	.....	12.00	.....	.....
Plowings, at $1 each	2.00	$2.00	$2.00	.....	.....	.....	.....	.....	.....
Hoeings, at $4 each	8.00	8.00	.....	16.00	$12.00	$8.00	16.00	$8.00	$4.00
Spraying	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00
Cutting:									
Salable rods, at $5 per ton	5.00	10.00	20.00	7.50	20.00	30.00	10.00	20.00	30.00
Left-over rods	1.00	1.00	1.50	1.00	1.00	1.50	1.00	1.00	1.50
Drafting, at $3 per ton	.....	.....	.....	.....	.....	.....	6.00	12.00	18.00
Peeling, at $10 per ton	.....	.....	.....	.....	.....	.....	20.00	40.00	60.00
Total	48.50	25.00	27.50	85.50	37.00	43.50	184.00	85.00	117.50
Annual returns per acre.									
Willow:									
Green, at $15 per ton	15.00	30.00	60.00	22.50	60.00	90.00	75.00	150.00	.....
White, at 5 cents per pound	.....	.....	.....	.....	.....	.....	.....	.....	225.00
Gross gain	.....	5.00	32.50	.....	23.00	46.50	.....	65.00	107.50
Gross loss	33.50	.....	.....	63.00	.....	.....	109.00	.....	.....
Amount of net loss of previous year, with interest at 5 per cent	.....	35.18	31.69	.....	66.15	45.30	.....	114.45	51.92
Net gain	.....	.....	.81	.....	.....	1.20	.....	.....	55.58
Net loss	33.50	30.18	.....	63.00	43.15	.....	109.00	45.25	.....

[a] Welsh willow, at $1 per M. [b] American green, Lemley, and patent Lemley willows, at $3 per M.

Column A is based on the present system as practiced in New York State, but should hold good for all regions under like conditions. The sets are supposed to be Welsh willow, and are taken at the usual cost near Lyons, N. Y. While many holts are less highly cultivated, this estimate may be taken as fairly representative of the average expenditures. From the figures it is seen that at the end of the third year the initial expenditure is entirely repaid and a net gain made of $0.81 per acre. A fair holt will average 4 tons of willow per year for twelve years after the second year. From the fourth through the fourteenth years the gain of $32.50 in the third year may be taken as an average, giving a profit of $357.50, or a total profit of $358.31 per acre for the fourteen years of the existence of the holt. In order to find the net profit for the period the following should be deducted:

Rent at $5 per acre for fourteen years at 5 per cent	$97.99
Incidental expenses	10.00
Total	107.99

This leaves $250.32, or an average net profit of $17.88 per acre for fourteen years. This estimate should hold good for all localities where willows are steam peeled.

In order to get a greater yield at a lower price the method as given in column B of Table I is proposed. According to German and English experience holts planted 20 by 9 inches yield an average of 6 tons per acre for at least nine years after the third year. Accordingly there is an average net profit of $46.50 per acre (as in the third year), or $418.50 for the period, amounting to $419.70 as a total yield for twelve years. To find the actual profit further expenses must be deducted as follows:

Rent at $5 per acre for twelve years at 5 per cent	$79.59
Fertilizer	10.00
Incidental expenses	15.00
Total	104.59

This leaves $315.11, or an average of $26.25 per acre for twelve years, as compared with $250.31, or an average of $17.88 per acre for fourteen years, obtained by planting 3 by 1 feet, as at present. A careful study of the items in column B will show that each cost estimate is an extreme figure, while the yields given have been found only a fair average in England and Europe, where many holts give 8 tons per acre as a regular average.

If the grower of osiers on upland intends to peel his stock in the sap, he should select American green, Lemley, and patent Lemley as well as Welsh willow. The sets of the first-named varieties cost about $3 per thousand at present. The results under close planting would be as given in column C. At a gain of $107.50 per annum, $967.50 will be realized from the fourth to the twelfth years. Including $55.58, the gain in the third year, a total of $1,023.08 is obtained.

The following additional expenses per acre must be deducted:

Rent for twelve years at $5 per acre at 5 per cent	$79.59
Fertilizer	10.00
Incidental expenses	15.00
Total	104.59

There should thus be a net profit per acre of $918.49, or $76.54 per year for twelve years.

WILLOWS GROWN ON LAND SUBJECT TO INUNDATION.

It is a noticeable fact that the best willow raised in this country, and that which commands the highest price, is grown on well-drained bottomland in Pennsylvania and Maryland. The actual methods of culture are, if anything, less intensive than those in other districts; yet the willow is less subject to insect damage, is better grown, and is generally of a finer quality than elsewhere. This is only in small part due to the use of better varieties (American green, Lemley, and patent Lemley); it may be almost wholly ascribed to the fact that the land is subject to overflow in the spring. This acts as fertilizer, builds up the soil about the stools, and, above all, keeps in check the insects which winter in the crevices of the stools and in the ground.

TABLE II.—*Willow culture on bottomland subject to inundation.*

	A—Sap-peeled rods as grown in Maryland.			B—Sap-peeled rods to be grown 20 by 9 inches apart.		
	First year.	Second year.	Third to fourteenth years.	First year.	Second year.	Third to twelfth years.
Annual expenses per acre.						
Share of $200 dam	.....	.....	.....	$10.00	.....	.....
Preparation of land	$25.00	.....	.....	25.00	.....	.....
Sets	42.00	.....	.....	105.00	.....	.....
Planting	5.00	.....	.....	14.00	.....	.....
Mowings:						
Grass, at $8 each	16.00	$8.00	$8.00	.....	.....	.....
Vines, at $2 each	2.00	2.00	2.00	2.00	$2.00	$2.00
Hoeings, at $4 each	.....	.....	.....	16.00	8.00	4.00
Cutting:						
Salable rods, at $5 per ton	5.00	12.50	20.00	10.00	20.00	32.50
Left-over rods	1.00	1.00	1.50	1.00	1.00	1.50
Drafting, at $3 per ton	3.00	7.50	12.00	6.00	12.00	19.50
Peeling, at $10 per ton	10.00	25.00	40.00	20.00	40.00	65.00
Total	109.00	56.00	83.50	209.00	83.00	124.50
Annual returns per acre.						
White willow, at 5 cents per pound	37.50	93.75	150.00	75.00	150.00	243.75
Gross gain	.....	37.75	66.50	.....	67.00	119.25
Gross loss	71.50	.....	.....	134.00	.....	.....
Amount of net loss for previous year, with interest at 5 per cent	.....	75.08	39.20	.....	140.70	77.39
Net gain	.....	.....	27.30	.....	.....	41.86
Net loss	71.50	37.33	.....	134.00	73.70	.....

In Table II, column A shows as accurately as possible the present cost of growing in Maryland. The rent has been taken at the normal price which should be paid for bottomland in brush. It was found in many cases that willow growers were paying for ground otherwise useless a rent which could hardly be obtained for the best truck-gardening sites. Such a state of affairs had come about in consequence of making short leases or renting from year to year. Once the land was cleared and in willows, growers would pay many times what they should rather than change or go out of business. Such conditions should not be considered in a normal expense account. From the present method of growing, a profit of $66.50 is made in the third year, as given in column A. The same will hold good for the next eleven years, giving $731.50 for the period, or a total of $758.80 from the acre. Deducting from this fourteen years' rent, at $3 per acre, amounting at 5 per cent compound interest to $58.80, and $15 for incidental expenses, a net profit of $685 is obtained, or $48.93 per acre per year for the fourteen years of the holt's existence.

The superiority of willows grown on bottomland has been explained as due to the greater uniformity of moisture, the value of the annual deposit of sediment, and the check given by the water to destructive insects. For this reason the building of a dam to regulate the water supply and drainage is urgently recommended on every willow plantation of any considerable size. In column B the figures are calculated on a basis of 27 acres (see fig. 3, p. 21) and the cost of the dam included. Estimating after the manner of the preceding columns, the total return from the acre in twelve years will be $1,115.11. Subtracting $47.75 for rent, at $3 per acre for twelve years, with compound interest at 5 per cent, and $20 for incidentals, there is a net return per acre of $1,047.36, or $87.28 per acre for twelve years.

SYSTEMS OF PEELING COMPARED.

In comparing the two systems at present in vogue in America, a great difference in returns appears between willows grown for steam and for sap peeling. Practically the entire amount of steam-peeled willow comes from New York. It seems strange that the district which produces nearly half the value of the entire production in America, and three-quarters of the actual amount grown, should resort to a cheap method when other districts get nearly four times as much for their willows. Yet the matter is more simple than it seems. New York is the center of an old industry, where there is no skilled labor, and the willows are steam peeled to help make a cheap product. The product of Maryland and Pennsylvania is sold to the makers of fine baskets and furniture, and competes with the imported French willow. Hence, it must not be forgotten that the market for willows grown according to the estimates in Table I is much larger than that for the estimates

FIG. 1.—COMMON WHITE WILLOW (SALIX VIMINALIS) GROWING ON RICH UPLAND. GERMANY, NOVEMBER, 1902.

Holt three years planted. Distance, 18 by 6 inches. Height, 11 to 14 feet.

FIG. 2.—FIRST-YEAR RODS OF COMMON WHITE WILLOW FROM NEWLY PLANTED SETS. GERMANY, NOVEMBER, 1902.

Rows, 20 feet apart. Distance in rows, 9 inches. Height, 7 to 9 feet. Compare with Pl. II, fig. 1.

of Table II. The market for willows which yield at present over $50 an acre is a limited one, and if many growers take up the new system, which is estimated to give a return of $87.28 per acre, they must count on a speedy fall in the price of raw willow. Yet the margin between $87.28 an acre and $50 an acre is amply sufficient to allow a substantial fall in price and still give the grower a better profit than he can now make by the present method of culture. Such a condition is exactly the ideal to be striven for. If fine willows can be raised profitably at 4 cents a pound, there is an import trade of nearly $20,000 to be captured, together with the increase in the basket output which would follow a reduction in price of the raw material. These facts should convince the willow grower that it is to his advantage to take up the new method, and in the increased yield per acre and superior quality of the stock to make a profit greater than that possible by his old method at a lower market price per pound. In practice the advantage of bottom over meadow land would be even greater than shown in Tables II and III. The highland willows must be regularly fertilized and the earth banked about the roots. They are subject to drought and to insect ravages, while those grown on land which is regularly inundated can be kept in better condition. For these reasons the average crop has been set at 6½ tons, a figure which results will certainly justify.

The increase in yield by the new system is proportionately the same for willows intended for sap and for steam peeling, and the choice of methods must depend entirely upon the local market or other conditions.

FIELD EXPERIMENTS OF THE BUREAU OF FORESTRY.

In the seasons of 1903 and 1904 experimental plats of basket willows were set out on different kinds of soil. Thirty-five square rods are on rich Potomac bottomland, and 18 rods on the slope of the river bank well above the flood level. The bottomland can be flooded at will, and is planted to American green, patent Lemley, Lemley, and Welsh willows in equal-sized plats of 6 square rods, one-half of each plat being planted 20 by 9 inches, and the other half at 3 feet by 1 foot. The remaining 11 rods of bottomland are planted as follows: Five rods to second-year rooted stock of American green, patent Lemley, and Lemley, 1 rod of purple or Welsh willow, 2 rods of American green, 1 rod of Lemley, and 2 rods of common white osier, imported from France, all planted at 18 by 6 inches. Four plats on the hillside of 4 rods each have been planted to the above-named willows, in each case at both 20 by 9 inches, and 3 feet by 1 foot. The soil of the hillside is a good sandy loam, with a gravelly substratum at from 8 to 20 inches below the surface. Two square rods of very gravelly soil on the highest elevation have been set to the Lemley willow,

to test its reputed capacity for successful growth in such a situation. Altogether the experimental plats comprise a total of 53 square rods, on which more than 10,000 sets are planted.

As soon as possible American green, patent Lemley, Lemley, and Welsh willows will be brought from Europe and planted here for the purpose of contrasting their quality with that of plants procured from the same strains long grown in America. Several new European species and strains will also be introduced, in order, if possible, to increase the varieties of basket willow suitable for cultivation in this country. Each variety will be planted at intervals of 3 feet by 1 foot and 20 by 9 inches, and a few at 18 by 6 inches, to determine the proportionate yield for each kind, according to distance, and the effect of close and wide planting on the life of the holt. The effect of low cutting on the yield, character of the rods, and vitality of the stools in both close and wide planting will also be noted. Many other important considerations are to be included in these experiments, such as the value of inundation in fertilizing and banking mud over the willow stools, and in ridding the holt of destructive insects. Careful study will be made of the proportion of wood to bark and of the comparative weight of the peeled and dried rods for each species, variety, and strain; the relative value of one and two-year-old shoots for sets; and the total actual cost of cultivating, weeding, cutting, drafting, and peeling willows under average market conditions.

Native American species will also be experimented with, to find the best methods of growing them.

The results of these experiments will be published from time to time for the benefit of those engaged in basket willow culture. A limited number of cuttings are likely to be available for free distribution as soon as the willow holts now established yield extra stock.

By the end of July, 1904, several points of interest had become plain in the experiments.

SECOND-YEAR STOCK.

Among the second-year rooted stock the American green or almond willow made by far the best showing. It commenced to grow about the 20th of April. In July the part planted 20 by 9 inches was over 7 feet 6 inches high, and had been growing at the average rate of an inch a day since the end of May. The rods completely sheltered the ground by the first week in May, and but one hoeing was necessary. In wide planting a tendency to branch was shown, but at 20 by 9 inches the rods were absolutely clean and of all sizes, so that it will yield a good proportion of every grade from "key basket" to at least 10 feet in length. The Lemley and patent Lemley were not so tall as the

American green, and had only recently completely covered the ground, even at 20 by 9 inches. In consequence they still showed a tendency to branch. It will probably be necessary to plant these willows at 18 by 6 inches for the best results.

FIRST-YEAR STOCK.

The necessity for thorough hoeing became evident very early. But for complete cultivation in the first six weeks, the plants would have been destroyed by weeds. Two of the most persistent pests of the holt are a wild morning-glory vine and the dodder (*Cuscuta*), both of which twine about the rods and would choke them if not removed. Many of the first-year rods were more than 6 feet 3 inches high after 3¼ months of growth, but the American green and the Lemleys showed a tendency to branch because of their open growth in the first year. From this showing the best of the first-year rods should average from 6 to 8 feet at the end of the season. This insures a paying crop in the first year.

All species of willow showed the effect of sunburn where they grew very fast. The tops die back for an inch or two in a way quite similar to the effect of the sting of the willow sawfly (p. 69). There is no remedy for this; but the difference between sunburn and insect damage should be distinguished.

WILLOW GROWING IN EUROPE.

DEVELOPMENT OF SCIENTIFIC WILLOW CULTURE.

As late as the sixteenth and seventeenth centuries there was no system of willow culture which could be called scientific, and even at present most of the peasant communities practice only the crudest methods.

The first method of obtaining long rods was undoubtedly by pollarding. In Europe the willow shoots are used not only for basket ware, but also for barrel hoops, for binding vineyard and garden trellises, for wattle fences, for bean poles, and even for firewood. When large poles, wattle fences, or firewood are wanted the shoots are allowed to gain considerable size, but when they are intended for binding or for coarse basket ware the heads are pollarded every year or two. Such pollard willows are a feature in the landscape of all parts of Europe where forests are scarce. In all rural districts great quantities of rough unpeeled willow baskets are made from the smaller shoots of such pollards.[a] When a better quality of rod is demanded for local basket ware, some variety of willow is selected and shoots are planted 3 or 4

[a] Generally *Salix alba*, or white willow.

feet apart. The rods are cut annually a foot or so above the ground, making large stools which soon rot and fall to pieces. In other cases the willows are layered and the row made to act as a hedge. Willows grown in this way are of a poor quality, fit only for the coarsest use in local consumption. Often small farms or peasant holdings satisfy their own demand for willow by planting several rows of good basket willows and tending them in a fairly correct manner. These willows are cut and sent to the basket maker, who works them up and returns the baskets, charging for his labor at a fixed price per dozen.

Such methods represent the general condition of willow growing prior to the time when the demand for great quantities of basket ware made a national market. Cheap and good willow can be produced only in great quantities by intensive culture. To satisfy this demand France, Holland, and Belgium early in the eighteenth century developed scientific methods which soon became common in favored localities throughout Europe, including Great Britain (Pl. VII, figs. 1 and 2). The European yield at present exceeds 2,000,000 tons per year at a conservative estimate.

WHAT EUROPEAN EXPERIENCE TEACHES.

The American grower of basket willow has much to learn from the experiments and the highly developed methods of culture of the most advanced European practice. If he is to bring his own methods, and with them his profits, up to the highest level, he can not afford to remain ignorant of what has been learned concerning economic willow growing, both in France and in Germany.

Scientific willow culture first reached perfect development in France, and to-day a larger proportion of willow is there scientifically cultivated than in any other country. Here exists also the most perfect relation between grower and basket maker. In the great willow centers osier holts and basket factories are close together. In this way the grower is always in touch with the manufacturer, and can easily vary and improve his stock in accordance with the demand of the consumer.

In nearly all the other countries of Europe scientific willow culture is displacing the old methods and has risen to the dignity of a large industry. Great pains have been taken of late in Germany, and the publications of some of her growers are the most valuable works extant on the subject.

The following may be taken as the most salient features of the best scientific culture in Europe:

(1) Willows are grown on all classes of land, but heavy, rather calcareous soil is preferred. Meadow land too sour for good grass may be very successfully used; but all willow holts should be thoroughly drained.

(2) Before planting the ground is thoroughly worked to a depth of 1½ feet, and fertilized with slaked lime, if the soil is not calcareous, as well as with wood ash or any mixture rich in phosphates and potash.

(3) The sets may be cut from either 1-year-old or 2-year-old rods. These should be cut into foot lengths very shortly before planting. They are put into the ground perpendicularly their whole length, the buds pointing upward.

(4) The sets are planted 8 inches apart, in rows preferably 16 inches apart. This gives about 58,000 plants to the acre. Experience has shown that this secures the heaviest yield of high-grade rods with a normal amount of care and labor.

(5) The holt is kept free of weeds. Under the intensive system of European agriculture weeds are thoroughly suppressed. Here the American farmer labors at a great disadvantage.

(6) The whole crop of rods is harvested the first year, and every plant cut close to the ground. The subsequent vitality and yield of the holt is more dependent on careful cutting than on anything else. All rods are removed, and every care taken to make the stump as compact and close to the ground as possible.

(7) To preserve the vitality of the holt, every fourth year or so the shoots are allowed to stand two years. This and careful cutting is even more important than fertilization, which, however, should be done in periods varying from three to five years, according to the quality of the soil.

(8) Insect pests are attacked early in the season, all growers in the neighborhood acting in unison.

(9) The willows are peeled by hand, and, after peeling, are carefully sorted into certain sizes, every rod of which is perfect. These are made into compact bundles and allowed to dry thoroughly.

(10) It has been proved that close planting undoubtedly shortens the life of the holt, but the increased yield and superior quality of stock produced more than make up for this circumstance. The holt may be expected to yield paying quantities for at least twelve years, and to return at least 20 per cent on a small investment.

(11) A few well-known and long-tried species are cultivated, and their quality is carefully improved.

METHODS OF EUROPEAN WILLOW CULTURE.[a]

SOIL.

Willows are grown in Europe on lands of all qualities, from the best wheat fields to unfruitful moor. The first necessity is that the soil be deep, moist, and, above all, well drained. Although the species vary in their demands, willow land should, as a rule, be rather heavy and rich in lime. Where wet lands can be easily drained, open ditches are laid at required intervals, but when the subsoil is permanently soaked and the water will not run off, the earth is thrown up in long ridges. On these beautiful willows have been cultivated. In America lack of ground will probably not force us to such extremities; hence it is not necessary to follow in detail the processes of willow culture save on ordinary soil.

PRELIMINARY CULTIVATION.

In preparing a holt the ground should first be thoroughly cultivated and pulverized to a depth of a foot or more. This is done either with a spade or with plow and harrow, preferably in the autumn, though early in the spring, before vegetation commences, will answer. If the land is not subject to inundation it should be manured. If it is strong and cold, lime may be used to advantage, but if lime be put on light land to kill the weeds, the willows will be scabbed or cankered.

PLANTING.

In the choice of cuttings, or sets, care is taken that all are of the variety of willow wished, so that no poor or unknown sorts may be introduced. It is bad enough to sow an undesirable kind of corn or wheat; but in the case of willows, which last for many years and do not yield paying returns for several seasons, the consequences of failure to secure the best are much more serious. As a rule, in both France and Germany sets are made from 1-year-old rods. Experiments with 2-year cuttings have shown that these rods are probably

[a] The following account of the details of European osier culture is based on a study of the best works dealing with the subject in France, England, and Germany, and on personal observation on the ground. The principal French authority is Moitrier, whose "Traite pratique de la Culture de l'Osier" (Paris, 1855) is very valuable, but is composed only of a few practical suggestions. The small and rare book by William Scaling on English willow growing, "The cultivation of the willow or osier" (London, 1868), is, for its size, the most concise and practical of anything on the subject. The most detailed information concerning willow growing is to be found in the published reports of the investigations of certain German foresters. Foremost among these stands Krahe, who for many years gave his whole time to willow culture in the town of Prummern, near Aix la Chapelle—the heart of the oldest German willow-growing district—and whose "Lehrbuch der rationellen Korbweiden Cultur" (J. G. Krahe, Aachen, 1897) may be taken as an authority for the most advanced system of culture.

more vigorous and capable of sending out stronger roots and branches, but they are harder to get than 1-year-old cuttings, and more expensive. These drawbacks would probably fully equal the advantages which their use would give.

The rods intended for sets are cut during the period of rest before the sap has begun to move, when the bark and buds are least likely to be damaged in handling and planting. About the end of February or earlier, according to climate, is the best time. Only thrifty rods should be cut; these are put together in loose bundles and stored in a safe place, which should be without a draft of air and not too dry, to avoid evaporation and drying out the stems. Sometimes the sets are covered with sand and left out of doors; this is a good practice, but by no means absolutely necessary. Shortly before planting the rods are cut into the necessary lengths with a sharp knife (fig. 9) or with sharp pruning shears, but not with a hatchet, which compresses the wood fibers and injures the shoot. As the lower end of the rod, where it was cut from the stock, has probably died, it is well to cut off about an inch. The best length for the set is 12 inches. Pieces much shorter than this can not send out roots enough to support a healthy crop of rods, and longer ones generally die off at the lower end. Care is taken that a bud comes as near the upper end as possible, even if a difference of an inch or so in length must be made to bring this about. Not more than three sets should be made from one rod, unless it is a 2-year-old, when it may be used through the length of its first year's growth. In making into bundles the cuttings or sets are arranged with the buds pointing upward in their natural position. This greatly facilitates planting, which takes place as early as possible in the spring—in Germany generally during the first week in March.

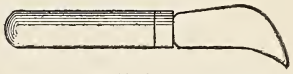

FIG. 9.—Knife for cutting sets.

The distance apart at which the cuttings are set has been the subject of much discussion. In France, England, Holland, Belgium, and parts of Germany near the Dutch and Belgian frontier from 35,000 to 81,000 plants per acre are used. In the neighborhood of Antwerp the number used is generally 121,000. In Germany the number formerly used seldom exceeded 25,000 per acre. Krahe first introduced the French system into his neighborhood, and his experiments in this direction brought some valuable facts to light. (See pp. 44–6.) It has been quite clearly shown that 81,000 plants to the acre give a better yield than any other, but such a method requires intensive culture and a ready market. Weeding, hoeing, and other cultivation is very much more difficult, and entails a prohibitive cost for labor unless wages are low. A spacing of 18 by 6 inches is more generally used, equal to 58,000 plants per acre. (See Pl. VII, fig. 1.) At these distances the yield is excellent, and the rows are much easier to work. There is no doubt

that the distance in planting is the main factor in the quality of European osiers, and much of the inferiority of American stock is believed to be due to open planting and careless cultivation. A comparison of Pls. I to III, inclusive, with Pl. VII brings out this contrast very strongly.

If the holt is to work easily and look neat, the rows must be regular. On the continent of Europe a marking line is generally used, but in England an ingenious frame has been devised, which has proved very efficient on small areas (fig. 4, p. 22). This frame is made to plant four rows of willows 16 inches apart and 8 inches in the rows. It is constructed of 4-inch boards about three-fourths of an inch thick, so that it can bend with the inequalities of the soil. A A are boxes for holding the sets, and are crossed with wires every 6 inches to keep them steady. B B are the finders to give the distance from the last plants in the row, and C C two similar pieces giving the distance between the last row planted and the first row in the frame. D D are notches 8 inches apart, where the cuttings are to be pushed into the ground. The frame is intended for two persons to use, and will be found a much more expeditious method than planting by lines. With this frame, if the ground is in good condition, two boys can plant 4,000 cuttings per day.

There has been much discussion about the direction of the rows. Some have held that they should run from southeast to northwest, in order that the morning sun may shine along them, while the hot, parching western rays can not dry out the soil. The only point worth considering, however, is to take care, in planting on land which may be overflowed, to run the rows at right angles to the direction of the water.

Hand leathers are used in planting, and the sets are pressed into the ground perpendicularly their whole length, so that the top bud alone is above ground. Planting the entire set is of great importance for the subsequent development of the stool. Everything possible is done to keep it low and as much as possible underground, away from fungi, insects, and disease, and to lessen the tendency to branch and spread out, which is so fatal to the life of the stool. The cutting must always be set with the buds pointing upward, and this will be easy if the slips were properly bundled.

It is very important to replant where cuttings fail to sprout, not only to complete the holt but also to prevent any spots growing up in weeds or grass. This replanting can be done either in the autumn or in the spring when the sap is in motion. Sets are not used for this purpose, but an entire rod is taken and planted a foot in the ground. Its length will prevent its being overshadowed by its neighbors. It is carefully cut back at the next harvest.

WEEDING.

The great foe of the holt is weeds. If they once get the upper hand of the close-planted, deep-set cuttings, the whole labor will be for naught. In the first year the ground is gone over lightly with a hoe once or twice, and every weed removed. Willows must be cultivated earlier than other field plants, for it is difficult later to force a way through their thick branches. If close and deep planting exposes the young plants to dangers, it gives a compensating advantage by the heavier stand of rods, which crowds out intruding weeds.

CUTTING.

Upon nothing else does the strength and vitality of the holt so much depend as upon the time and method of cutting. Opponents of close planting assert that it exhausts the holts out of proportion to the increased yield. The advocates of the system deny this, and declare that it is not so much the exhaustion of the soil as continued cutting which decreases the longevity of the willow. The annual cutting back of a plant is the severest possible test of its endurance, and the shortness of life of a pollarded willow compared with one which is uncut gives ample proof of this. Whether open or close planting is used, this fact must be faced.

It is shown on page 45 that the annual harvest from a close-planted holt yields higher returns than those possible under any other system. From this it would seem that yearly cuttings pay handsomely, even at the expense of a short life for the stools. Krahe, however, advises that the life of the willow be prolonged as much as possible, and to this end lets the rods stand every fourth year. In this way both roots and stools get rest and new development, while the two-year rods cut the following season always find a ready market for basket frames and other uses. As annual cutting with speedy exhaustion of the holt and periodical rests with larger vitality are both financially successful, it lies with the individual to make his choice according to local conditions.

The proper time for harvesting the crop is from the middle of October to the beginning of April, the best period being from November to March. All other times are absolutely inadmissible. Whether salable or not, all the shoots of a newly established holt are cut the first year, and they should be cut as low as possible. If the ground has sunk about the sets the projecting part should be removed. This rule is strictly observed.

The shoots are taken off as close as possible to the stump. As a rule, a peculiarly shaped knife is used (fig. 1, p. 17), but great care is taken not to cut the shoot in a slanting direction. Fig. 10 shows an example of good and bad cutting. One shoot has been cut at an angle, and four buds have a chance to grow next year. This will make the original stock branchy. Such broad-branching stools grow poor-grade rods, and are more open to attacks from insects and decay. To keep the willow in good condition the rods must be cut squarely and close to the parent stool. For this reason a powerful pair of pruning shears makes the best implement.

FIG. 10.—Example of good and bad methods of cutting.

No shoots are left standing. Good and bad, all are removed and the stock left quite bare.

As a general thing the rods are sorted as they are cut, put into bundles of convenient size, and labeled according to their grade.

CULTIVATION AND FERTILIZATION OF THE HOLT.

If the stools are kept small by close cutting, a light shovel plow can be run through the rows without causing great damage to the roots. After the ground has lain some time in ridges and will break down, it should be run over lightly with a blunt harrow. This will cover the stools with earth, and protect them from decay and the attacks of insects. This method is not so expensive as hoeing, and is much more effective in exterminating the weeds. The roots are slightly disturbed, but the vigor imparted to them by working the ground more than offsets this disadvantage. If the stools are closely cut and kept compact, light plowing can be done for several years, even in a 20-inch row, and has the best results of any method of cultivation.

A plant which must yield such a quantity of wood as the willow, and which has such an extensive root system, must necessarily take much nourishment from the ground. For a time the fall of leaves meets this need; nevertheless, a good fertilizer is also necessary. The principal mineral constituents of the soil needed by the willow are phosphates, potash, and lime. These are well mixed with the soil, preferably at the preliminary cultivation before planting. The phosphates and potash can best be obtained from wood ashes; the lime should be slaked and well pulverized. For surface fertilization nitrogen is necessary; ordinary stable manure will supply this. A poor, sandy soil needs such treatment every three years; a good loam, only once in six.

Where the willow holts are overflowed, other manuring is unnecessary. Flooding in the spring or winter is very good for willows, but the ground should not be in a position to wash, and above all, the water should not stand after vegetation commences.

PEELING.

In Europe, with the exception of England, where willows are often steam-treated, the rods are almost invariably peeled mechanically in the sap. This may take place either in the winter or in the spring. In winter, peeling takes place in a large closed building, heated, preferably by steam, to a uniform temperature of 50°. In this room, which should not be light, large flat troughs are filled with water at the same temperature as the air to a depth of 2 inches or so. The willow bundles are stamped upon the ground to bring all the ends to the same level, and are then stood in the troughs, care being taken that the bundles do not press tightly against one another, which would cause fermentation. The tops are sprayed frequently with warm water. In a very short time the rods begin to sprout, and are ready for peeling.

This system is expensive and seldom practicable. Hence peeling is generally done in the spring, and out of doors. As soon as the earth and water have been thoroughly warmed, in April or May, the willow bundles are stood in little ponds, or "pits," about 2 inches deep, with gravel (not mud) bottoms. Small spaces left between the bundles permit the free circulation of air, while bars or wires placed at intervals over the pit keep the bundles upright. Only the ends of the rods are immersed, because the part in the water is likely to turn black.

In the warm spring air it does not take the willows long to sprout. After they are covered from top to bottom with green sprouts and the submerged ends have developed root hairs, the rods should be peeled within a week. It is well not to take bundles out of the water until needed for immediate use. The peeling is almost entirely by hand; machines have been tried, but as yet none have proved satisfactory.

In hand peeling the rod is drawn through some form of "brake" to loosen the bark. Of these brakes there are many forms. The simplest is made of some tough, elastic wood (fig. 2, No. 1, p. 19), driven into the ground, the laborer sitting before it. Such a tool is extremely primitive, and is used only when willows are grown on a very small scale. In many parts of Germany a hand brake is used. A very simple one of wood is shown in fig. 2, No. 3. The effectiveness and durability of this instrument is much enhanced by a heavy steel wire facing. A still more effective hand brake is made entirely of steel (fig. 2, No. 2). For large quantities of willow a well-constructed steel brake is necessary. There are several forms (fig. 2, Nos. 4, 5, 6, and 7), all of which are serviceable and easily worked.

Peeling on a large scale is usually done under a shed or awning raised near the pit. A long beam is run across the shed about 3 feet from the ground, and on this, at regular intervals, the brakes are perpendicularly inserted (Pl. V, fig. 1). After chopping off the blackened end the workman passes the rod through the brake, first holding the rod by the lower end to peel the tip and then reversing it in order to loosen the bark on the base. The rod is then passed back to a child or woman, who removes the loose bark with a small hand brake if it has not fallen away, gathers up the peeled osiers, and carries them to the drying racks.

CARE AFTER PEELING.

The drying racks are simply a series of light frames upon which the rods are laid to dry in the air. Rain and dew rob the osiers of their brilliant whiteness, hence it is advisable to keep them well above the ground and to have an awning or other covering available. It is absolutely necessary to turn the osiers often, so that the sun may dry them thoroughly. This should not take longer than two days; then they are put into loose bundles and stored on end in a clean shed or room, where they must stay about two weeks. They are then sorted according to quality and size, bound into tight bundles by means of a machine like that shown in Pl. VI, fig. 1, and stored in a room which should be kept as dark as possible.

Such is the method of the most advanced willow growers in Germany, and it may be taken as an example of the best European culture.

CLOSE PLANTING.

To show that planting as close as 60,000 to 80,000 plants per acre produces a much larger yield, and at the same time greatly improves the quality of the rods, Krahe published the figures given below. Growers in other parts of Germany had contended that such a method of planting was contrary to the nature of the tree, that the increased yield was secured at the expense of speedy exhaustion of the holt, that no great improvement in quality followed, and that the method was consequently unprofitable in the long run. Krahe planted five sample plats on fairly heavy soil of average quality with American green or almond willow, set at distances of 16 by 4 inches, 18 by 6 inches, 20 by 8 inches, 21.5 by 10 inches, and 23.5 by 12 inches. The following table shows the number of sets per acre, and the average number of rods produced per acre at each distance during the second, third, and fourth years, and also the average weight (green) produced during the second, third, fourth, and fifth years:

TABLE III.—*Close-planting production.*

[Average of second, third, and fourth years.]

Approximate distance apart.	Number of sets per acre.	Percentage of sets in 16 by 4 inch planting.	Number of rods per acre per year.	Percentage of rods from 16 by 4 inch planting.	Weight of rods per acre per year.	Percentage of weight from 16 by 4 inch planting.
		Per cent.		*Per cent.*	*Pounds.*	*Per cent.*
16 by 4 inches	101,000	100	628,908	100	40,080	100
18 by 6 inches	59,800	59	496,223	79	26,720	67
20 by 8 inches	40,400	40	354,775	60	19,303	48
21.5 by 10 inches	29,000	29	318,085	50	16,136	40
23.5 by 12 inches	22,400	22	284,031	45	13,479	34

This table shows that the yield per acre during the early years of the life of the holt is increased by close planting, though not in proportion to the increase in the number of plants. It is the comparative yield of the later years, however, under the two methods, which is needed to show conclusively which will give the largest return, since the opponents of close planting hold that the increased yield is obtained at the expense of the early exhaustion of the plant. That a rapid decline in the amount produced does in fact take place is shown by Table IV, which gives the annual value for twenty years of the product of almond willows planted at intervals of 17 by 5 inches, or 81,000 to the acre. The willow was sold on the stock in the open market, and yielded returns as follows:

TABLE IV.—*Annual returns from close-planted willows.*

Year.	Return per acre.	Year.	Return per acre.
First	$24.99	Thirteenth	$45.69
Second	67.59	Fourteenth	18.56
Third	73.78	Fifteenth	18.08
Fourth	64.26	Sixteenth	14.28
Average return during first four-year period	57.65	Average return during fourth four-year period	24.15
Fifth	60.69	Seventeenth	17.61
Sixth	55.21	Eighteenth	15.94
Seventh	44.98	Nineteenth	27.60
Eighth	63.78	Twentieth	11.66
Average return during second four-year period	56.16	Average return during fifth four-year period	18.20
Ninth	39.74	Average for the first twelve years.	50.60
Tenth	40.02		
Eleventh	41.88		
Twelfth	30.22		
Average return during third four-year period	37.97		

Table IV proves that for at least twelve years a good return can be expected from close planting, and that the proportionately higher yield of rods lasts for a sufficient time to make this system advisable. These facts seem to argue conclusively for the principle of close planting and low cutting; but it must never be forgotten that such a system involves intensive cultivation. Much labor is required to weed and work the soil, and the increased number of stools raises both the initial expense of founding the holt and that of the subsequent tending and harvesting. It also shortens the life of the holt. The principle, however, is unassailable, and should be applied just as far as economic conditions permit.

VITALITY OF THE HOLT.

Although no accurate table is available to show the vitality of a willow holt planted with the stocks wide apart, there is no doubt that close planting rapidly exhausts the holt. It does not follow, however, that this is because the soil is exhausted. In comparison with field crops, trees draw little from the soil. Willows planted without further fertilization on the land of an exhausted holt have yielded the same returns as those of their predecessors in their most vigorous years. For this reason the small additional loss of plant food occasioned by close planting must be ignored, and the real cause of decline sought in the treatment of the stock itself.

Cutting back the entire leaf system of a plant brings about an abnormal condition. The root system develops out of all proportion to the rest of the plant, and in the spring a far greater quantity of sap is taken up than can be assimilated. This, coupled with the exhaustion which follows continued cutting, leads to a general degeneration of the stool. To this comes the danger from insects and fungi, which always attack the cut surface and bark of naked stumps. This is why stools must be kept as compact and close to the ground as possible. Close-planted stools are necessarily smaller and show less tendency to spread, because of their fewer and more erect rods—another argument in favor of this system of planting and cutting.

It has been found that the more a willow species tends to develop into a tree the less tolerant it is to coppice treatment, while those willows which are naturally shrubs can stand a long series of cuttings. For this reason American green or almond willow is soonest exhausted; then follow the Caspian or Lemley, the common white osier, the Welsh or purple willow crossed with the white osier, and, longest of all, the Welsh or purple willow. The regularly cut willow, of every variety, lasts longest on heavy soil, and the shortest time on peaty moor.

Most expert willow growers are unanimous in advocating a periodical rest from cutting. By permitting the willows to grow undisturbed

for two seasons at fixed intervals a more normal relation between the root system and the branches is established. In this way the plants become more healthy and gather energy for the succeeding crops. Nor is this done at a loss. Heavy rods are necessary for basket frames and in the manufacture of furniture, bringing in a return which fully covers the loss of a year's crop. The following table shows very clearly the advantage of an occasional year of rest:

TABLE 5.—*Increased return from 10.7 acres after one year's rest.*

1864	$595.00	1869	$342.85
1865	919.52	1870	165.70
1866	900.00	1871	135.72
1867	768.57	1872	Not cut.
1868	435.71	1873	361.90

The vitality of the holt, however, does not depend merely on occasional rests. Much depends on the methods of cultivation and management. The grower should always bear in mind the following points:

(1) Nothing is more detrimental to the holt than a growth of grass and weeds. Thorough weeding and cultivation are of the first importance.

(2) The time and method of cutting is a matter of great importance. Care must be taken to cut the rods in the manner already described, and every effort must be made to keep the stools compact and close to the ground. The willow must on no account be cut at any other time than during the season of rest from growth, and the stool must always be completely cleared of rods.

(3) The holt should be occasionally manured or flooded. Some writers recommend spreading the bark over the holt. This serves the double purpose of fertilization and smothering the weeds.

The profitable life of a well-tended holt should be fifteen to twenty years. In very favorable circumstances and under good care holts have been known to pay for forty years.

RELATION OF SPECIES TO SOIL.

The choice of species depends on varying circumstances of soil con ditions, vitality of the species, method of culture, and quality of rod desired. Very accurate results obtained from growing the principal willows on different soils have been given by Krahe in the table following.

TABLE VI.—*Average annual yield per acre of willow cut at 1, 2, 3, 4, and 6 years.*

Species.	Good wheat land.	Clay loam (low meadow land).	Poor clay soil.	Good sandy soil.	Poor sandy soil.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
White willow (*Salix viminalis*)	13,816	33,150	5,698	14,102	10,186
American green or almond willow (*S. amygdalina*)	14,647	26,774	9,836	14,894	7,986
Hybrid (*S. purpurea* × *viminalis*)	8,316	21,758	8,822	13,332	7,832
Welsh or purple willow (*S. purpurea*)	9,328	16,588	6,270	12,672	7,260
Lemley, patent Lemley, or Caspian willow (*S. pruinosa acutifolia*)	11,484	6,534	4,576	12,958	7,194

Each acre was set with 64,750 plants. The weight is that of the green, unpeeled rods.

The "good wheat land" is ordinary farming soil.

The "clay loam" is heavy meadow land, which is rich in humus, but also contains enough bog iron and phosphoric acid to make the grass poor fodder.

The "poor clay soil" is a mixture of clay, poor in humus, loam, and sand, so hard at a depth of 1½ feet that it was scarcely to be broken with a mattock.

The "good sandy soil" is well-worked sand and gravel mixed with earth rich in humus.

The "bad sandy soil" is composed of ferruginous sand and gravel mixed with a very small quantity of loam. At a short distance from the surface there is an impenetrable stratum of ferruginous clay. Three or four inches of poor wheat soil was spread over the bad sandy land. It stands on an elevation, and is exposed to the burning sun.

One of the most noticeable facts developed in this table is the greater yield on otherwise useless soil than on regular farm land. This is a fact of great importance for willow culture, provided it is not pushed too far. A glance at the yield on really bad land shows that the adaptability of the willow has its limits.

Of all willows the white osier (*S. viminalis*) is the most consistent in its yield, although it is pressed close by almond or American green (*S. amygdalina*). The other three species are scarcely to be compared with the first two, although they have their undoubted value under certain conditions.

A further consideration in the choice of the willow is the proportion of bark to the wood. This proportion is as follows:

TABLE VII.—*Proportion of wood and bark in different willows.*

Species.	Wood.	Bark.
	Per cent.	*Per cent.*
American green or almond willow (*Salix amygdalina*)	51.30	48.70
Lemley, patent Lemley, or Caspian willow (*S. pruinosa acutifolia*)	45.50	54.50
Hybrid (*S. purpurea* × *viminalis*)	42.40	57.60
Welsh or purple willow (*S. purpurea*)	42.15	57.85
White willow (*S. viminalis*)	41.85	58.15

Remembering that the results in Table VI were for green unpeeled rods, Table VII puts almond willow (*S. amygdalina*) in a more favorable light than ever.

EUROPEAN SPECIES USED FOR OSIERS.

It has already been said that in France only three or four varieties of willows are grown, and that the culture of these has been raised to a very high stage of perfection. The principal varieties of basket

willows are: The American green or almond willow (*S. amygdalina*), the white willow (*S. viminalis*), the Welsh or purple willow (*S. purpurea*), a hybrid, *S. purpurea* × *viminalis*, and the Caspian or Lemley willow (*S. pruinosa acutifolia*).

Of the 92 varieties of willow and hybrids known to European culture, those just given are the only ones worthy of consideration. It is worth while to describe them in some detail.

(1) *Common white osier* (*Salix viminalis*, Pl. XII).—This willow is one of the best known and most widespread varieties. In the soil best suited to it it holds its vitality a very long time, and Table VI shows that it is under nearly all conditions the most adaptable of all the species. This willow has been found to pay best where the demand is for unpeeled rods. For peeled willow the rods of other kinds are more sought for because, although the white osier has long, slender shoots, which do not tend to branch, the color of the peeled rod is not so brilliant as that of amygdalina, for instance, while the wood is less durable in basket ware than that of other willows. In spite of these faults the sustained yield, vitality, and clean rod of this willow will always hold it in the foremost rank. It has not been generally introduced in America.

(2) Of late years the almond willow (*Salix amygdalina*, Pl. I, fig. 2, and fig. 8, p. 28) has come much into vogue. It is the most widely cultivated willow in the north of France, and is much used in England and Germany. The growers in the Baltimore and Pennsylvania regions also grow it under the name American green. There are good reasons for its popularity. In productiveness it almost equals *S. viminalis*. At the same time the wood is strong and heavy, so that basket ware made from it is very durable—an important point in competition with rattan. It is also easily bent, tough, and not difficult to split, and its color is a brilliant white. Yet it is just as easily used for coarse work as for fine, and for "brown" or unpeeled as for peeled basket ware. Some of the shoots are heavy enough to be used for the heaviest baskets; others are good for fine workmanship. Although *S. amygdalina* prefers a heavy land, it does well also on sandy soil. It demands, however, a soil full of nourishment. It has the heaviest foliage of all willows. This great leaf area makes vigorous growth possible, and in the fall covers the earth with litter. Consequently weeds have the least chance to grow, while the heavy shade keeps the ground fresh and unburnt. One of the most serious faults of this willow is a tendency to branch. Certain varieties show this peculiarity less than others, which close planting reduces to a minimum. It is also more sensitive to damage by hail than any other willow, wart-like excrescences or black spots forming on the spots struck by hailstones. This, however, is not peculiar to *S. amygdalina*. *S. viminalis* suffers in like manner, as do most other species.

(3) *Welsh or purple willow* (*Salix purpurea*, Pl. II, fig. 1, and fig. 6, p. 26)—This is perhaps the most beautiful of all the willows. It produces a large number of supple, slender, and even-sized shoots, with no tendency to branch. It grows slowly, however, and never attains a great size. The rods are very difficult to peel, and the wood is extremely hard, of a bad color, and not easily split. The ground most suited to its growth is a fresh sandy loam with considerable humus. On heavy land it does poorly. The purple is the hardiest osier known. Cold and heat, wet and excessive drought—all these extremes have less effect on its growth than on any other member of the willow family. It is also a good cropper; holts have often been cut forty years.

In spite of these advantages, however, its cultivation is seldom advisable. The returns even under the most favorable conditions are far below either the common white osier or almond, and a full harvest of rods is not obtained until the fourth year. This is the most commonly grown willow in America, under the name of Welsh willow.

(4) In the hybrid *Salix viminalis* × *purpurea* an attempt has been made to combine the good points of these two species. The experiment has been most successful. The numerous shoots are as slender and smooth as the purple willow, and on good soil they grow to the size of the common white osier. The wood is tough and sufficiently hard; it peels well, but takes on later a rather dark color. At the same time the holt has almost the vitality of purple willow. Because of these advantages the willow is often grown, and the rods are in good demand from the basket makers. This osier will be introduced into America and tested in the field experiments of the Bureau of Forestry.

(5) *Lemley or Caspian willow* (*Salix pruinosa acutifolia*, fig. 7, p. 27).—This has been much recommended for planting on sandy soil, where it was said to do better than any other willow. Table VI does not show such a result, but it is a serviceable species and gives good rods, which peel well and are white. With its hybrid, the patent Lemley, it is common and highly valued in parts of the willow-growing district of America.

MANUFACTURE OF WILLOW WARE IN THE UNITED STATES.

GENERAL REMARKS.

In Europe to-day every grade of basket, from the finest to the coarsest, is made of willow, and of almost nothing else.[a] The heaviest farm baskets and receptacles used for handling rough merchandise are made out of unpeeled willow, and from this its use extends through all the grades of basket ware—peeled willow market, clothes, and fruit

[a] A very small quantity of wooden-strip baskets is manufactured in Sweden and Norway.

baskets, furniture, hampers, and trunks, to the finest examples of split willow ware, wrought with a skill which gives them a real artistic value.

In America the market has a different aspect. Here a very large number of baskets are made of wood, some of woven pine, oak, ash, and elm strips, others constructed from broad veneers laid together at the bottom and fastened at the rim by a strip. Market, clothes, and laundry baskets all are made of wood, and the willow is forced to be content with a limited share of the general trade. Rattan, too, has always enjoyed a high degree of favor, and has a permanent place in the American market. Baskets made from wood other than willow are much less durable and have not the combined lightness and elasticity which is so desirable. Rattan is quite as lasting as willow, but it is less rigid, and its rough surface soils quickly. It is also much more expensive.

Since baskets made of other wood are less durable than those made of willow, they can be sold at a profit only when they are enough cheaper to offset the difference in quality. In Europe ash, oak, elm, and rattan are relatively expensive, and as willow can be grown at a small cost under an intensive agricultural system and peeled by hand cheaply where wages are low, the prepared oak or ash stock can not be put on the market at a much lower price than the osier rods. Of course oak or ash splints, being large and easily manipulated, are much easier to weave into baskets, but where such stock is dear and labor cheap this advantage is more than offset.

Rattan is very much dearer than willow in Europe, and for this reason can enter into competition with it only where its superiority is apparent. This is only in extremely heavy shipping crates and baskets.

On this continent, where economy of labor is of the first importance, the manufacture of those baskets intended to be filled but once, such as fruit baskets, etc., forms a class by itself, which lies necessarily entirely outside the field of the willow. In their case cheapness is the only essential, and the preparation of the material is entirely done by automatic machinery, while the hand process of manufacture is the simplest imaginable. Indeed, a recent machine has entirely supplanted hand labor and reduced the cost tremendously.

In those baskets intended for lasting use the parts must be woven and put together carefully by hand.[a] In the case of wooden baskets, however, the cost of the preliminary preparation of the stock has been reduced to the lowest figure by the invention of intricate machinery to split, trim, and otherwise make ready in large quantities the oak, elm, ash, and hickory strips. Putting such material together is a simple

[a] Some wooden-strip baskets are woven by machinery and then built up by hand.

process, and if the product were as durable as it is cheap, no other ware could enter the market. The nearer willow baskets approach in quality the wooden ones, the harder their struggle for a place, particularly as the wooden basket has an ally in the cheap import from Europe. This import is not a growing one, but it is still large and keenly felt by a certain class of home manufacturers. High-grade willow ware has also a rival in the form of rattan. This material is mostly used for heavy crates, hampers, and large baskets, where stout frames can be used to insure the rigidity which rattan lacks. To secure this, willow is also mixed with the rattan. In such heavy basket ware rattan is undoubtedly a competitor of willow, and its competition is made much more formidable by the fact that it is easier to work.

WICKER FURNITURE.

For many years huge quantities of rattan have been used in the manufacture of furniture. In consequence a high degree of skill has been evolved, and the designs have become more and more elaborate. Willow is less easy to work, the result being that furniture made from it has greater simplicity of design. This, together with its durability, lightness, and beautiful color, has brought it into popular favor, and many important manufacturers have given up rattan entirely and gone over to willow. As a consequence the output has increased more than 100 per cent in the last ten years. It is worth to-day more than $150,000 per annum.

The manufacture of willow furniture requires a high degree of skill. The lower cost of the willow is neutralized by the greater difficulty in working it, so that the two kinds of furniture enter the market on equal terms. Willow furniture is also made in Europe, but it is bulky and the transportation is very costly. As a result the import is not worth considering.

The industry in America is centered in New York and Boston. There are small concerns in various other places, but all the wholesale supply comes from a few large houses in these two cities. Wages are as high as $20 a week, but most of the workmen are foreigners: few young Americans adopt the trade, although really first-class men can always find work even at $3 per day. If the industry increases as it gives promise to, one of the greatest problems will be that of skilled labor.

Yet the question of the raw material is of even greater economic importance. At present all furniture makers use far more French willow than they do American. There are several reasons for this. The French osier is of a much more beautiful color, is more pliant and easily worked, and is better sorted and easier to get in small sizes. The American is sorted and packed with less care, and the rods are

apt to be large, the average grower not appreciating the value of small stock. The latter is more difficult to peel, and consequently more expensive to produce. As a result it is generally discarded, although there are growers who supply small rods at cost price just for the sake of the trade. Apart from this, American willows are less consistently good, more branchy, and often seriously damaged by insects.

Further, there is the question of price. The French willow costs as follows, per bundle of 50 pounds, in cities on the Atlantic coast:

Small-sized rods	$3.75
Medium-sized rods	3.25
Large-sized rods	3.00
Extra-sized rods	2.75

The average price is thus about 6⅜ cents per pound. American willow of the best quality also comes in four sizes, and is sold at from 6 to 6½ cents a pound. The smallest size is hard to get, and the other sizes are not satisfactorily sorted. The chief objection, however, is that American willows are sold almost immediately upon peeling, and are not thoroughly dried out. As a result the buyer pays for considerable water in his stock. Thereafter he finds his willow growing continually lighter. Twenty per cent of the weight is said to be thus lost before the osiers are fully dry.

In spite of all this, the use of the American rod is slowly increasing. The willow grown here is heavy and durable, and such varieties as the Lemley and American green are eminently adapted to fine work. If the growers in Maryland and Pennsylvania knew their market better they would undoubtedly increase their sales. The fact that the American willow dries after it is received is because the whole crop is bought up immediately after peeling. If a larger quantity were produced, the crop could be held longer and this difficulty would be obviated.

Remembering that American willow is favorably looked upon by furniture makers and that most of their objections can be removed by greater care in its culture, every effort should be made to obtain possession of this most favorable market.

HIGH-GRADE WILLOW BASKET WARE.

The makers of high-grade willow basket ware are generally in the larger cities, and as a rule are naturalized foreigners, who through thrift, industry, and perseverance have built up a regular custom trade. Their establishments are found throughout the North, from the Atlantic to the great cities of the Mississippi. High wages in the far West make it more profitable to buy in the East, although there are several establishments in San Francisco and Sacramento. In the South, where large cities are fewer, such basket makers are to be found only in Richmond, Charleston, and New Orleans.

Almost without exception these workmen make no attempt to compete with the manufacturers of cheaper baskets, and confine themselves entirely to the production of goods for their particular customers. The present duty on foreign basket ware is 30 per cent, and with this protection Europe can not supply a similar basket at the same price. Hence the only competitor of this grade of basket is rattan, which is almost exclusively used for heavy shipping crates, large baskets for merchandise, and such purposes, and because of its durability can never be supplanted by the willow. Lighter crates, trunks, and clothes baskets are made of rattan, generally mixed with willow to give rigidity. In this direction the willow should gain ground if it can be produced in this country more cheaply and of a better quality than now.

One of the most serious questions which this phase of basket making must contend with is labor. Even in New York and Boston difficulty is found in getting good men at the wages which the basket maker can pay, and the farther west one goes the greater is the lack of good hands. The men available are nearly all foreigners, mostly Germans. Occasionally American-born workmen are to be found, but the long hours and comparatively small wages ($2 a day is a maximum) drive young men into other and more attractive fields. Throughout the country there is many a master basket maker who could enlarge his trade if he could secure more labor. As it is, he must be content to hold what custom he has.

The source of supply of raw material varies in different parts of the country. In the East both foreign and domestic osiers are largely used. The large furniture makers of Boston and New York also manufacture baskets, and for their best wares use French stock. This is done for the same reasons as those given in the case of willow furniture. Nevertheless, they all use American willow, and say they would use more if they could buy it, as it is heavier and more durable than the French. All willow used for fine baskets, and still more so for furniture, must be brilliant white, and for this reason only sap-peeled rods are to be considered. The foreign willow at present has a better color, but for basket ware American sap-peeled willow is white enough, and if it is properly sorted, not branchy, and with long, straight rods, it answers every purpose of the trade. Apart from the furniture makers there are many flourishing establishments in New York, Boston, and Philadelphia which use far more foreign willow than American. Yet these men are almost unanimous in preferring home-grown willow, if they can get it of uniform quality and in sufficient quantity at all times. They complain chiefly that it is only to be got immediately after peeling in the spring. They then lose by its subsequent drying, and if they run out of stock are compelled to buy the foreign, which is always uniform and well sorted, and always in the market.

There is no reason why the custom trade of the great Eastern cities should not be supplied by home growers who take the time to improve their methods. Baltimore is the seat of a large number of expert basket makers, who are almost entirely supplied by the willow growers of the neighborhood. Richmond is supplied by an establishment which has taken the wise step of growing its own willows, and with the most gratifying result. Indeed, these two towns, with their supply of raw material near at hand, are able to ship high-grade baskets to other parts of the country, and afford a very instructive example of what may be done in this line. Another such town is York, Pa., which is the center of a willow-growing district, and which ships a considerable amount of good basket ware to other places.

As one travels farther west the transportation cost raises the price of foreign willows, so that even in Cincinnati it stands at 7 to 8 cents a pound. As the best native stock of the neighborhood costs but 6½ cents, and lower grades only 4 or 5 cents, it needs only quality to command the field. About Indiana, Ohio, and Kentucky the question is entirely one of better growing and a successful contest with dangerous insect pests. A few years ago the best willows sold at 3 cents a pound, but now can hardly be bought at 6. Some of the larger basket makers in St. Louis use French rods, but the vast majority of the stock comes from the neighboring willow-growing States, and even from Baltimore. Chicago is supplied with a very good willow from Wadsworth, Ill., and from Indiana and Kentucky. The same is true of Milwaukee and other cities in the same district. One and all, the basket makers seem to prefer the solid American willow if they can get it clean and well grown.

In the far South and on the Pacific coast no willows are grown to speak of, and as French willow enters the East at the same price as American rods the transportation cost is the same for both to these distant places. For this reason quality is the only consideration, and we find considerable quantities of French willow used in California and New Orleans. Of late, however, the willow from Indiana, Ohio, and Kentucky is known, and would be preferred if its quality were better.

The custom-made basket has a steady market throughout the country. If the basket maker can get good stock at a low price there is no doubt but that he can enlarge his trade. For this reason there is a promising outlook for scientific willow culture.

Apart from the basket here dealt with there is also a steady demand for an elaborately finished article. This is a product of the highest skill of the basket maker, and can not be produced in America at a salable price. For this reason such wares will always have to be imported. A less ornate, but similar and equally serviceable basket, is made in many cities in this country.

LOW-GRADE WILLOW BASKET WARE.

The best quality of willow basket, it has been seen, has scarcely a competitor in the field. The demand for such goods, however, is comparatively limited; the great mass of the population are either unable or unwilling to pay a high price for household basket ware. It is to satisfy this demand that the wooden basket exists and has so large a sale. Nevertheless, willow is known to be so superior to it for hand baskets, clothes baskets, hampers, etc., that people will buy it in preference if its price reaches a figure which represents, in comparison with the cheaper forms of basket ware, the ratio of durability between the two. To bring prices to this level has been the attempt of a large section of the basket-making population for many years, and upon them alone falls the brunt of the competition with wooden baskets, and also with the cheap willow product imported from Europe.

In order to gain a clear view of the situation it is necessary to divide the manufacture of cheap willow baskets into two sections. The first of these is the wholesale basket industry in western New York State, and the second the manufacture of cheap baskets in small isolated establishments in the great cities and throughout the country.

The basket industry about Syracuse, Rochester, and other western New York cities is different from that in any other part of America, and more nearly approaches that of certain sections of Europe. It is centered in the midst of an important willow-growing district, and is mainly in the hands of a few large dealers. These men buy the willows and give them out to the basket makers, who make them up into baskets at home, receiving a specified sum per dozen, according to size. The principal object in view is cheapness, and everything is done to reduce the cost to a minimum. The willows are steam peeled, a process which very much reduces the price, but which turns the rods a red-brown color and ruins them for all manner of fine work. The basket makers are nearly all German immigrants, who are accustomed to the most frugal living and continued labor. Everyone in the family works at least twelve hours a day; even the children are compelled to spend much of their time out of school hours in the shop. Some who are better situated own land and grow their own willows, peel them, and make them into baskets. These, however, sell to the same dealers, and only gain an extra amount equal to the profit of their willow growing. By this intense system of labor a very cheap basket is produced, but the whole situation savors very strongly of European conditions rather than American. If the cost of living were correspondingly cheap all might be well, but it is not, and therein lies the struggle. There is no doubt whatever that it is European competition which sets the price of this basket ware, and which has reduced the New York basket industry to such a low margin of profit that its very existence

is threatened. Certain large importing houses in New York have buyers continually in Europe, who procure large quantities of cheap wares at every opportunity. These baskets can be compactly stored and shipped at low rates, the import duty paid, and the goods put on the American market at a phenomenally low price. Every large order for baskets throughout the country is known to these New York importers, and their low offer always commands attention. An average-sized foreign clothes basket can be put on the market at $4 per dozen, and the American maker must meet this price. The following table shows how this is done:

TABLE VIII.—*Cost of clothes baskets from one ton of willow.*[a]

Green rods	$15.00
Transportation	1.50
Steaming	1.50
Stripping	7.00
Total cost of prepared rods	25.00
Manufacturing 16 dozen baskets, at $1.80 per dozen	28.80
Total cost of baskets	53.80
Cost of 1 dozen baskets	3.36
Selling price of 1 dozen baskets	4.00
Profit on 1 dozen baskets	.64

No one can claim that 64 cents a dozen for clothes baskets is a large profit, yet a greater sum is not to be expected as a regular condition of the trade.

How does the workman fare under these conditions? The average cost of making has been estimated at $1.80 per dozen. As the best workman can make but six dozen per week, his wages for that time amount to $10.80, and this by working ten to twelve hours daily. A medium man makes but four dozen a week, which sets his wages at $7.20. When a whole family works a comfortable living can be made, and many of the frugal German families of basket makers seem in thrifty circumstances, but only those bred under European conditions are content with such a life. The younger generation almost invariably wanders away to other labor and conditions more genuinely American. Of course there are American families engaged in basket making, and there are others who grow their own willows and make a good living, but they are comparatively scarce, and even then are governed by the low prices on all sorts of basket ware. In waste baskets America can hardly compete at all, and in the case of hampers, trunks, and all other forms of cheap articles the relative price is not better than in the case of the clothes basket.

[a] Liverpool, N.Y.

The competition of the foreign basket is illustrated by the case of the willow growers and dealers of Syracuse, who about fifteen years ago, favored by the cheap price of willows, formed themselves into a stock company and began to assume control of the trade in America. Immediately the importers bought up a large stock of cheap baskets in Europe, underbid the American combination, and deprived them of their sales. The large number of baskets left over in the warehouse at Liverpool was set on fire—probably by those who feared for their next year's work—and since that time no attempt has been made at combination. To make matters worse, at that time the willows were sadly devastated by insects and the price of the raw material was consequently very much increased.

Although the import of foreign baskets sets the price of the American-made product, this import itself is not a growing one. The whole consumption of basket ware in America is not increasing, and besides, the foreign basket, to sell at so small a price as it does, must necessarily be of very low quality. For this reason it has lost favor, and the American basket is beginning slowly to assert itself. Certain basket makers even in the New York district sell their product for much more than the European basket ware brings. This is an approach to the class of the high-grade basket, but as yet the tendency is not marked; the great mass of the workmen are in active competition with the European product, because, even if it is not largely imported, it is always overhanging the market and preventing any rise in price. Nor is this the only depressing force which the cheap American basket must face in seeking a market. Certain grades of wooden baskets actively encroach on its field. Huge quantities of covered hand baskets are made of splints at a very low cost, and have a large sale. A wooden "satchel basket" can be bought for 70 cents, while a willow one of equal capacity costs $1.25 to $1.50. The willow basket is much more durable than the wooden one, but not enough so to make up for the difference in price. This is the case not only with hand baskets, but also with clothes, market, and bushel baskets. It may safely be said that the entire decrease in the willow basket output since 1890 has gone to swell the sales of the same article made of wood.

Nevertheless, the cheap grade of willow basket has a regular place in the market, and one necessary to the general trade. A reduction in the cost of the raw material would allow the dealer to pay a better price for making the baskets. Nor need this reduction in the cost of the raw material be carried out at the expense of the farmer. More scientific methods, a greater yield per acre, and a better knowledge of his market will give him a larger profit on his willows in the increased demand.

Although nowhere else is there so large a center as in western New York, there are basket makers scattered through the country dis-

tricts of Pennsylvania and the Middle Western States as far as the Mississippi. These work under very much the same conditions as their colleagues in New York, using, as a rule, however, sap-peeled willow. Apart from a small sale in their neighborhood they all sell to the nearest large city, and here they invariably meet the French or German basket on sadly unequal terms. In Cincinnati, for instance, the large dealers can afford to sell a "nest" of four foreign baskets (three pecks, a half-bushel, a trifle more than a peck, and a half-peck) at 64 cents, while the American maker loses money by selling better made baskets for less than 90 cents, although he is compelled to sell at this price if he sells at all. Thus it is throughout the country.

In all the large towns small basket makers are found who sell low-grade baskets at a very low price. They are almost always foreigners who live in the simplest way and in the smallest space possible. Their material they obtain as cheaply as they can, and with the help of their whole families and by working long hours they are able to produce baskets which they sell in their neighborhood or peddle in the streets, probably making a very good profit. From this laborious, frugal class of foreigners have come nine out of ten of the successful, well-to-do master basket makers.

UNPEELED WILLOW BASKETS.

There is much too little heavy basket ware of unpeeled willow used in America.[a] Of course such material would enter into direct competition with the splint basket of oak or ash, but it is almost certain that large commission merchants and wholesale dealers in fruit and vegetables would be glad of a heavy, strong, and reasonably cheap willow basket of this kind. At the present time unpeeled willow can be bought (transportation included) at about $17 a ton. Under better methods of cultivation the price can be greatly reduced if willow growing becomes more common. As a ton of willows would make from 16 to 17 dozen average sized clothes baskets, the same amount should make about 20 dozen half-bushel baskets. Labor costs about $1.80 per dozen to make clothes baskets, and the same price would be a liberal estimate for the cost of making a dozen unpeeled willow bushel baskets. This makes the unpeeled willow basket cost about $2.65 per dozen wholesale, or about 28 cents apiece, inclusive of profit to the dealer. This is at a very low wage rate, but if the price of willow falls the difference can go to pay better wages. Nor should the grower object to lower prices. If he gets a greater crop per acre by improving his methods he can still secure his profit, while he must not forget that the future of willow growing in this country depends on better wages, without which only high-grade basket ware

[a] A small quantity is worked up on Long Island.

will be possible, and the market for willow will be correspondingly limited.

At 28 to 30 cents apiece such baskets should more than compete with other kinds. A glance at Pl. VI, fig. 2, gives a faint idea of the many uses of unpeeled willow ware in Europe. If farmers and wholesale vegetable and fruit merchants, grocers, etc., could be made to see the advantage of such baskets, there is a large field for their use without in any way coming into competition with the wooden fruit basket or shipping crate.

INDIAN WILLOW BASKET WARE.

The basket ware of the Indians of the Sierras, the Rockies, and Arizona and New Mexico, is unsurpassed in its quality. The work is done by the squaws, and centuries of experience has taught them just what species to use for each purpose, until the art has become highly perfected. Besides many other species of trees, shrubs, roots, and grass fibers, a great amount of willow is used for all grades of work, from the coarsest to the finest baskets. The only species of willow known to be used for these purposes is *Salix lasiolepis.*[a] The willow is almost always peeled and split before weaving.

The Indians of the eastern part of the United States did not reach the proficiency of their western relations. A great part of their basket work was made from split wood. They also used willow, however, and developed a very unique and attractive pattern.

Such work has great merit and can command a market, and the movement which is already commenced to encourage such work on the reservations and elsewhere is worthy of all the support which can be given to it.

SUGGESTIONS FOR BASKET MAKERS.

In Europe basket ware is used for many purposes practically unknown in this country. In dairies and bakeries on the Continent and in England, eggs, buns, rolls, etc., are displayed in very delicately woven shallow baskets of the finest kinds, which are very beautiful and make the store much more attractive than ordinary vessels. Grocers often use willow hampers for dried fruits, nuts, etc. The hampers are made with one side higher than the opposite, so that the wares can be better seen. The hamper is set on short feet to keep it off the ground.

In England great quantities of split willow ware are used. Screen doors and office window screens are beautifully fashioned in willow, and even hotel washstand splashers are made out of the same material. Beautiful little mats for hot dishes at table are also made from split willow, to say nothing of very dainty bread baskets.

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[a] Dr. C. Hart Merriam.

A half-bushel basket is made in England and Holland which is singularly durable for its weight. The bottom is arched, giving the whole basket great strength. Nurserymen ship their trees in baskets of unpeeled willow, the uprights of which project from the basket and are tied together over the top of the plant for its protection.

A very beautiful and light basket is made in Germany, with the sides formed simply of uprights strengthened by one or two single lines of weaving.

In England commercial travelers' sample boxes are made of willow, lined with waterproof leather or canvas, the corners and edges bound with rawhide. These trunks are very light, and are serviceable enough for almost any usage. Laundry hampers are also made on the same principle. Parcel trucks on the English railways are almost always of willow, and seem to render perfect service. Willow trunks and hampers are a feature of European traffic, and their use, particularly for suburban transportation, might become more general here.

INSECTS INJURIOUS TO BASKET WILLOW.

By F. H. Chittenden,
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GENERAL REMARKS.

Willows are especially subject to insect attack. In 1890 Dr. A. S. Packard[a] enumerated 186 species, and the writer has in manuscript a list of 380, affecting the genus Salix. A considerable proportion of the insect enemies of willow also infest the poplars, although most forms affect more or less particularly one or another of these trees.

Prominent among willow pests in recent years is the streaked cottonwood leaf-beetle, which, with some other forms, does periodical damage and sometimes occasions severe losses to basket willows. Among other destructive willow feeders are the larvæ of several species of sawflies, which injure shoots and trees by defoliation; while the larva of a related form, the willow-shoot sawfly, does injury to the shoots by gnawing rings around the young branches, causing them to wither, so that a field which they have attacked appears as though scorched by fire. Willow is also subject to the ravages of numerous kinds of caterpillars, some of which do serious damage. The trees are seldom much injured by wood-boring species, but there are two exceptions in the European willow curculio and poplar girdler. The bronze birch borer is also harmful to the willow, as are a few other species which more particularly affect poplar. Numbers of sucking insects, like bark-lice or scale insects and plant-lice, also at times do considerable injury, and many forms of gall-makers produce excrescences on various parts of the trees.

Before considering the insects which affect basket willows and the most serviceable methods of combating their ravages, it is desirable to call attention to what has been said elsewhere in this bulletin (p 20) concerning the advisability of selecting, for planting basket willow, land that can be inundated. The value of flooding as a means of destroying many species of insects is well known, and Mr. W. F. Hubbard's observations that willows growing on high land are much more subject to the attack of insects than those growing on land which has been inundated are particularly borne out by the writer's experience. Where the land can be completely covered by water for a week or

[a] Fifth Report U. S. Ent. Comm., pp. 557–600.

ten days, the insects will rise to the surface and be carried away with the receding water, so that comparatively few will have to be fought in the early spring, and consequently fewer during the entire season. Where the inundation is not complete the insects are likely to crawl up the stems of plants, trunks of trees, and similar objects, and thus survive to return to the fields as soon as they are dry.

THE IMPORTED WILLOW CURCULIO.

(*Cryptorhynchus lapathi* Linn.)

Perhaps the most serious menace to the culture of willow for the manufacture of baskets and similar wares, as well as for shade and ornamental purposes, is the imported willow curculio, also called poplar curculio. As its name indicates, it is an introduced species, and has already attracted considerable attention in the region which it has invaded.

This beetle is not unlike the common plum curculio, to which it is related. It is larger, however, measuring one-third of an inch or a little longer. The ground color is dull dark brown, nearly black,

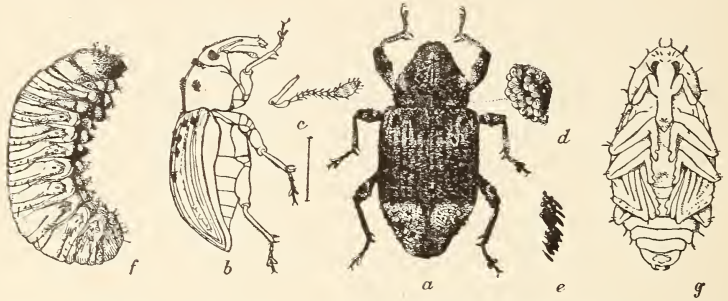

FIG. 11.—Imported willow curculio (*Cryptorhynchus lapathi*): *a*, beetle from above; *b*, beetle in outline; *c*, antenna; *d*, scales of thorax; *e*, scales from elytra; *f*, larva; *g*, pupa—*a*, *b*, *f*, *g*, 3½ times natural size; *c*, *d*, *e*, more enlarged (original, loaned by Bur. Entom.).

variegated above and below on the legs and thorax with yellow scales. These form a pattern more or less as figured (fig. 11, *a*, *b*). There is a band of variable extent between the base of the elytra and their middle, and another larger band covering the posterior third or more of the elytra. The snout is curved, as illustrated, and the femora are bidentate, or two-toothed, while the tibiæ are armed each with a terminal claw. The entire surface of the body is very deeply and strongly punctured, the punctures of the elytra being particularly large and deep and arranged in longitudinal rows.

The eggs are pale yellowish white in color, elongate-oval in form, and about twice as long as wide, the length being 1.5 mm.

The larva (*f*) is of the ordinary curved form of curculios, fleshy, white in color, and without legs, but with fairly distinct leg pads.

The head is large and pale brown, variegated with yellowish, with the mouth-parts and surrounding portions dark brown, nearly black. The pupa is white, like the larva.

The history of this species in America is interesting.[a] In the year 1882 Wilhelm Juelich found a single specimen on willow in Williamsbridge, New York City. This was the forerunner of injury in later years, the first announcement of the occurrence of the species in the United States not being made until five years later. From that time onward various persons have become interested in this species, and it has been given considerable study, since it has already shown itself to be a pest, and evidently destined to be more troublesome on this side of the Atlantic than on the other. It is common in Europe, and ranges through Siberia to Japan. It was probably introduced in the United States near Boston or New York, or possibly in both localities, and is now quite generally distributed through the Upper Austral life zone from Boston to Ashtabula and Painesville, Ohio. It has been known in Buffalo since 1896.[b] It attacks most if not all of the willows, as well as most poplars, birches, and alders.

FIG. 12.—Poplar branch showing work of larva and punctures made by willow curculio (near bottom at right); also beetles—natural size (original, loaned by Bureau of Entomology).

The life economy of the species is somewhat remarkable. It is generally conceded that a single generation is produced annually, but hibernation occurs in the three stages of larva, pupa, and imago. In Europe it has been observed that the sexes pair and oviposit in May, and pair again in September. According to Altum, the life cycle, although completed within twelve months, covers a portion of two calendar years. The larva as observed in Silesia first works under the bark, making flat chambers the first summer, and the next spring begins the excavation of a gallery in the wood, ascending in a steep passage directly into the sapwood; but before pupation the larva reverses its position and lies head downward in its burrow. According to the observation of Mr. A. H. Kirkland, in Massachusetts, the forming of pupal cells begins toward the end of June. Small larvæ

[a] An extensive account, with bibliography, is furnished by F. M. Webster, Journ. Columbus Hort. Soc., Vol. XVI, No. 4.

[b] It undoubtedly occurs also in Canada, and half-grown larvæ of what are probably this species have been received since this paper went to press, from Detroit, Mich.

pass the winter in the cambium, enter the wood in the spring, and make a rapid growth to maturity. The base of trees is a favorite point of attack. In October it was noticed that eggs were being deposited in cavities in the bark at the base of young branches. The parent beetle gouges out a hole for each egg, and leaves from one to four in a spot. From these the larvæ hatch and winter, as described (see figure 12).

METHODS OF CONTROL.

An ichneumon fly, *Ephialtes irritator* Fab., and a braconid parasite, *Eurogastra hartii* Ashm., have been discovered destroying this species. Possibly in the course of time other natural enemies will be found, and we may hope for some assistance from them in reducing the numbers of the pest. Otherwise it is feared that nature will have to take her course, as with other insects which are practically beyond the control of man. The fact that the young larvæ develop late in the fall makes it difficult to check infestation the first season; it is not until the next year, as a rule, that affected trees are discovered, so that it is not practicable to burn them when first attacked. The only thing to do is to cut out and destroy all affected trees as fast as they are discovered. Possibly some of the many deterrent washes that have been suggested for other borers, such as kerosene emulsion and soap solutions, may deter the insect from attack. Nursery trees, which are peculiarly subject to injury, can be protected to a considerable extent by means of mechanical barriers, such as newspapers placed about the bases, that being the principal point of attack by the female when depositing her eggs. Above this point deterrent washes may be applied.

THE POPLAR GIRDLER.

(*Saperda concolor* Lec.)

Among the number of boring insects which affect poplar, and less seldom willow, the poplar girdler is, when numerous, a decided pest. Fortunately, although widely distributed, it is not as a rule especially abundant save in exceptional seasons. The beetle, which belongs to the same group as the injurious round-headed borer of the apple tree, is of a nearly uniform gray color, with moderately long annulate antennæ. It measures a little less than half an inch, and is of the form illustrated in figure 13. Its distribution extends from New England and Canada to Minnesota, and southward to Texas. The principal form of injury is to saplings, and is twofold. First, the beetle makes longitudinal incisions through the bark with her mandibles for the deposition of her eggs. Several such incisions will frequently cause the death of a tree the following year. The second form of injury is due to the larva

girdling the trunks by mining under the bark and causing rough annular swellings or galls, sometimes half the diameter of the tree. This form of attack causes the decay of the trunk at this point, and also frequently results in the death of the tree.[a] Many willow rods are thus destroyed. *Salix longifolia* and *S. discolor* are among the insect's favorite food plants, and small rods varying from one-fourth to three-fourths of an inch in diameter are usually selected for breeding purposes. It has been predicted of this species that if its habits are perpetuated it will probably prove in time to be a formidable enemy to both willow and poplar. The presence of these borers in willow may be detected by discolored blotches on the bark, accompanied by little piles of castings which are extruded during boring operations. Where observed, the beetles appear throughout the month of May and at least to the middle of June.

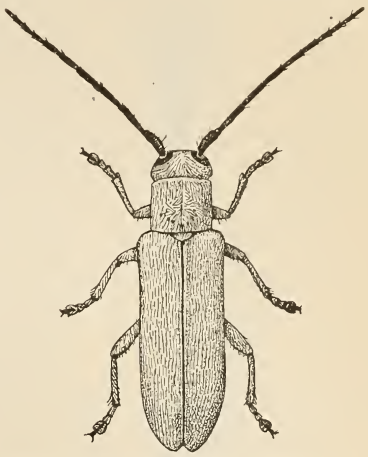

FIG. 13.—The poplar girdler (*Saperda concolor*)—enlarged (original, loaned by Bureau of Entomology).

It is fortunate that this species is not more abundant, since, like most borers, it is difficult to control. The larvæ, however, can be killed by inserting a pliable wire into the holes, but it is usually better to remove and burn the infested rods. Keeping the trees in thrifty condition will assist in enabling them to develop in spite of borer attack.

THE BRONZE BIRCH BORER.

(*Agrilus anxius* Gory.)

Although, so far as records show, this insect has only once been detected attacking cultivated willow, in the experience of the writer and some others it seems to prefer wild willows to other wild trees. Its injuries are chiefly to birch, and it is a growing pest from New England westward to Iowa, having been decidedly destructive to trees grown for shade and ornament in public parks and elsewhere.[b] It is occasionally found on poplar.

The beetle is shown at *a*, fig. 14. It measures nearly half an inch in length, and is dark bronze-olive in color. The larva is white and of the peculiar form shown at *c*.

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[a] Hamilton, Can. Ent., Vol. XX, pp. 8, 9; A. J. Cook, Mich. Bd. Agr., 1890, p. 118.

[b] A more complete account has been given by the writer in Bul. 18, n. s., Bur. Entom., pp. 44–51.

Fortunately this species is rather closely restricted to northern regions, being obviously a transition species extending somewhat into the Boreal zone. It follows, therefore, that trees which grow in southern portions of the Northern States, except at high elevations, are not apt to be attacked. In fig. 15 the nature of injury to white birch is shown. It seems probable that willow is affected in the same way, but this has not been observed. The cause of attack which has been noticed in many localities is almost invariably carelessness in permitting the insects to breed instead of cutting out and destroying the injured and dying trees. If the trees are cut down, they should always be burned at once.

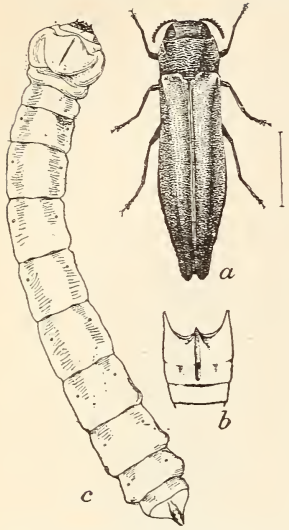

FIG. 14.—Bronze birch borer (*Agrilus anxius*): *a*, female beetle; *b*, first abdominal segments of male from below; *c*, larva from above—all enlarged about 3½ times (from Chittenden, loaned by Bureau of Entomology).

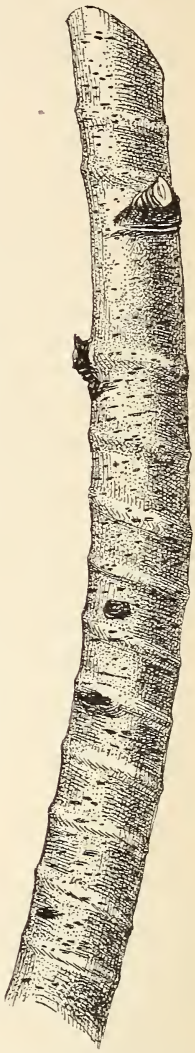

FIG. 15.—Work of *Agrilus anxius* on limb of white birch—somewhat reduced (from Chittenden, loaned by Bureau of Entomology).

It seems probable that in course of time, after this insect has caused great destruction to birch, it will be driven to attack willow or poplar for food. It is therefore desirable that a close watch be kept for evidences of its presence, and that affected trees be destroyed either in late summer or before the insects leave the trees, in May or June, to deposit eggs for another generation. Owing to the nature of the bark of birch, ordinary washes are not perfectly effective. Willow could be more easily treated.

THE WILLOW-SHOOT SAWFLY.

(*Janus integer* Nort.)

Injury by this insect has been noted since about 1885, reports indicating that it is capable of being very troublesome. In 1886 it did considerable damage to both willow and poplar in Washington, D. C., and in Maryland. Attack begins on young shoots near the tips, causing them to hang down and become brown and dry during the more

heated portion of the day. Admiral Ammen reported to the Division of Entomology that in 1885 nearly an entire field looked as if it had suffered from severe frost, or as if a fire had run over it, and that by autumn large numbers of shoots had been killed close to the ground.[a] Mr. W. F. Hubbard has observed similar injury to basket willows in portions of the States of Kentucky, Indiana, and Ohio. In the territory where these three States join, willows were absolutely destroyed. Injury was noticed during the years 1900, 1901, and 1902.

The damage is done by the female sawfly, in inserting her eggs in willow rods. After laying an egg, she girdles the twig to prevent its further growth and protect the egg from being crushed—a remarkable display of instinct, which, however, is observable in other insects

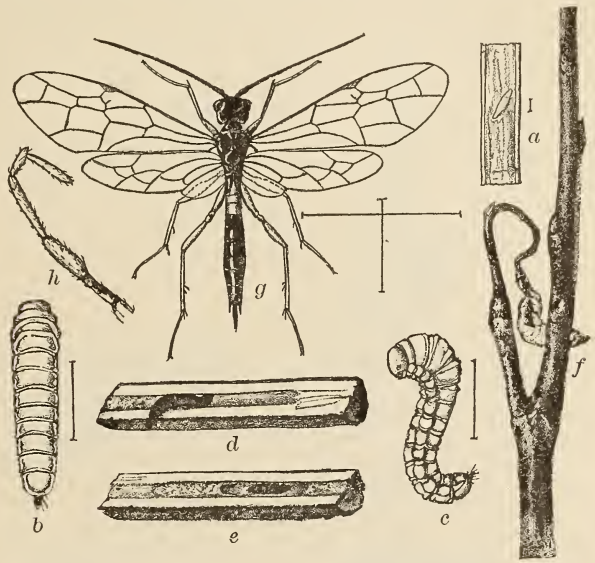

FIG. 16.—Willow-shoot sawfly (*Janus integer*): *a*, egg; *b*, larva, dorsal view; *c*, same, side view; *d*, *e*, two views of burrow; *f*, twig, showing damage; *g*, adult—all enlarged except *f*; *h*, antenna, still more enlarged (from Riley, loaned by Bureau of Entomology).

of different orders. The tips are evidently punctured with the saw-like ovipositor of the "fly," since punctures can be traced into the pith. The adult sawflies have been observed about the middle of April, continuing to issue until early June. As with many borers, the larvæ are slow of growth. They gradually bore their way downward through the pith to a distance of 2 feet or more. By the beginning of November most of them have completed their growth, and fill the lower ends of their burrows with frass, or castings. They then eat a passage through the side of the shoot about one-fourth of an

[a] As recounted by C. V. Riley, pp. 8–11, Vol. I, Insect Life.

inch above the prospective pupal cell, leaving the outer bark intact. Within this they construct a delicate, transparent, cylindrical cocoon, in which the larva passes the winter. About the first of March the pupa is formed, in which the creature remains for about six weeks.

The insect is shown in its various stages in fig. 16. The adult (*g*) is shining black, with yellow or reddish lighter portions. The wing expanse is three-fourths of an inch or a little more, and the length of the body about half an inch. The larva (*c*) is yellowish, and measures a little less than half an inch when mature. A damaged twig is shown at *f*.

REMEDIES.

The willow-shoot sawfly can be controlled by the simple remedy of pruning the tips of the affected shoots. As soon as these begin to wilt they should be cut off 2 or 3 inches below the point where the punctures of the sawfly girdle the stem. The severed tips may then be allowed to remain on the ground, as the insects will not develop in them, and such parasites or natural enemies as they may have will be apt to mature.

THE YELLOW-SPOTTED WILLOW SLUG.

(*Pteronus ventralis Say.*)

This is one of the worst enemies of the basket willows. It has long been known as a willow insect, and in 1887 was given considerable study by Dr. L. O. Howard, in the city of Washington.[a] Nearly all kinds of willows are subject to injury by this species, including the imported osier willows; but different forms of white willow appear to be the preferred food. Poplars also are attacked.

As with most other noxious insects, the greatest damage is to young plants. In the present case this is a redeeming feature, as insecticides are the more readily applied. A single defoliation of willow is bad enough, but as this insect is capable of producing several generations in a climate like that of Washington, the result is a series of attacks on the leaves during a season or in consecutive seasons which in time will serve to kill the plants. But injury is not confined to the impaired vigor resulting from the loss of leaves. After defoliation the tree puts forth new leafage, but from new side shoots, thus destroying the commercial value of the original shoots.

The first manifestation of the presence of this slug is little blister-like swellings on the under surfaces of the leaves, due to eggs deposited by the female sawfly. A single female will deposit 80 eggs, and sometimes several sawflies will oviposit on a single leaf, inserting

[a] Insect Life, Vol. I, pp. 33–37, August, 1888.

as many as 200 eggs. When the young slugs hatch, they begin to gnaw small holes in the leaves, which increase with the growth of the insect, and in ordinary cases the plant is soon denuded, only the thicker portions of the midribs being left intact.

The parent sawfly (fig. 17, *d*) is black, and the female has the under surface of the abdomen, tibiæ, and base of wings bluish green. The edges of the abdomen and obsolete bands between the segments are pale yellow. The male is distinguished by the yellowish brown or orange-colored upper surface of the abdomen. He measures one-fourth of an inch, while the female is nearly five-twelfths of an inch long. These sawflies are rather dull and heavy in their motions; the males are more active than the other sex.

FIG. 17.—Yellow-spotted willow slug (*Pteronus ventralis*): *a*, *a*, *a*, young larvæ; *b*, full-grown larva; *c*, cocoon; *d*, adult—all slightly enlarged (from Howard, loaned by Bureau of Entomology).

The distribution extends from the sea coast of New England to Minnesota.

The egg is large in proportion to the insect, measuring fully 0.3 mm. in length. It is of elongate form and translucent green in color. Eggs are laid on the under surface of leaves, and hatch in from four to eight days. Soon after hatching, the slugs become black, with small yellow spots, and a slimy ooze completely covers the skin. The yellow spots gradually increase in size, until the fully grown larva presents the appearance shown in fig. 17, *b*. It then measures about four-fifths of an inch in length. Four molts are undergone before maturity is

reached, which happens in from ten days to three weeks. The larva now descends into the ground, where it forms a shining, glue-like cocoon of a dark bronze color (fig. 17). Within this it changes to a yellow pupa, and in the course of a week comes forth a winged sawfly. In the District of Columbia the flies deposit eggs from May until the middle of October.

The eggs are attacked by a small chalcis fly (*Trichogramma* sp.); and an ichneumon fly (*Ichneumon subcyaneus*) and the wheel bug (*Arilus cristatus*) are of considerable service in depleting the numbers of the slugs.

REMEDY.

This and other sawflies can be readily controlled by means of arsenical solutions, applied in the form of a spray. Either Paris green, or preferably arsenate of lead, which adheres better and will not scald tender foliage, may be used, at the rate of a pound of poison to 150 gallons of water.[a]

THE LARGE WILLOW SAWFLY.

(*Cimbex americana* Leach.)

The larva of this sawfly is one of the best known of willow-feeding species. Until 1884 the only injury that had been noted was that of defoliation. In that year, however, the attention of the Division of Entomology[b] was called to a peculiar form of attack near Washington, due to transverse incisions made by the strong mandibles of the adults on small branches and twigs, after the manner illustrated in fig. 18, *b*.

This is one of our largest native sawflies. It is four-winged, and looks much like a bumblebee, except that the head is quite distinct from the thorax, the body is not hairy, and the legs are longer. The body is shining black or brown and blue, and the net-veined wings are infuscated or dusky.

The egg is oblong oval (*c*) and more or less translucent, showing through its shell the green color of the leaf in which it is laid. Eggs are deposited, as is usual with sawflies, on the under surface of leaves, through slits made by the sawlike ovipositor of the female. The bluish gray young larva (*d*) remains for some time after hatching within the blisterlike egg pouch. Mature larvæ are shown at *e*, *e*. They are apt to be mistaken for smooth caterpillars. They are pale yellowish or greenish in color, are thickly covered with a flourlike substance, and the middle of the back is marked with a single longitudinal black line. Transformation to pupa takes place within a compact dark brown cocoon (*f*).

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[a] See Farmers' Bulletin No. 127, pp. 9–12, for full directions concerning the preparation and use of these and other arsenical insecticides.

[b] See accounts by Riley, Rept. Entom. U. S. Dept. Agric., 1884, pp. 334–336; 5th Rept. U. S. Entom. Comm., pp. 584–587.

This insect is somewhat partial to white willow, but also occurs in great abundance on other species. Bruner records an instance in which it was so numerous on willow hedges in Nebraska that trees were completely defoliated before the larvæ had attained their growth, so that the insects practically destroyed themselves. It is evidently an Upper Austral species, which occasionally invades the transition zone. It is

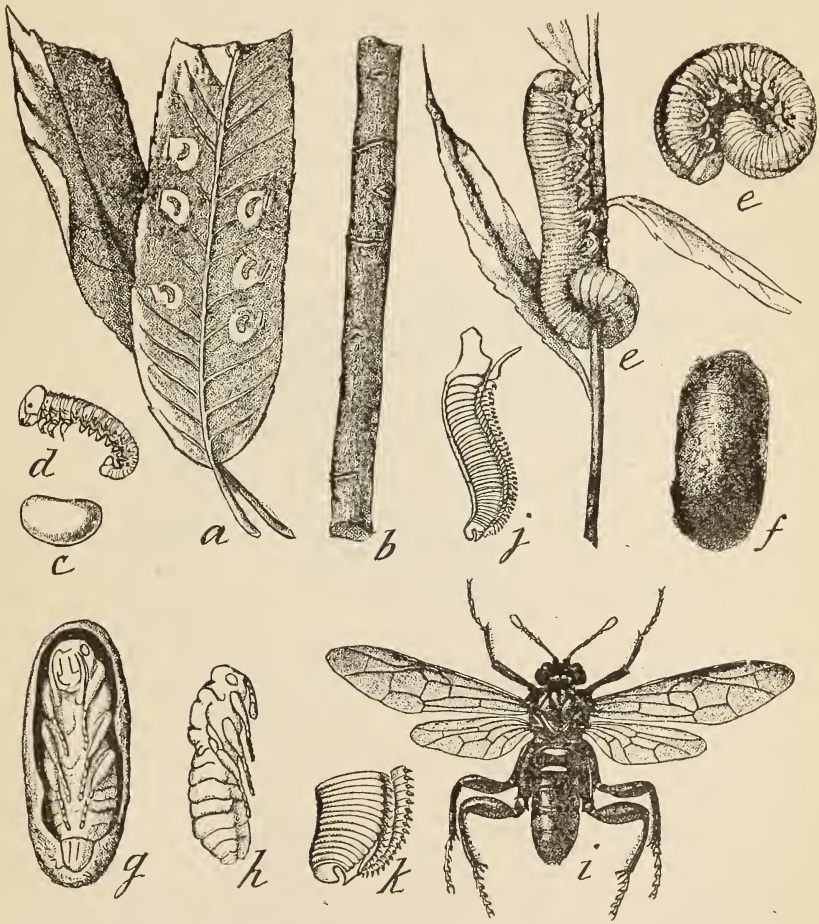

FIG. 18.—Large willow sawfly (*Cimbex americana*): *a*, willow leaves showing location of eggs; *b*, twig showing incisions made by adult; *c*, egg; *d*, newly-hatched larva; *e*, *e*, mature larvæ; *f*, cocoon; *g*, open cocoon showing pupa; *h*, pupa, side view; *j*, *k*, saw of female; *i*, mature sawfly—*c*, *d*, *j*, *k*, much enlarged, the rest less enlarged (after Riley, loaned by Bureau of Entomology).

found from Maine southward to Maryland and the District of Columbia, and westward to the Dakotas and Iowa. Numerous parasites assist in holding it in check.

REMEDY.

The larva of this sawfly yields readily to a spray of Paris green or other arsenical, and this remedy has the advantage of destroying other leaf-feeders which happen to be present.

OTHER SAWFLIES.

Several other species of sawfly larvæ are associated with injury to willow. They are less troublesome as a rule than the species already mentioned, and can easily be controlled by means of an arsenical spray—Paris green or arsenate of lead.

THE STREAKED COTTONWOOD LEAF-BEETLE.

(*Melasoma scripta* Fab.)

This insect is the most important enemy of basket willow. It is a species somewhat nearly related to the Colorado potato beetle. The body beneath is blue black; the sides of the thorax and elytra are dull yellow, streaked with black. The normal form is about as shown in fig. 19, *a*. Paler forms and dark-blue or blue-black forms are shown in the same illustration. An egg mass is illustrated in fig. 20, *a*, while an egg in outline is shown at *b*. Eggs are deposited in dense masses, sometimes to the number of a hundred. The larva when first hatched is black, but when mature is a dingy yellowish color, with black head and legs, two rows of black spots down the back, and in line with these a row of black tubercles on each side. Young larvæ are shown at *c*, *d*, and a pupa at *e*.

FIG. 19.—Streaked cottonwood leaf-beetle (*Melasoma scripta*): *a*, beetle, normal form; *b*, *c*, *d*, *e*, variations—somewhat enlarged (after Riley, loaned by Bureau of Entomology).

The range of this species extends from New York southward to Mexico, and westward to California and Oregon. It is native to North America, and has probably come from the south, until now it is well known all over the country. In 1890 Dr. J. A. Lintner first observed this species as destructive in New York, and the writer noted individuals in great abundance on willow growing in the public parks of New York City, and in the vicinity of Orange, N. J.

This leaf-beetle was first brought to public notice in Kansas in 1875 as an enemy to cottonwood, and later developments show that it was injurious the same year to many acres of willow in Onondaga County, N. Y. A few years later the Division of Entomology was informed of destructive outbreaks in Nebraska and North and South Dakota, where poplars had been extensively planted by settlers in the treeless plains of that region. In after years more or less injury was done to willow and cottonwood in the Northwest, and in Pennsylvania, Texas, Alabama, Colorado, and Minnesota. In 1894 this pest became markedly destructive to European basket willows in central and western New York. Since then injuries have been more or less continuous in that as well as in other regions, including Missouri, Arkansas, District

of Columbia, North Carolina, Indiana, and Mexico. The infested territory during recent years also includes portions of Indiana, North Carolina, Arkansas, and Missouri. During 1903 defoliation of Lombardy poplar was reported at Bartow, Fla., and of willow at Biltmore, N. C.

Besides the injury to willow grown for market and for ornament and shade, the insect occasionally does damage in nurseries and to forest trees. Cottonwood is much injured in the West, and box elder is said to be attacked.

The growth of straight, flexible rods or "whips" of willow is seriously interfered with by the attack of the beetle. The injury as described by Lowe[a] is not so much the weakening of the plant by loss of foliage as the branching consequent upon damage to the growing tips. Hibernated beetles are astir early in May, or sometimes during the latter part of April, and feed for two or three weeks.

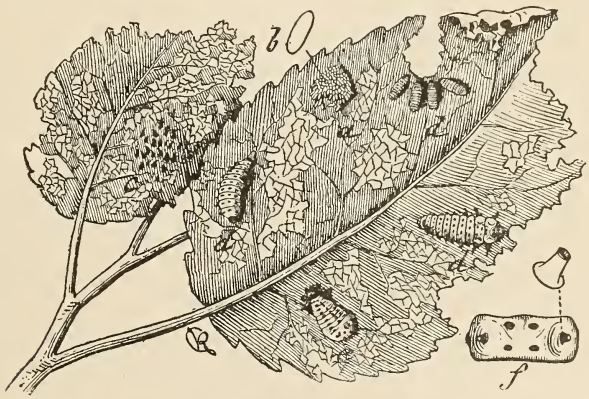

FIG. 20.—Poplar leaves, showing stages of streaked cottonwood leaf-beetle and work: *a*, eggs; *b*, egg, enlarged; *c*, newly hatched larvæ; *d*, *d*, larvæ of different ages; *e*, pupa; *f*, a middle segment of larva, dorsal view, showing enlarged tubercle above—all natural size except *b*, *f* (after Riley, loaned by Bureau of Entomology).

They vigorously attack young willow, feed largely on new growth, and cause the tips to wilt and die. Not infrequently entire tips are eaten off, and in this manner irreparable injury is caused early in the season. The work thus begun by the wintered beetles is continued by the much more numerous larvæ and beetles of later generations, and as this happens when the trees are growing at their best the loss occasioned is much greater. Not only is the growth retarded, but the value of the rod for basket-making purposes is greatly impaired, if not altogether destroyed.

In central New York the beetles begin egg-laying about the middle of May, or a little earlier or later according to the season. The eggs

[a] Bul. 143, New York Agric. Exp. Sta., Geneva, 1898, pp. 1–24.

ordinarily hatch in from ten days to two weeks, but in exceptionally cold weather the period of incubation is sometimes twenty days. In ten to fifteen days more the larvæ attain full maturity, and after a day or two of comparative inactivity transform to pupae. The first new generation of beetles appears about the middle of June, continuing to issue until the second or third week in July. By the first of August most of the beetles have left the trees and found shelter in any convenient resting place, as under stones or logs, under the bark of trees, and among fence rails. There are probably two and possibly three generations produced annually, but the third is with little doubt only a partial brood.

Some species of ladybirds and ground beetles attack this insect in the larval and egg conditions. A pteromalid parasite (*Cœlopisthus linæ* Ashm.) has been reared from this species at Enterprise, Fla.

METHODS OF CONTROL.

There are two methods of control generally employed by growers. They consist in the application of poisons or repellents, and the use of special machines for the capture of the beetles.

Paris green or arsenate of lead is used in the same manner as for the willow slugs. To be perfectly effective the first application should be made very early in the season, upon the first appearance of the beetles, and should be followed by one or two more sprayings a week or ten days apart.

Two forms of machines for catching the beetles are illustrated in Bulletin No. 143 of the New York Agricultural Station at Geneva, N. Y.[a] These machines, which are simple, home-made devices, are nevertheless effective, and their use has been found on the whole more satisfactory than poisons. They do not, however, prevent serious injury from beetles in the early part of the season, when the willows are too small to permit the machine to work well, and when the young larvæ are not easily dislodged. The dimensions of the horsepower machine shown are, length 5 feet, depth 6 inches, width of rear end 2 feet, width of front end 1 foot 8 inches. The body is a shallow tank lined with zinc or tin to hold kerosene oil, or kerosene oil and water, the oil floating on top if water is used. Above this tank are placed longitudinal strips, as shown in the illustration, to prevent the willows from touching the oil. The machine is borne on two stout runners fastened on the underside, and is made to run between the rows; the long arms which extend obliquely from the arms of the machine bend the willows inward and rub off the beetles, and many of the larvæ and pupæ fall into the oil and are killed. The hand machine works on the same principle.

THE SPOTTED WILLOW LEAF-BEETLE.

(*Melasoma lapponica* Linn.)

This species, also known as the spotted cottonwood beetle, is like the preceding in form and size, and has much the same habits. It is of different color, being red above and strongly marked with black; and save for its larger size and more elongate, somewhat pear-shaped form, might be mistaken for a ladybird. It is black on the lower surface. Though not so variable as the streaked cottonwood leaf-beetle, some specimens lack the black markings or have less than are shown at fig. 21, which is an average form. This insect has been identified with more or less injury to willow and cottonwood from Massachusetts south, and west to Nebraska. In some seasons it is as abundant as the more injurious cottonwood leaf-beetle. During the year 1902 it was reported by Mr. W. F. Hubbard as destructive to willow at Lyons, N. Y. In its preliminary stages this species scarcely differs from the other; in fact, the differences have not been definitely pointed out. As its name indicates, it feeds quite as readily on poplar as on willow.

FIG. 21.—The spotted willow leaf-beetle (*Melasoma lapponica*)—five times natural size (original, loaned by Bureau of Entomology).

An arsenical spray is all that is necessary in the treatment of this species.

THE POPLAR LEAF-BEETLE.

(*Phytodecta pallida* Linn.)

Several leaf-beetles closely allied to the two species which have just been discussed, inhabitants of the colder portions of the Northern States, some of them circumpolar and common to Europe, Asia, and America, are occasionally destructive to willow and poplar. One of these is the subject of the accompanying illustration, and will serve as an example of this group. It has been observed in injurious numbers on the aspen (*Populus tremuloides*) in Michigan, its occurrence having been noted in early June, when it was so abundant as to skeletonize the leaves and do serious injury to the trees. This species is about one-fourth of an inch in length, of the form illustrated in fig. 22. It is variable in color, but is usually a rather pale brown, either marked with black spots as shown or lacking a portion or all of these. It ranges across the continent from the White Mountains of New Hampshire

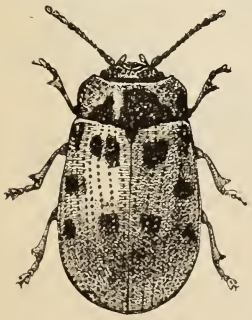

FIG. 22.—Poplar leaf-beetle (*Phytodecta pallida*)—about five times natural size (original, loaned by Bureau of Entomology).

through the Lake Superior region, Wyoming, and Utah, to California and British Columbia.

OTHER LEAF-BEETLES.

One of the most abundant leaf-beetles is a dull red willow leaf-beetle, a species known scientifically as *Galerucella decora* Say (fig. 23). It has been said by Riley to be the most numerous and most dangerous of willow insects. It will be noted that it closely resembles the very nearly related imported elm leaf-beetle. Its eggs are a little larger, more brightly colored, and less acuminate, and the young larvæ are of darker color, though very similar. The writer has observed this species on swamp willows in central New York in great numbers, both as larva and as imago.

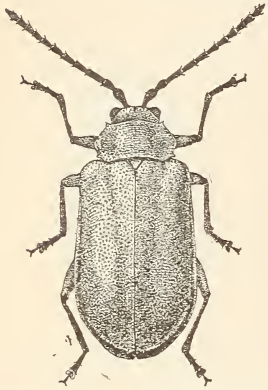

FIG. 23.—Dull red willow leaf-beetle (*Galerucella decora*)—much enlarged (original loaned by Bureau of Entomology).

Several species of leaf-beetles (*Calligrapha philadelphica* and others) of about the same shape as the Colorado potato beetle, but smaller, and with white and black or bronze markings, are commonly known to affect willow, but seldom appear in sufficient abundance to cause injury worthy of mention.

LEAF-FEEDING CATERPILLARS.

The bulk of the insects which affect the willow are leaf-feeding caterpillars of moths, largely of the superfamily Bombycoidea, or spinners, and the family Noctuidæ, or owlet moths. Only a few of these defoliators can be mentioned here. Among the best known are the white-marked tussock moth (*Hemerocampa* [*Orgyia*] *leucostigma* S. & A.) and the fall webworm (*Hyphantria cunea* Dr.), both of which are discussed in Farmers' Bulletin No. 99, of this Department. The bagworm (*Thyridopteryx ephemeræformis* Haw.) is another common species and, like the other two that have been mentioned, a general feeder. Among those which are partial to willow, poplar, and related species,

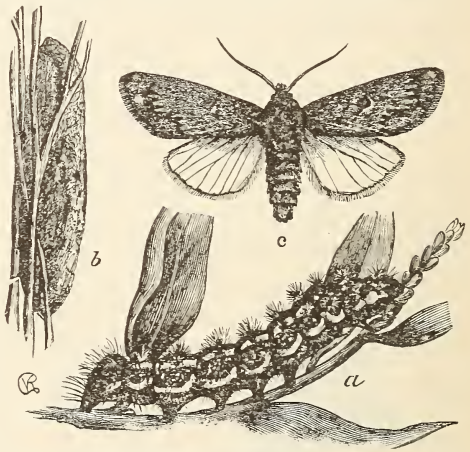

FIG. 24.—Smeared dagger (*Apatela oblinita*): *a*, larva; *b*, cocoon; *c*, moth (after Riley, loaned by Bureau of Entomology).

are the willow tussock moth (*Hemerocampa* [*Orgyia*] *definita* Pack.), the smeared dagger (*Apatela oblinita* S. & A.), shown in fig. 24, the mourning cloak butterfly (*Euvanessa antiopa* Linn.), and the willow tent-maker (*Melalopha* [*Ichthyura*] *inclusa* Hbn.). The last two species may receive brief special mention.

The Mourning Cloak Butterfly (*Euvanessa antiopa* Linn.).

The caterpillar of this species is particularly abundant on basket and other willows, and on poplar, birch, and related plants, and a defoliator of other shade and forest trees. It is generally distributed, and periodically or locally troublesome. It is, however, rather more abundant northward, and commoner in this country than in Europe. It hibernates as a butterfly, and appears on the wing during the first days of spring; it is, in fact, perhaps the earliest of all our common and conspicuous butterflies. Two generations are produced in the North. During 1902 complaints were made of injury by this insect in New York and Pennsylvania. In 1903 it defoliated mulberry trees at Delavan, Ohio, and balm-of-gilead at Kaslo, British Columbia. It was observed by Mr. W. F. Hubbard on willow at Lyons, N. Y., in 1902.

It can readily be controlled with the arsenicals already mentioned.

The Willow Tent-maker (*Melalopha* [*Ichthyura*] *inclusa* Hbn.).

This caterpillar is at times a decided pest on willows, and during the late nineties several times attracted the attention of the writer because of its complete defoliation of young willows in and near the District of Columbia. Its habits were observed in connection with attack on

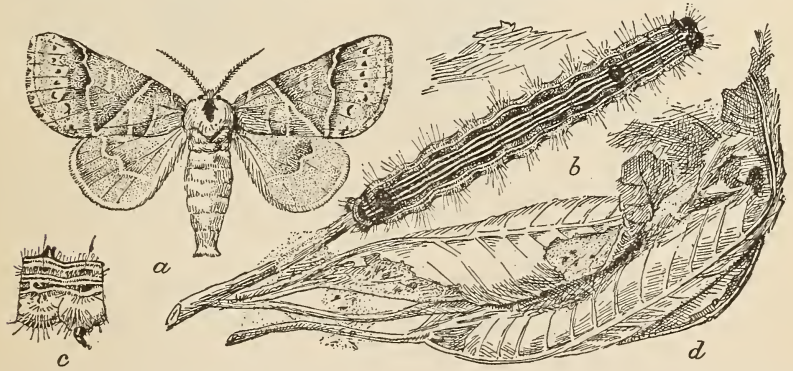

FIG. 25.—Willow tent-maker (*Melalopha inclusa*): *a*, moth; *b*, full-grown larva; *c*, lateral view of two segments of same; *d*, small nest containing young larvæ—all somewhat enlarged (original).

the balm-of-gilead as early as 1838. The caterpillars are gregarious, and form a common shelter or tent (fig. 25, *d*) consisting of leaves folded longitudinally and lined with a thick web of silk, beneath which the insects conceal themselves and feed. The full-grown caterpillar (*b*) measures about an inch and a half. It is slightly hairy, and pale

yellow in color, with head, thoracic legs, and some other portions of the body, including tubercles and stripes, black. The general appearance of the moth is shown at *a*. Its geographical distribution extends from New England southward at least to Maryland and Virginia, and westward.

PLANT-LICE.

(*Aphididæ*.)

Plant-lice of several species affect willow, and ornamental varieties are sometimes badly infested, the insects not only injuring plants, but dropping on sidewalks and the clothing of pedestrians, where they leave dark-colored stains. They also cover the sidewalks with honeydew, and are at times annoying by crawling into dwellings in the vicinity of willows. Considerable correspondence was had during the year 1902 in regard to a large and abundant willow plant-louse (*Melanoxanthus salicicola* Uhler), and its occurrence in Wisconsin. Some other common forms of this genus are the willow-grove plant-louse (*M. salicti* Harr.), the spotted willow plant-louse (*M. salicis* Linn.), and the toothed willow plant-louse (*Lachnus dentatus* LeB.).[a] Two species, the two-colored willow plant-louse (*M. bicolor* Oestl.) and the flocculent plant-louse (*M. flocculosus* Weed), are shown in figs. 26 and 27, respectively.

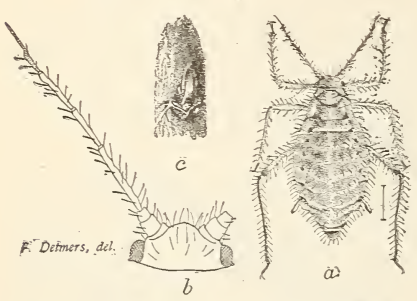

FIG. 26.—Two-colored willow plant-louse (*Melanoxanthus bicolor*): *a*, oviparous female; *b*, head and antenna of same: *c*, eggs on willow twig—*a* much enlarged, *b* greatly enlarged (after Weed).

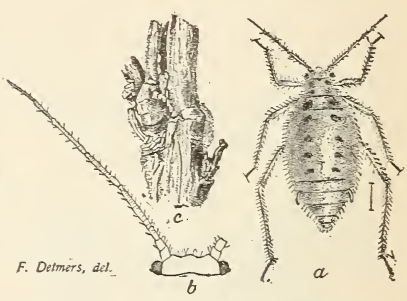

FIG. 27.—Flocculent plant-louse (*Melanoxanthus flocculosus*): *a*, oviparous female; *b*, head and antenna of same; *c*, eggs on willow bark—*a* enlarged, *b* greatly enlarged (after Weed).

THE EUROPEAN BASKET WILLOW BORER.

(*Gracilia minuta* Fab.)

This longicorn beetle is deserving of passing mention as the only species known to affect seriously dry commercial willow and its manufactures, such as baskets, hampers, barrel hoops, and other articles. It is of sufficiently common occurrence in dwellings and other buildings in Europe to have received mention in Butler's Household Insects, and is less commonly seen in America.

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[a] C. M. Weed, Tech. Ser., Vol. I, No. 2, Art. 5, Ohio Agl. Exp. Sta., pp. 111–120, Pls. III–VIII; Ins. Life, Vol. III, pp. 285–293.

APPENDIX.

PRODUCTION AND CONSUMPTION OF WILLOW IN THE UNITED STATES.

By William F. Hubbard.

IMPORTS OF RAW AND MANUFACTURED WILLOW.

To gain a clear view of the value and extent of willow growing and basket making in America is no easy matter. It is a small industry, and one which has attracted so little attention that all figures relating to it are meager and difficult to obtain.

The following table gives our imports of osier prepared for use, and of common and fine basket ware, since 1855:

Table IX.—*Imports of willow.*

[From Commerce and Navigation.]

Year.	Raw material.	Basket ware.	Year.	Raw material.	Basket ware.
1855	$45,459	$132,658	1864	$139,353	.....
1856	36,554	125,808	1865	116,831	.....
1857	41,773	175,484	Total	504,612	.....
1858	35,141	112,725	Average	100,922	.....
1859	38,359	125,677	1866	57,907	$225,660
1860	39,556	143,495	1867	39,078	202,408
Total	236,842	815,847	1868	28,872	155,304
Average	39,474	135,975	1869	37,512	178,689
1861	[a]122,313	.....	1870	50,715	204,409
1862	36,199	.....	Total	214,084	966,470
1863	89,916	.....	Average	42,817	193,294

[a] The records for imports during the civil war do not distinguish between raw and manufactured material.

Note.—The principal port of entry for both raw and manufactured willow is New York. In 1901 $15,505 worth of raw willow was there entered out of a total of $17,334 for the whole country. Other imports of willow rods were: Pittsburg, $571; Boston, $446; Philadelphia, $196; San Francisco, $162; and a host of others much smaller.

Of manufactures, New York imported $122,576 out of a total of $141,692. Next in order follows; Philadelphia, $5,151; Boston, $3,334; San Francisco, $2,152; Chicago, $1,323; St. Louis, $2,864; New Orleans, $1,172.

Unfortunately no record is kept of the countries from which the willow is imported. In rods prepared for use France leads, followed by Germany, Holland, and Belgium. Manufactures come mostly from Germany and France, also Belgium, Austria, Holland, and Italy.

TABLE IX.—*Imports of willow*—Continued.

Year.	Raw material.	Basket ware.
1871	$39,935	$205,572
1872	48,884	265,145
1873	37,478	228,056
1874	34,082	195,155
1875	34,282	162,785
Total	194,661	1,056,713
Average	38,932	211,342
1876	31,440	146,270
1877	24,268	118,627
1878	15,966	91,445
1879	9,142	84,216
1880	21,833	142,214
Total	102,649	582,772
Average	20,530	116,554
1881	36,259	246,449
1882	44,952	266,914
1883	54,424	262,056
1884	51,690	237,833
1885	28,665	202,662
Total	215,990	1,215,914
Average	43,198	243,183
1886	$15,164	$238,379
1887	18,516	312,179
1888	18,366	334,006
1889	20,973	345,419
1890	27,646	372,356
Total	100,665	1,602,339
Average	20,133	320,468
1891	93,207	223,334
1892	82,632	123,820
1893	64,427	125,916
1894	32,039	74,487
1895	18,476	107,914
Total	290,781	655,471
Average	58,156	131,094
1896	12,522	106,045
1897	13,074	100,672
1898	9,640	80,320
1899	12,009	84,798
1900	14,791	187,708
Total	62,036	559,543
Average	12,407	111,909
1901	17,334	141,692

Previous to 1855 no record was kept of willow imports, but it is plain that the United States had been importing from abroad long before that date. The period from 1855 to 1860 shows a steady demand for both manufactured and unmanufactured wares, which was suddenly and disastrously checked by the civil war. At its end importations rose somewhat above the level of 1855–1860. The period from 1866 to 1875 shows a normal development for basket ware, but the five year period 1876–1880, drops decidedly in general average. From this time to 1890 there is a small but steady growth in imports, but since 1891 there has been a very noticeable decrease. In 1894 the imports sank to $74,487, the lowest figure on record except during the civil war. Since that time they have recovered slightly.

The imports of osier rods, prepared for use, have also been irregular and fluctuating. From 1866 to 1870 they averaged $42,817, the highest figure for the period being $57,907 in 1866. In the next five-year period, 1871 to 1875, they averaged $38,932, but fell to $20,530 in 1876–1880. From 1881 to 1885 the average was $43,198, the trade for 1883 amounting to $54,424. Then came a sudden change; in 1886–1890 the average was only $20,133. From this level the imports of 1891 suddenly sprang to $93,207, the highest figure ever reached, and for the succeeding years the amounts remained high enough to bring the average for 1891–1895 to $58,156. Since that time they have again abruptly fallen, the average for 1896–1900 being $12,407, with the minimum in 1898, when the import fell to $9,640, the lowest figure recorded—less than one-fourth the average for the years 1855–1860. The decline since 1891 is very noticeable, and there is no probability of any marked recovery.

There must be some good reason for the turn the import trade has taken, and only two alternatives, or a combination of them, are possible. Either the home supply of osiers and the manufacture of them into commodities has so increased as to affect the import of such articles, or willow ware has been supplanted by other forms of basket making.

AMERICAN WILLOW GROWING AND BASKET MAKING.

To decide this matter definitely accurate statistics of the home industry are necessary. These are not easy to obtain. In the census returns the osier willow has received scant attention. The agricultural schedules did not specify the basket willow, but left the farmer a single blank space in which to make note of miscellaneous farm products. In this way most willow holts have been overlooked, and from this source even approximate data can not always be given for districts where the industry has reached some proportions.

The following table gives the amount grown in 1899, according to the Census of 1900:

TABLE X.—*Twelfth Census returns for willow culture in the United States.*

State.	County.	Value of product.	Number of holts.	Area of holts.
				Acres.
New York	Onondaga	$10,217	44	159
	Monroe	1,090	5	35
	Cayuga	1,014	4	22
	Wayne	9,008	12	127
	Oswego	500	1	6
	Yates	101	1	5
	Steuben	184	2	3
	Tompkins	154	1	4
	Seneca	72	1	2
	Ontario	125	1	2
	Wyoming	120	1	1
	Total	22,585	73	366
Kentucky	Campbell	5,329	39	77.75
	Boone	1,753	4	12
	Total	7,082	43	89.75
Ohio	Butler	800	2	9
	Wayne	164	2	2
	Others	180	1	3
	Total	1,144	5	14
Indiana	Ripley	2,199	28	20
Maryland	Baltimore	2,838	6	31.25
Illinois	Lake	1,635	6	33.50
Pennsylvania	Allegheny	775	4	5
	Total for United States	38,258	165	559.50

With regard to basket making the information is almost as obscure. In the census returns "basket, rattan, and willow ware" all come under one head, and are almost inextricably mixed. Table XI is an attempt to separate the willow industry from other forms of basket ware. The manufactures schedules of the census have been gone through State for State and town for town, those manufactures using willow separated, and the amounts of raw and manufactured material carefully tabulated. Such a method is very open to error, but the general results may be accepted as fairly reliable. As basket making is usually carried on in very small establishments with no machinery, any attempt to estimate the invested capital was found impossible.

TABLE XI.—*Willow ware in the United States, 1890–1900.*

[Compiled from census and other sources.]

NEW YORK.

County or city.	Establishments.		Raw material.		Manufactures.	
	1890.	1900.	1890.	1900.	1890.	1900.
Onondaga County:						
Liverpool[a]	1	79	$48,000	$26,852	$100,000	$72,260
Syracuse	11	3	20,649	2,093	55,067	8,533
Other than Liverpool and Syracuse	1	1	200	150	613	400
Rochester	4	12	7,740	6,717	42,500	40,681
Monroe County (other than Rochester)	.....	1	.....	575	.....	2,850
Buffalo	12	6	4,220	4,525	14,350	16,350
Other places in western New York	3	2	275	145	2,075	950
New York	28	14	39,436	25,218	97,900	76,457
Brooklyn	15	14	8,610	2,733	35,450	9,615
Total	75	132	129,130	69,008	347,955	228,096

PENNSYLVANIA.

Philadelphia	63	31	$16,912	$8,231	$56,823	$27,537
York	1	12	150	1,500	600	9,400
Allegheny	4	2	1,520	3,252	11,590	18,260
Harrisburg	3	2	930	160	4,200	700
Others	4	30	3,175	7,418	10,704	15,699
Total	75	75	22,687	20,561	83,917	71,596

MARYLAND.

Baltimore	18	28	$9,250	$9,659	$36,467	$42,346
Others	.....	1	.....	30	.....	605
Total	18	29	9,250	9,689	36,467	42,951

MASSACHUSETTS.

Boston and Chelsea	7	3	$2,080	$6,640	$8,076	$33,220
Others	2	2	350	300	2,100	1,780
Total	9	5	2,430	6,940	10,176	35,000

MISSOURI.

St. Louis	7	12	$6,000	$12,810	$8,300	$28,040

OHIO.

Columbus	1	2	$500	$325	$2,500	$3,418
Dayton	.....	2	.....	472	.....	2,240
Cincinnati	12	9	3,310	2,080	20,750	11,977
Others	14	8	7,875	1,265	26,815	5,535
Total	27	21	11,685	4,092	50,065	23,170

[a] In 1890 all the basket makers in Liverpool, Onondaga County, were united in a basket makers' union, returning to the census as one establishment.

TABLE XI.—*Willow ware in the United States, 1890–1900*—continued.

ILLINOIS.

County or city.	Establishments.		Raw material.		Manufactures.	
	1890.	1900.	1890.	1900.	1890.	1900.
Quincy	1	2	$100	$90	$700	$360
Chicago	5	4	18,050	2,220	61,000	19,325
Others	1	3	50	152	650	543
Total	7	9	18,200	2,462	62,350	20,228

KENTUCKY.

Grant County	.....	2	.....	$520	.....	$1,275
Claryville	1	7	$1,200	2,149	$2,400	6,955
Covington	4	.....	1,975	.....	7,700	.....
Louisville	6	6	805	549	4,238	2,982
Lexington	1	1	200	100	600	200
Newport	8	.....	6,535	.....	18,700	.....
Total	20	16	10,715	3,318	33,638	11,412

LOUISIANA.

New Orleans	6	5	$2,746	$1,310	$12,283	$9,570

INDIANA.

Terre Haute and others	4	6	$2,195	$890	$8,975	$3,304

NEW JERSEY.

Total	1	8	$313	$570	$950	$1,160

WISCONSIN.

Milwaukee	5	4	$926	$740	$5,665	$3,168
Others	.....	3	.....	225	.....	956
Total	5	7	926	965	5,665	4,124

CALIFORNIA.

San Francisco	.....	4	.....	$708	.....	$2,350
Others	1	2	$60	425	$390	1,000
Total	1	6	60	1,133	390	3,350

WEST VIRGINIA.

Wheeling	2	2	$480	$612	$1,200	$2,405

MICHIGAN.

Detroit	2	3	$900	$230	$3,000	$1,500
Others	2	1	325	75	1,150	311
Total	4	4	1,225	305	4,150	1,811

TABLE XI.—*Willow ware in the United States, 1890–1900*—Continued.

SOUTH CAROLINA.

County or city.	Establishments.		Raw material.		Manufactures.	
	1890.	1900.	1890.	1900.	1890.	1900.
Total	1	1	$300	$360	$1,095	$1,650

DISTRICT OF COLUMBIA.

Total	.....	1	.....	$135	.....	$872

MINNESOTA.

St. Paul	1	2	$167	$230	$600	$600
Winona	1	.....	800	.....	2,200	.....
Total	2	2	967	230	2,800	600

VERMONT.

Total	.....	1	.....	$65	.....	$533

DELAWARE.

Total	.....	1	.....	$27	.....	$224

KANSAS.

Total	.....	1	.....	$14	.....	$200

GEORGIA.

Total	1	1	$40	$30	$550	$200

THE UNITED STATES.

Total	265	345	$219,349	$135,526	$670,926	$493,496

With the aid of Table XI it is now possible to analyze and amend Table X. Table XI shows that the total value of raw material used for basket making in the United States in 1900 was $135,526. The import of foreign osier for that year was $14,791. Allowing the importers a profit of 20 per cent in handling this stock, the cost to the basket makers would be $17,749. Subtracting this sum from the total amount paid for willow, $117,777 is left as the value of that grown in this country. The Census returns account for only $38,258. Very often the farmer who grows the willow sells direct to the basket maker, but as American willows are also handled by dealers, it is well to allow a commission of 20 per cent, thus assuming the cost of the home-grown stock to the manufacturer at $45,909. This leaves $71,868 worth of willows unaccounted for.

From investigation in the willow districts, from information given by dealers and basket makers, and from the Census statistics of basket manufacture in Table XI, Table X can be revised with considerable accuracy.

To begin with New York State: Buffalo, Rochester, Syracuse, Liverpool, and other places in western New York take practically all the willows grown in the same neighborhood and depend for their raw material on the local supply. All the rods here used are steam peeled and made into common basket ware. The value of the willow stock consumed in 1900 in the places mentioned is given in Table XI as $41,057. Table X credits this district with but $22,585 worth. To this estimate of the New York yield, about $20,000 may therefore safely be added.

In Kentucky the willow-growing districts have been badly devastated by a fly in the last few years, and it is improbable that the figures of Table X for this State should be at all increased.

In Ohio the census finds five holts, distributed by counties as follows: Butler County, 2; Wayne County, 2; unlocated, 1. But willow culture exists to no small extent about Cincinnati, in Hamilton County, and small quantities are scattered over a wide area comprising almost the whole of the State. To the $1,144 credited to Ohio, $1,000 may safely be added.

Indiana returns willow culture only from Ripley County, yet there is little doubt that the industry throughout the counties in the south along the Ohio would yield an additional $1,000.

In Maryland, only Baltimore County has been reported. Yet the center of the willow district undoubtedly lies in Howard County. In the neighborhood of Elkridge alone the output exceeds $5,000 per year, while Anne Arundel County contributes $2,500. The additional amount may be put at $8,000.

Willow growing is common in Pennsylvania, particularly in the southeastern corner and along the Susquehanna, the Delaware, and their branches. First in importance is York County. At Goldsboro and the neighboring village of Marsh Run there must be 50 acres, yielding a gross sum yearly of $4,500. About the city of York the value of the crop must be $2,000, giving for the county an annual yield of at least $6,500. In nearly all the adjoining counties and far up in the State, north and west, the German inhabitants have spread the willow, until the value of the crop in those localities can not be less than $5,000. To this must be added the crop about Reading, the total yield of the State amounting to about $15,775. It is put down for only $775.

Willow culture in Illinois is mainly concentrated in Lake County, the product of which forms the only entry for the State in the census figures; but in St. Clair County, across the river from St. Louis, and in isolated areas throughout the State to Lake Michigan, the willow is grown in amounts equal to at least the home consumption of the district. The value of this additional product can not be estimated at less than $500.

Outside of the States mentioned in Table X there are certain others producing willows. About St. Louis willows were long ago introduced by German emigrants, and at one time were a more important crop than they are to-day. Even at the present time, however, Missouri may be credited with at least $1,500 worth annually. New Jersey has considerable areas under willow, the yield of which is at least $1,500 per year.

These are the most important willow States. Virginia grows about $500 worth a year, West Virginia grows an inconsiderable quantity, and about Muskegon, Ann Arbor, and Lansing the willow is known, so that Michigan will produce an amount perhaps equal to $275. In the neighborhood of St. Paul there is probably a further $200 worth or so to be found, Minnesota thus closing the list.

Using these estimates, Table X may be corrected as follows:

TABLE XII.—*Value of willow produced in the United States in the census year 1900.*

States.	Census return.	Additional estimate.	Total.
New York	$22,585	$20,000	$42,585
Pennsylvania	775	15,000	15,775
Maryland	2,838	8,000	10,838
Kentucky	7,082	.....	7,082
Indiana	2,199	1,000	3,199
Ohio	1,144	1,000	2,144
Illinois	1,635	500	2,135
New Jersey	.....	1,500	1,500
Missouri	.....	1,500	1,500
Virginia	.....	500	500
Michigan	.....	275	275
Minnesota	.....	200	200
United States	38,258	49,475	87,733

Adding once more 20 per cent for the commission in handling, the sum becomes $105,279. As the value of home-grown stock, according to the Manufacturers' Statistics (Table XI), minus the foreign export was found to be $117,777 (p. 87), it will be seen that the estimate is still considerably below the mark. The figures, however, are sufficiently accurate to give a practical idea of American willow culture and its areas of distribution in 1899.

It is worth while now to try to discover what changes the industry has undergone in the last ten years. Here, however, our difficulties increase. The census of 1890 gives no willow-growing statistics except for the single town of Liverpool, Onondaga County, N. Y. The figures given compare with the corresponding ones of the census of 1900 as follows:

TABLE XIII.—*Willow culture at Liverpool, N. Y.*

Year.	Value of product.	Weight of product.	Number of holts.	Area of holts.
		Tons.		*Acres.*
1899	$13,047	681.5	30	205.5
1900	7,666	303.5	30	109.75

The falling off in acreage and production here described has no general significance. It was due not to economic conditions but to the depredations of insects, which appeared in this district about 1894 and have since done terrible injury to the crop.

In the absence of fuller information concerning the production of willow before 1899, the only course left open to us is to turn again to Tables IX and XI. By deducting the imports of foreign willow for the census years 1890 and 1900 from the amount of raw stock used in America during the same years we should obtain the amounts of home-grown stock. To such a course, however, the objections are many. It is a very unreliable method to contrast the results of isolated years separated by a long interval of time. This is particularly true of the basket industry, for the yearly record of imports show tremendous fluctuations, which undoubtedly stand in intimate sympathy with the home production. This, however, is the only method

available, and for certain districts where the home-grown willow is known to be used to the exclusion of the imported stock, some idea of the development of willow culture can be obtained.

Referring once more to Table XI, it will be seen that the total value of the raw material used in the census year 1890 was $219,349, and in 1900 $135,526. In the same years the value of foreign willow fell from $27,646 to $14,791, Table IX, a decrease of 46.5 per cent. Subtracting the imports (plus 20 per cent) from the total consumption of the years 1890 to 1900 (Table XI), the value of American willow is found to have fallen from $186,174 to $117,777, a decrease of 36.7 per cent. Thus foreign imports have fallen off somewhat more than the consumption of American willows. Indeed, the decrease in the purchase of European stock is seen to be far greater than this when the average import of $58,156 for the years 1891 to 1895 is compared with $12,407 for 1896 and 1900. This is further corroborated by the fact that all the best basket makers, save in the larger cities of the East and a few others, have given up the use of any but home-grown willows. But the fact remains that the consumption of osier rods has fallen off, and if the foreign stock has suffered more than the American, the latter, too, has felt severely the same general influences.

It has been said that only the larger towns in the East use imported willows. To these must be added New Orleans in the South and San Francisco and others in California. Of course American stock is also used largely in these places, but at least 95 per cent of the total import is here consumed. In Boston, New York, Brooklyn, Philadelphia, Allegheny,[a] New Orleans, and San Francisco there was $71,364 worth of willow used in the census year 1890, compared with $48,517 in 1900—a decrease of $22,847. Comparison of this sum with $15,426,[b] the decrease in imports for the same years, shows that the consumption of American willow in these places has positively fallen off to the extent of $7,421. If, however, the sums of American willow used in these towns—namely, $38,189 in 1890 and $30,768[c] in 1900—be compared with the total amounts consumed in those years, it will be seen that 53.5 per cent of the total was American in 1890, against 63.4 per cent in 1900. This invasion of home willow into the preserves of the foreign stock implies a betterment in the quality of American osier, and is a favorable sign, small as it may be and counteracted as it is by the actual decrease of basket making in these cities.[d]

Boston, Baltimore, and St. Louis are the only places of importance showing an actual growth in the basket industry. This is for widely different reasons. Boston shows an increase because of the sudden growth of a large manufacture of willow furniture which took place in a town where no great basket-making industry had existed. New York has also developed a large manufacture of the same furniture, but the simultaneous decline of basket making renders this fact invisible in the statistics.

In Baltimore the number of basket makers has increased, and, in consequence, there is more demand for the good willows of the neighborhood. In this case

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[a] Allegheny has an important import of foreign willow.

[b] Difference between import in 1890 and 1900, plus 20 per cent. The discrepancy in the total comes from the fact that 20 per cent addition to the price in the handling is probably too small an estimate.

[c] Total consumption in above-named towns, according to Table XI, minus the import for 1890 and 1900 plus 20 per cent.

[d] It must be borne in mind, however, that the calculations of the last two paragraphs are no more than approximations in which a general tendency only can be detected. Raw material reported by the basket makers in the census year 1900, for instance, was consumed in the year ending about May, 1900, while the figures given in Table IX as imports for 1900 represent goods brought into the country between July 1, 1899, and June 30, 1900. While these figures do not actually coincide, they are the best which can be taken for purposes of comparison and have a relative value.

willow growing and basket making stand in close relationship. The economic conditions resulting from this conjunction of growing and manufacture are particularly worthy of note, especially when compared with western New York, and with the district which centers in Cincinnati.

For St. Louis the basket-makers' schedules in the 1890 census have unfortunately been misplaced, and no record for that year can be found. The 1890 figures for St. Louis in Table XI are a very conservative estimate. This industry, however, has undoubtedly increased very much in the last ten years. As St. Louis has also a large and well-established wood-basket manufacture, this growth shows that willow ware has a position in the market, and is sinking to a fixed place in the nation's basket market, rather than disappearing from the trade entirely. At one time the St. Louis district more than supplied the local demand for willow stock; now the dealers must call on Cincinnati and Baltimore.

In most interior towns, dependent on the American supply of willow, the state of affairs is in striking contrast with that in Baltimore and St. Louis. The raw material used in Onondaga County, Monroe County, Buffalo, and other places in western New York fell from $81,084 in 1890 to $41,057 in 1900, the greatest loss being in Onondaga County. A glance at the figures for Kentucky, Ohio, and Indiana shows an even greater falling off in this willow-growing and basket-making region. Indeed, save for a few noticeable exceptions, the statistics for the whole country indicate this same state of decline.

The only willow-growers who are really doing well are those about Baltimore and in Pennsylvania, who sell mainly to Baltimore, Philadelphia, New York, Boston, and St. Louis. Otherwise willow culture is in no great state of prosperity. For this condition the devastation of insects is largely responsible, but it is also indisputably true that the import of cheap baskets from abroad and the use of other wares at home has first hurt the basket maker and, through him, the grower.

That the use of raw material has fallen off shows at the same time that willow basket making has, on the whole, decreased in America in the last ten years.

As the statistics of manufactured imports also show a decrease, it is very evident that foreign wares are not at present actively wrecking the willow industry. The total consumption of willow basket ware in America for 1890, foreign and domestic, amounted to $1,043,282, and for 1900, to $681,204. In 1890 American basket ware comprised 64.3 per cent of the whole, and in 1900 72.4 per cent. These figures show that the homemade basket has slowly and painfully begun to supplant the imported article during the last ten years. At the same time, from the fact that both are decreasing, it is clear that strong external forces are at work upon the industry.

In 1890 the value of the manufactured product of all kinds of basket ware was $3,633,592, the value of the raw material $1,398,483, and the number of establishments 403.[a] The census of 1900 reports a manufactured product valued at $3,851,244, which used $1,292,096 worth of raw material in 550 establishments. These figures show that the manufactured product has slightly increased, and the raw material fallen off in a slightly greater degree. The discrepancy, however, in the relation between raw material and manufactured product is too small to be considered, and the only conclusion to be drawn from the figures is simply that the basket industry as a whole has remained stationary in the last ten years.

Basket ware is made of willow, of rattan, and of wood in various forms. The vast bulk of the import of rattan is not used for basket ware, but enters into the manufacture of furniture, baby carriages, etc. A very large amount of rattan thus used has not been reported by the census under "Baskets, rattan, and willow ware," but rather under the head of "Furniture." For this reason the import of rattan can not be taken as equivalent to the amount of rattan under the head "Baskets, rattan,

[a] It is not to be forgotten that all the basket factories of Liverpool were returned as one establishment in 1890 and as 79 different ones in 1900.

and willow ware," and no conclusions can be drawn from a comparison of these figures. Nevertheless, it can be stated that rattan is encroaching upon certain branches of the willow-basket industry to a marked degree. At the same time, however, willow furniture has begun to replace rattan to an extent which more than counteracts the invasion of the tropical product into the realm of the willow basket.

As basket making in general has made no advance, and as rattan has not gained much on willow, it follows that the ground lost by the willow has been won by the cheaper wooden basket.

Although no statistics are available which show the development of wooden and willow basket ware in the past, there can be no doubt that wooden baskets were made in this country before the use of willow was commonly known, the art having been learned from the Indians. About 1850 willow basket ware was introduced into New York and Pennsylvania, and a market for high grade baskets was soon developed. To answer this need the imports rose to good proportions, and willow basket making commenced to be an important industry. Between the years 1866 and 1880 the imports, both of raw and manufactured willow, rose to their maximum, and the home-made basket had a large share of the field. At the same time, however, the prices were high, and it did not take long for American inventive genius to construct machines which would reduce the cost of wooden baskets to a level which would outsell the willow. This happened probably about the latter years of the seventies, and wrought great havoc in the willow basket industry.

Since 1890 it has been seen that the total basket industry of the country has remained stationary, but that the willow has still continued to lose to the wooden basket. Nevertheless, the willow is absolutely necessary for a certain kind of goods, and it can be safely asserted that it can lose but little more ground even under existing conditions. Everything tends to show that a state of equilibrium will soon be reached, and that the willow will always remain in demand. Indeed, only the price of the willow basket prevents it from being more widely used. A tangible reduction in the price of raw material, as a result of scientific cultivation, would turn the balance in its favor and increase its demand in the market.

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