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THE WILLOWS OF OHIO

A MONOGRAPH

BY

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William R. Lazeney,
John H. Schaffner,
C. J. Herrick,
Trustees.

INTRODUCTION.

The purpose of this paper is to make the willows of Ohio knowable to persons of moderate skill in the determination of plants. Perhaps it would be too much even to hope that it will enable beginners in Botany to deal with the willows. But if it helps those who have already some knowledge of the native flora to extend their acquaintance to this very common genius, it will have justified its preparation. For Salix, like Carex and Crategus is considered by many Botanists too difficult for any but the specialist. Many competent workers seem to be unable to cope with Salix and there are few even of the larger herbaria in which the willows are correctly determined. The reason for this the writer believes to be not in any inherent difficulty of the group for it is not so difficult as many better known genera, but in the fact that an adequate description of it has never been presented. It is toward filling this need that the present effort is directed.

The species are all rather similar and variable but the differences between them are not as inconstant as has been supposed. But the space that has been devoted to them in the manuals is entirely too small for their accommodation even when treated by such a master as Bebb, whose account published many years ago in Gray's manual remains the best treatment of the species within our area. Nor can their character be represented by line drawings such as appear in Britton and Brown's Illustrated Flora; even the lithographs of Sargent's Silva are but little better. The *character* of a willow leaf is too subtle a thing for the ordinary scientific artist to portray; for that, the camera is necessary. Another fault of most of the descriptions and keys hitherto published is that they have been written with a complete specimen in mind, as it might be assembled on the herbarium sheet with both kinds of flowers and leaves. But a collector never has a complete specimen and is sure to be balked by lack of the missing parts. It must be admitted, to be sure, that there are some stages of some species which are almost indeterminable. But they are not so numerous as to make it inadvisable to construct keys for the others.

Any successful treatment of the genus must for the present be local in its scope for Salix is subject to very great geographical variation and a treatment of a given species which would be entirely accurate in a given area might be entirely inadequate for the same species if observed a thousand miles from the first locality. The description of *Salix nigra* given below for example would not cover at all satisfactorily the southern and western plants which go by that name. And yet though the characters

which we use in the descriptions vary enormously, one would still recognize without much difficulty that the southern plant was *Salix nigra* in a metamorphosed condition. Consequently, as far as the native species are coneerned, at least, though it is hoped that this paper will be of service all over the northeastern portion of the United States, one must expect to find it more and more at fault as one recedes from Columbus. Some day when there is a monograph like the present covering every state in the country, some genius will write a general treatment that will effectively handle all the species.

One reason why it is necessary at present to limit the treatment to a small area is that no one has yet succeeded in describing the qualities by which we recognize a willow. We define the species by external, artificial characters such as the shape and hairness of the leaves, the length of the pedicels and so on; but all such characters may vary enormously and still leave the qualities by which the expert determines the species, constant. We cannot study willows profitably by tables of dimensions and geometrical descriptions of the leaves any more than we can study the faces of our friends by measuring the length of their noses. As there is a certain almost indefinable individuality in a human face, there is in a species of plants an individuality no less indefinable but no less important.

I here desire to extend my thanks to friends who have aided me very greatly in the preparation of this paper: to Dr. W. A. Kellerman of the Ohio State University, who at one time planned to be joint author with me, for innumerable kindnesses done and suggestions given during the whole course of the work; to Prof. John H. Schaffner of the same institution for help especially in verifying and testing the keys and to Mr. Otto E. Jennings of the Carnegie Museum for the loan of the collections of that institution.

The present paper is based on studies and collections of willows begun in the spring of 1898 and carried on as opportunity afforded ever since. During that time the author has been enabled to study the plants in the field in various parts of Ohio, in the vicinity of Washington, D. C., and in the Red River Valley of North Dakota and Minnesota. The herbarium on which he has mostly depended is that of the Ohio State University at Columbus. The United States National Herbarium and the Herbarium of the Carnegie Museum at Pittsburg have also contributed considerably to whatever value the work may possess.

TERMS.

Most of the terms used are those common to Botanical descriptions, but those referring to the venation may be so unfamiliar as to require definition. They are based on a most excellent paper by Dr. Glatfelter (Rep. Mo. Bot. Gard 5:46–60. 1894.) on the venation of the willows.

Primary. A main vein branching directly from the midrib.

Costal. A smaller vein from the midrib, of considerable size but not reaching as far as the primaries.

Secondary. A vein of the second order given off from a primary.

Tertiary. A vein given off from a secondary.

Arch. The joining near the margin of a primary with a fork sent off from the one next above, the two branches together forming the arch which rests upon the two primaries.

Loop. Formed by a primary near the margin curving forward and inward and merging into the next above, similar to an arch but lacking the angle at the apex.

Regular. Veins parallel.

Bract. } In his treatment of the genus in Britton's Manual
Scale. } Mr. P. A. Rydberg applies the term bract to the rudimentary perianth of the flower, a small leaf subtending the essential organs, whereas previous writers have termed this a scale and reserved the former term for the bracts which support the aments. This departure from the accepted usage seems to me almost as confusing and unjustifiable as the departures from the rules of priority in nomenclature which the New York Botanists condemn so strongly. Further the meaning given the terms in the glossary at the end of the book, accords better with the older usage than with Rydberg's application of them. Those definitions are here followed. According to Britton, a "Bract" is "A leaf, usually small, subtending a flower or a flower cluster or a sporange." That is, in this case one of the leaves which appear at the bases of the aments. And a "Scale" is "A minute rudimentary or vestigial leaf."—In this case one of the small leaves in the axils of which the flowers are borne. To make the matter worse, Rydberg uses *bract* in both senses thus introducing ambiguity also.

The Willows of Ohio.

THE GENUS SALIX AND ITS RELATIONSHIPS.

The willow family contains but two genera, Salix and Populus. These, in most cases distinct enough in their leaves are separated by the following floral differences. Populus has fimbriate scales, cup shaped discs, elongated stigmas and many stamens, while Salix has entire or only slightly crenate scales, mostly glandular clavate discs, short stigmas and few stamens, two in the majority of the species. In the polyandrous willows which are treated first in the present paper, there is a distinct approach from the diandrous or prevailing willow type toward the poplars, most conspicuously shown in the increased number of stamens but also evidenced in the disc which becomes compound with several glands and sometimes almost forms a lop-sided cup. It is, too, in the polyandrous willows and in those diandrous species manifestly most closely related to them that we find most of the arborescent species--a habit prevailing among the poplars—while most of the willows are shrubs.

There are recognized in all something like two hundred species of willows. They are mostly natives of the north temperate zone but are not entirely absent from the torrid and south temperate zones.

The willow may be counted one of the most successful of present day plants. In few other genera, so compact and homogeneous in respect to their floral characters, is there shown so great a variety of adaptations to varied conditions of life. Within this one genus may be found plants all the way from large trees to dwarf herbs, affecting habitats from the fertile alluvial plain to the barren mountain peak. They grow almost everywhere but yet there are certain limitations in their habitat. Varying from hydrophytes to xerophytes, they are uniformly lovers of the sun and never found to any extent in deep forests or other shaded situations. In their various habitats their vegetative structures undergo wide modifications to accommodate them to their environments. Some species like *Salix lucida* have broad thick leaves, protected from too severe conditions by the hard glossy surface. In others like *Salix adenophylla* the same protection is gained by a thick coating of wool on one or both surfaces. Or a heavy coat of glaucescence may be developed probably to a degree at least for the same purpose. In other cases the leaves are so small as to enable them to endure the most severe conditions, especially when, as is often the case,

there is coupled with the small surface exposed a prostrate habit which shelters them from the wind and allows them any advantage to be gained from warmth radiated from the ground. In great contrast to these dwarf creeping almost herbaceous forms are the tree willows so well known to every one. These, by their rapid growth are enabled to succeed well in their favorite habitat along streams and lakes because they can quickly repair the damage done by floods and storms, while more slowly growing trees would be almost hopelessly beaten down and destroyed before they could rear their trunks to a sufficient size to enable them to withstand the elements. Likewise their well known ability to grow from cuttings and broken branches renders them able to use the very storms which break them in pieces as the means of their further dispersal.

Their well known variability under different conditions is an evidence of plasticity of constitution and adaptability to various environments which is as important a factor in the success of a plant in meeting the competition to which it is subjected as is the same quality in the success of a man. From their adaptability, variability and the large number of intermediates between very divergent forms we may safely infer that we have here a group of species with a very large amount of "Vital Motion" in rapid course of evolution.

ON USING THE KEYS.

To construct a key which will hold for all individual willows is well nigh impossible, because in the first place, there is a greater or less number of hybrids for which no pretense at a key is made; and secondly, there is so much variation in some of the species that even after including them in two or three different places, the writer is not so sanguine as to suppose that he has covered all the variant forms. Bearing this probable defect of the key in mind, it will be understood that the greater the diligence with which each clue given is followed out, the greater will be the probability of a correct determination. If the plant you have seems to fit in both divisions of the key by all means run it through both and after doing so refer to the descriptions and plates as well.

The synoptic table is intended primarily to give some idea of the relationships of the different species and consequently the whole anatomy of the plant is used while all the parts are never present in a single specimen. But in the keys proper everything is subordinated to the end in view, namely the identification of the plant; and only such characters are used as are actually present on a single specimen. In the foot-notes under the keys their especial uses and limitations are discussed.

Synoptic Table of Ohio Willows.

Stamens 3 or more, filaments pubescent at base, catkins appearing on leafy branches. *Polyandrae.*

Trees with rough, flaky, brown bark and brown twigs. *Amygdaleneae.*

Capsules short pedicelled, short globose conic, forming dense thin catkins; leaves green on both sides, glabrous, primaries distant, very fine net veined, with a marginal running nearly to the base of the leaf, linear-lanceolate when mature, often falcate; of very scragly growth, seldom upright; frequenting streams. *S. nigra.*

Capsules long pedicelled, short conic, in lax aments; leaves sometimes 15 cm. long, typically oblong with straight sides, glaucous beneath, generally hairy, primaries ascending, but scarcely forming a marginal; sprawling shrub or straggling tree; southern, river banks. *S. Longipes.*

Capsules long pedicelled, long conic, forming large loose catkins; leaves glaucous beneath, glabrous, primaries close, reticulation not so fine, marginal seldom running below the middle of the blade, broadly lanceolate, petiole often red; an elegant shapely tree; northern, prefers swamps. *S. amygdaloides.*

Shrub, twigs shining brown, scales often dentate, capsules large and glossy, aments thick; leaves ovate-lanceolate, often very long attenuate, sub-coriaceous, glossy above, light green, glands very prominent, especially on stipules; mostly in rocky wet places, northern. *S. lucida.*

Stamens less than 3.

Stamens 2. *Diandrae.*

Filaments pubescent, catkins appearing with the leaves, on leafy branches, except early flowers of *S. interior*, scales nearly as long as the ovularies at anthesis.

Large trees with bark rough but not flaky, leaves glaucous below, capsules glabrous, short pedicelled. *Fragiles.*

Not weeping, primaries and secondaries close and regular.

Bark greenish, leaves glabrous, rather coarsely serrate, and strongly glandular; capsules long conic, remaining green *S. fragilis.*

Bark yellowish, leaves pubescent at least when young, fine serrate; capsules short conic, turning yellow in fruit. *S. alba.*

Bark golden yellow, leaves glabrous in age *S. alba vitellina*

Branches pendent, leaves small, very fine net veined, primaries and secondaries irregular; capsules short globose conic, remaining green in fruit, staminate plants practically unknown. *S. babylonica.*

Shrub, often growing in dense clumps with many slender stems; leaves often very long, linear-oblong, with a strong marginal vein and distant primaries, smaller veins except a few costals vanishing; catkins often in cymose clusters which continue flowering all summer, or the earliest only leafy bracted. *S. interior.*

Leaves short and broad (more than 1 cm.) inclined to be very wooly; cymose clusters of catkins very pronounced, carpellate plant rare. *S. interior wheeleri.*

Filaments glabrous, catkins coming before or with the leaves but not on leafy branches unless in fruit.

Capsules pubescent at least in flower.

Styles short and inconspicuous, less than half as long as ovulary.

Leaves mostly broad, coarsely serrate or entire; capsules long conic, very hairy; upright, many stemmed shrubs preferring lowland swamps. *Capreae.*

Catkins at anthesis seldom 2 cm. long, not very wooly, bracts conspicuous, scales light brown, persistent, pedicel very long, filaments slender; venation prominent below, leaves dirty white tomentose, especially on the veins. *S. bebbiana.*

Catkins seldom less than 2 cm. long, wooly pussies, bracts small, scales almost black, filaments thick, pedicel medium; leaves mostly glabrescent, veins not very prominent below. *S. discolor.*

Leaves narrow.

Leaves undulate-revolute to entire, primaries prominent on the under surface, distant, coming out at right angles and arching or looping regularly to the base of the leaf; aments small short pussies without leafy bracts, capsules long conic, very hairy; upland swamps and hillsides. *S. humilis.*

As above but smaller throughout; leaves up to 5 cm. long, aments less than 1 cm. long, shrub less than 1 m. tall; prairies especially. *S. humilis tristis.*

Leaves sharply serrate, showing a decided tendency to blacken in drying, aments from pussies, bracts small or none, capsules when long conic, thinly pubescent; lowland shrubs. *Sericeae.*

Capsules blunt, short pedicelled, short conic, densely silvery silky; leaves dull above, lustrous sericeate below, at least till old. *S. sericea.*

Capsule long conic, long pedicelled, sparsely pubescent; leaves shining above, glaucous below, glabrous (or rusty sericeate when young); northern. *S. petiolaris.*

Style very long, capsule short conic, silky, white; leaves long and narrow, revolute with veins prominent below and depressed above, not distinctly arching, snowy tomentose below; wet prairie shrub not more than a meter tall; northern. *S. candida.*

Capsules glabrous, styles short, filaments glabrous.

Filaments distinct to the base; leaves sharply serrate, good sized shrubs. *Cordatae.*

Leaves dull on both sides, only a little paler beneath

Leaves thickly pubescent on both sides alike, short and broad, bracts broad, remaining green; northern. *S. adenophylla.*

Leaves thinly pubescent with most of the hair on the veins beneath, or glabrous, green on both sides or slightly glaucous beneath, lanceolate, bracts narrow, remaining green. *S. cordata.*

Leaves glossy above, very glaucous below, glabrous, generally broad, bracts narrow; turning black; northern. *S. glaucophylla*

Filaments frequently united at the base, capsule long pedicelled in fruit, leaves small, entire, purplish green, conspicuously reticulated; low shrub in sphagnum bogs. *S. pedicellaris.*

Stamen 1, formed by the coalescence of 2, anthers 4, scales black, reflexed in staminate flower, capsules rarely seen, short, thick, hairy; leaves oblanceolate, opposite or scattered, purplish; shrub with long slender branches. *Synandrae. S. purpurea.*

Key Based on Carpellate Aments.*

1. Flowers appearing in pussies before the leaves, bracts small or absent. 2.
1. Aments and leaves unfolding together, bracts mostly large. 11.
2. Capsules glabrous from a wooly rachis, inner membrane of bud scale growing out beyond the outer. 3.
2. Capsules silky till after breaking open, bud scale not as above. 5.
3. Capsules turning brown when ripe, 10 mm. long, aments lax, bracts glabrous and glaucous in fruit. *S. glaucophylla.*
3. Capsules remaining green, less than 10 mm. long, bracts green on both sides. 4.
4. Bracts narrow, obscurely serrate or entire, aments becoming rather lax, leaves becoming glabrous above. *S. cordata.*
4. Bracts broad, prominently glandular, aments dense, leaves becoming densely tomentose above; northern. *S. adenophylla.*
5. Style very long and slender, rose red at anthesis, conspicuous, capsule snowy white; leaves tomentose; dwarf shrub; northern. *S. candida.*
5. Style less than half as long as ovulary, leaves glabrous above. 6.
6. Capsules short conic. 7.
6. Capsules long conic. 8.
7. Aments long, 35 mm. or more, very dense, often opposite, capsules large, strictly sessile, carpellate plant rare. *S. purpurea.*
7. Aments short, 30 mm. or less, moderately dense, not opposite, capsules small, short pedicelled. *S. sericea.*
8. Capsules short pedicelled. 9.
8. Capsules long pedicelled; northern. 10.

*The fruiting aments of our willows are quite distinctive and though the differences between the species are not always easy to describe, they are constant and easily learned, so that with fruiting specimens we should have a minimum difficulty in determination. But in flower they are by no means so easy to determine. The ovularies are all very much alike and seem not to develop character until filled out. In fruit too, the leaves of most specimens are present and help greatly.

The greatest need of caution in using the key is to be sure that the descriptions of capsules are not applied to younger stages which are more slender with shorter pedicels. It will also be found difficult to use the key after the capsules have burst. The leaves referred to are those present at flowering and fruiting time. They may or may not be similar to the mature leaves of the species.

9. Aments long in fruit with many capsules, stigmas greenish white when fresh. *S. discolor.*
9. Aments short and thick, few flowered, stigmas red when fresh. *S. humilis.*
10. Aments short, scales frequently darkened at the tip, leaves narrow, turning black. *S. petiolaris.*
10. Aments long, scales yellow, leaves broader, strongly veined, remaining green. *S. bebbiana.*
11. Capsules hairy. 12.
11. Capsules glabrous. 16.
12. Style more than 1 mm. long. *S. candida.*
12. Style less than 1 mm. long. 13.
13. Capsule subsessile, blunt pointed, stigmas sessile. *S. interior.*
13. Capsule with a distinct pedicel, acute, narrow conic, stigmas rarely sessile. 14.
14. Capsule thinly hairy, almost glabrescent, aments short, leaves narrow, silvery, blackening; northern. *S. petiolaris.*
14. Capsule persistently hairy, aments long. 15.
15. Scales persistent, light colored, leaves broad, wooly below with prominent veins, pedicels very long; northern. *S. bebbiana.*
15. Scales usually deciduous at length, almost black, leaves without prominent veins, pedicel short to medium. *S. discolor.*
16. Capsules long pedicelled. 17.
16. Capsules short pedicelled or sessile. 19.
17. Aments short, bracts obtusish, small, capsules generally redening; small shrub in sphagnum bogs only. *S. pedicellaris.*
17. Aments long, bracts large; good-sized shrubs or trees. 18.
18. Capsules narrow conic; northern. *S. amygdaloides.*
18. Capsules mostly globose conic; extreme south. *S. longipes.*
19. Capsules short conic, aments nearly glabrous. 20.
19. Capsules rather long conic. 22.
20. Aments dense, short (25 mm. or less) of small calibre, with a few small bracts. *S. babylonica.*
20. Aments longer, bracts larger. 21.
21. Scales as long as the ovulary, capsules yellowing in fruit, aments rather lax; leaves pubescent, glaucescent. *S. alba.*
21. Scales shorter than the ovulary at anthesis, capsules green, aments dense; leaves glabrous, green *S. nigra.*
22. Bracts, especially stipules, very glandular, coriaceous, bracts and leaves broad, green, capsules when ripe more than 6 mm. long; northern. *S. lucida.*

22. Bracts not especially glandular, stipules seldom present, capsules less than 6 mm. long. 23.
23. Stigmas sessile, capsule blunt, flowers often fascicled on the rhachis with a distinct interval between the fascicles, bracts green; shrub in dense clumps. *S. interior.*
23. Stigmas on a short style, capsules pointed, flowers not fascicled. 24.
24. Sprawling shrub. *S. cordata.*
24. Trees in clumps with few stems or single. 25.
25. Leaves green, reticulate venation very fine, bark brown, undeveloped stages of *S. nigra.*
25. Leaves glaucescent, venation coarse, bark yellow or green. 26.
26. Leaves glabrescent. *S. fragilis.*
26. Leaves pubescent, young stages of *S. alba.*

FIELD KEY BASED ON MATURE LEAVES AND HABITS.*

1. Leaves alternate. 2.
1. Leaves opposite, oblanceolate, nearly sessile, stiff ascending, purplish green; shrub with long slender branches. *S. purpurea.*
2. Secondary and tertiary veins prominent by transmitted light, unless concealed by tomentum. 3.
2. Secondaries and tertiaries almost obliterated with age, primaries distant, running into a strong marginal; leaves narrowly oblong, serrate with distant spinulose teeth or entire; often forming dense slender stemmed clumps. *S. interior.*
3. Leaves persistently pubescent. 4.
3. Leaves glabrous unless very young. 18.
4. Pubescence not concealing the upper surface. 6.
4. Both surfaces hidden, at least till mature, by a thick coat of tomentum; shrubs growing in exposed places. 5.

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* NOTE. This key is constructed for *mature* well developed leaves. It will not hold for leaves which have not acquired their full size or venation, nor for those of water-shoots and suckers. In immature leaves the primaries are usually more ascending, the other veins not well developed; and the leaf is commonly relatively broader and blunter than when mature. Frequently the two or three terminal leaves of a twig do not assume the character of the species so that one must be careful not to be misled by them when they are different from those lower down on the twig. The leaves of water-shoots are so characterless that it is often difficult for an expert to determine them certainly. They are all thin, green on both sides, lacking both the pubescence and glaucescence which may render the normal leaves distinguishable.

5. Leaves oblong, hair long and straight. *S. interior.*
5. Leaves ovate, hair shorter, matted. *S. adenophylla.*
6. Pubescence not lustrous. 7.
6. Leaves clothed below, sometimes only thinly, with silvery short hair having a lustrous appearance almost like changeable silk, glabrous above, narrow, narrowed to both ends, sharply serrate, generally blackening in drying, venation irregular; sprawling shrub. *S. sericea.*
7. Leaves narrow, oblong or spatulate, broadest above the middle, margins mostly revolute, venation very prominent below. 8.
7. Not as above, margins serrate (or rarely entire but not revolute.) 10.
8. Hair dull red brown, leaves dull above, not revolute. *S. discolor.*
8. Pubescence not ferruginous, leaves revolute. 9.
9. Secondaries depressed above, leaves very thickly snowy tomentose, especially on the veins, margins mostly entire; dwarf prairie shrub, northern. *S. candida.*
9. Secondaries not depressed above, leaves gray tomentose, margins mostly undulate; growing larger, in hillside swamps and uplands. *S. humilis.*
10. Leaves coarsely serrate with relatively distant, blunt teeth incurved except when young, or entire; swamp shrubs with ascending stems. 11.
10. Leaves closely and sharply serrate, rarely entire, teeth not incurved. 12.
11. Veins often depressed above, dirty white tomentose and very prominent on the under surface; northern only. *S. bebbiana.*
11. Veins not depressed above, not very prominent beneath nor especially hairy, frequently ferruginous. *S. discolor.*
12. Pubescent on both surfaces. 13.
12. Pubescent only below. 14.
13. Leaves ovate, subcoriaceous, very glandular, rarely entire, tomentose with matted wool, green on both sides; shrub, northern. *S. adenophylla*
13. Leaves lanceolate, thin, not especially glandular, pubescent with parallel hairs, glaucous beneath; tree. *S. alba.*
14. Pubescence evenly distributed. 15.
14. Pubescense mostly on the veins, wooly. 16.
15. Venation regular, neither arching nor looping; arborescent. *S. alba.*
15. Venation irregular, arching or looping; sprawling shrub *S. sericea.*

16. Primaries ascending a long way near the margin, usually not arching; leaves narrow, often auriculate in rank growth. *S. longipes.*

16. Primaries more distant, forming a series of arches or loops near the margin; not auriculate. 17.

17. Leaves ovate; northern. *S. adenophylla.*

17. Leaves lanceolate. *S. cordata.*

18. Leaves green on both sides, only a little paler if at all beneath. 19.

18. Leaves glaucous beneath. 27.

19. Leaves relatively thin, dull. 20.

19. Leaves subcoriaceous, glossy above, strongly glandular especially on the stipules, ovate or broadly lanceolate, often, especially in rank growth, very long attenuate; buds and twigs bright shining brown, buds large; a beautiful shining shrub; northern. *S. lucida.*

20. Marginal vein prominent, extending nearly to the base of the leaf, primaries distant. 21.

20. Marginal not present, primaries closer. 23.

21. Leaves very finely serrate, reticulate venation very fine, long acuminate, frequently falcate; growing into a scraggly tree, along streams. *S. nigra.*

21. Leaves spinulose serrate to entire, teeth rather distant, meshes coarse, acute, not falcate; shrubs tending to form close thickets. 22.

22. Leaves, except those at the bases of the season's twigs, less than 1 cm. wide. *S. interior.*

22. Leaves more than 1 cm. wide. *S. interior wheeleri*

23. Leaves dark purple green, entire or obscurely serrate. 24.

23. Leaves bright green, mostly distinctly serrate. 25.

24. Leaves elliptical; dwarf shrub in sphagnum bogs only. *S. pedicellaris.*

24. Leaves mostly oblanceolate; shrub with many ascending branches, often planted. *S. purpurea.*

25. Venation irregular, primaries mostly arching or looping; shrubs. 26.

25. Venation regular, primaries ascending to near the margin; arborescent; water-shoots of *S. fragilis.*

26. Leaves sharply serrate; shrub with branches lopping over onto the ground. *S. cordata.*

26. Leaves distantly serrate with incurved teeth; shrub with stems ascending. *S. discolor.*

27. Leaves spatulate, elliptical, or oblong-oblanceolate, not sharply serrate. 28.

27. Leaves lanceolate or broader than above, serrate. 31.

28. Leaves distantly serrate with incurved teeth, not revolute. *S. discolor.*

28. Leaves entire or very obscurely serrate, frequently revolute. 29.

29. Margin undulate-revolute, veins very prominent below, bright green, only rarely completely glabrous. *S. humilis.*

29. Margin not undulate, veins not raised below, purplish green. 30.

30. Leaves elliptical, widest near the middle; dwarf shrub in bogs. *S. pedicellaris.*

30. Leaves oblanceolate, widest above the middle; good-sized shrub; often planted. *S. purpurea.*

31. Leaves with a strong marginal vein, smaller veins forming a very fine meshwork, leaves small, narrow, often falcate; tree with pendent branches. *S. babylonica.*

31. Marginal if present not extending much below the middle of the leaf. 32.

32. Leaves bluntly and coarsely or irregularly serrate with incurved teeth or entire; shrubs. 33.

32. Leaves sharply serrate with projecting teeth. 36.

33. Leaves extremely glaucous below, glossy above, broadly lanceolate or ovate; northern. *S. glaucophylla.*

33. Leaves with a thin bloom beneath, not glossy. 34.

34. Leaves lanceolate, long acute, venation regular; bark of branches green, smooth; arborescent. *S. fragilis.*

34. Leaves mostly broadest above the middle, short acute; bark of branches brown, soon roughened. 35.

35. Water shoots, blackening in drying { *S. glaucophylla.* and *S. discolor.*

35. Well developed leaves, remaining green. *S. discolor.*

36. Leaves held up by the stiff midrib so as to display their white under surfaces, broadly lanceolate or ovate, mostly glossy above and very heavily glaucous below; northern. *S. glaucophylla.*

36. Leaves not held up against the twigs, mostly lanceolate. 37.

37. Primaries mostly forking and arching; sprawling shrubs. 38.

37. Primaries mostly ascending without forking, arching or looping; arborescent, not sprawling except *S. lanifera*. 39.

38. Leaves dull above, not very glaucous, almost always with a trace of hair on the veins above or below, quite sharply serrate, petiole slender. *S. cordata.*

38. Leaves subglossy, frequently very glaucous, when young sometimes pubescent but with evenly distributed sericeate hairs, inclined to be distantly serrate with prominent glands, petiole slender, leaves hanging down gracefully from the twigs. *S. petiolaris.*

39. Venation mostly regular, reticulations not very fine, no marginal; trees with smooth bark on the branches. 40.

39. Venation mostly irregular, reticulations very fine, with a strong tendency toward a marginal; bark of branches ridgey, brown. 41.

40. Bark of branches yellow to olive; serrations very fine and sharp, not especially glandular. *S. alba.*

40. Bark of branches green; serrations rather distant, glands prominent, glauscescence absent from the veins beneath leaving them contrasted with the rest of the leaf. *S. fragilis.*

41. Northern and western parts of state only, shapely tree, especially in swamps; leaves ovate-lanceolate, twigs smooth. *S. amygdaloides.*

41. Extreme south only, straggling tree or sprawling shrub in river beds; leaves oblong-lanceolate, twigs usually pubescent. *S. longipes.*

AMYGDALENAE, BLACK WILLOWS.

Mostly trees with rough brown bark, leaves long attenuate, often falcate, with a marginal vein at the tips at least, reticulations of the secondaries and tertiaries very fine. Catkins unfolding with the leaves, stamens 5 or more, filaments pubescent, scales one colored, deciduous, capsules glabrous, green, style short or none. Conspicuous inhabitants of the temperate regions of America and extending clear through the tropics to Chili and Peru.

For a key to this section of the genus I feel that I cannot do better than copy the following table in which the characters of the three species are contrasted, from an article by Dr. Glatfelter in Science Nov. 1, 1895, which I have found quite useful. It is constructed for the forms about St. Louis and is particularly servicable on that account; for Missouri is the only region where the ranges of all three species overlap and all can be studied together.

S. nigra	*S. longipes*	*S. amygdaloides*
Range extended north and south	south of 39° lat.	north and west
large tree, branches crooked, ascending	small spreading top	large, branches straight
stems in clumps	single	single
old bark flaky	deeply laticed ridg'y	smooth or roughish
twigs very brittle at base	tenacious	somewhat brittle
hardy	buds winter-killed	hardy
shoots pubescent	hoary pubescent	glabrous
leaves oblong or linear lanceolate	same or broader	ovate-lanceolate
bases acute to truncate	acute to auriculate	acute to cordate
under surface green	whitish glaucous	bluish glaucous
venation very minute, strong marginal	without marginal	coarser more regular
petiole short	short	very long
stipules pointed, persistent, non-glandular	obtuse, persistent, non glandular	obtuse, caducous, always glandular
blossoms about April 25	May 5	April 15
stamens mostly less than 6	4–7 mostly 5–6	6–9
scales short, obtuse	ovate	ovate-oblong, acute
capsules ovoid conical	globose conical	ovoid conical
pedicel short, slender	long, stout	long, stoutish
notched stigmas and style	both poorly developed.	as in nigra.

SALIX NIGRA Marsh. BLACK WILLOW.

A tree occasionally reaching a height of 40 meters and a trunk diameter of 1 meter but generally dying when about 15 meters tall. It most often grows in characteristic straggling clumps with four or five crooked, leaning stems. In the fall it drops off most of the season's twigs leaving the old branches bare, a habit which hinders their elongation and in a few years makes them thick and stubby. This excess of self-pruning together with the straggling clumps in which it grows give it a habit which in typical specimens clearly distinguishes it from any other

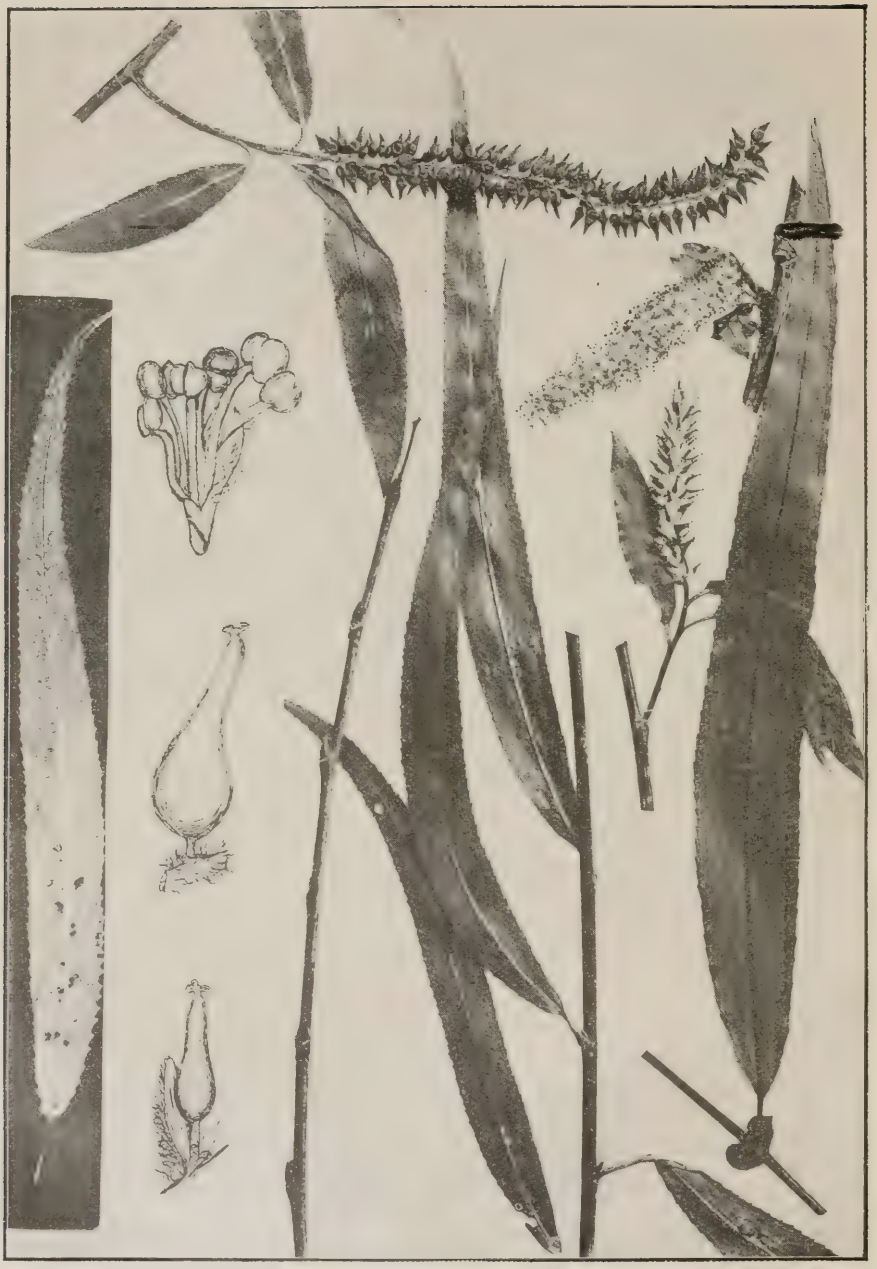

Plate I. SALIX NIGRA.

species, especially in winter when it is leafless. In summer the long slender twigs sometimes give it almost the appearance of the Weeping Willow from which, however, it can be easily distinguished by its leaves green, not glaucous. The winter buds are very small, less than 3 mm. long, broadly ovate, acute, commonly but not always without the mark of the leaf base across the back. The leaves commonly are about 10 cm. long by 1 wide, narrowly lanceolate with a very long attenuate-falcate tip, mostly very finely serrate, green and glabrous on both sides. The characteristic venation of the Amygdalenae is at its fullest development in *Salix nigra*. The marginal vein often runs almost to the very base and the secondaries and tertiaries blend into a system of meshes finer than in any other of our species.

Sometimes broad, blunt leaves are found at the bases of lateral twigs but they are still easily recognized by their fine reticulation. The aments appear with the leaves, capsules glabrous, short conic, short pedicelled, forming thin close cylindric catkins which, supported as they are by the characteristic leaves, resemble those of no other species. The staminate resemble very closely those of *S. amygdaloides* (which see), stamens 5 or more, filaments pubescent.

Everywhere throughout the state, *Salix nigra* is our commonest willow. But it assumes a much more important role in plant society along the southern border than further north. There it attains its greatest size and at the same time becomes much more abundant than elsewhere. For long distances along the Ohio River it is almost the only native willow met with and occupies all the territory which in the north is divided up between several species.

So far as Ohio is concerned it is perhaps the most constant and easily recognized of our willows but in the south it is almost identical with *S. humboldtiana* and is rather hard to separate from *S. longipes*. In the west it is represented by several variable varieties which seem to connect it with related forms and render it a very difficult subject indeed.

Its typical habitat is along streams but it may be found in wet places generally though it seems to prefer moving to stagnant water and is much more infrequent in swamps.

The variety "*falcata*" is a form with narrower more falcate leaves. In my opinion it is scarcely worthy of consideration since it is not genetically different but is merely an accidental leaf variation without correlated variation in other characters

Plate I. *Salix nigra*

Leaves of ordinary growth and of ranker growth with stipules; flowers and fruit typical; natural size; drawings of the flowers and capsules made with camera lucida and photographed enlarged seven times.

of the plant. All the leaves are more or less falcate; their falcation varies greatly on the same plant.

A hybrid between *S. nigra* and *S. alba* has been reported from New York.* It is said to have the catkins of *S. alba* and the leaves of *S. nigra* x *amygdaloides*. Such a cross is most surprising in view of the distant relationship of the parents. It has not been reported from Ohio.

Salix longipes Shuttlew. Ward's Willow.

This species has not as yet been found in the state; its nearest reported station is at the falls of the Ohio at Louisville. Though this is some distance south of our territory it is possible that it may be found along the Ohio River. I include it here because of that possibility and in order to make the paper more useful outside the state. Its range extends from Missouri to Washington, D. C., and southward to the Gulf. Dr. Glatfelter says that it is not found like *S. nigra* sometimes away from the banks of the streams but is strictly confined to them.

Sometimes it grows into a tree like *S. nigra* but much more bushy. Around Washington it is a low shrub resembling *S. cordata* surprisingly, considering the remoteness of their relationships. The leaves have short stout petioles which with the midribs and larger veins are usually hairy. The blades are extremely variable. Frequently in rank growth they are auriculate at the base; this character when present segregates them at once from any other of our species. Sometimes they are very long, oblong-lanceolate with straight edges narrowing gradually to the tip; and this again is like no other of our species. More often they are lanceolate with upper surfaces varying from shiny and glabrous to dull and hairy. Sometimes they resemble those of *S. nigra* closely except for the glaucous under surface. Or they may be so similar to those of *S. cordata* as to deceive even the expert; often this resemblance is especially well borne out by the under surface which is at times gray glaucous and hairy exactly like that species when grown in a dry place. The two can best be distinguished by the venation which is similar to that of the rest of the Amygdaleneae except that the marginal is hardly perceptible and in its place the primaries ascend a long way near the margin.

From printed descriptions *Salix amygdaloides* might be confused with the present species but they are not very similar. *Salix amygdaloides* is a much cleaner more shapely tree, never shrubby; its leaves are long petioled, decidedly broader, much

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* Bebb, Abrorescent Willows of North America 3. Gard. & For. 8:423 1895. Fig. 58.

more sharply pointed and never pubescent. While both have a bloom on the under surfaces, *S. longipes* is gray glaucous and *S. amygdaloides* bluish glaucous. Besides all this their ranges do not overlap in Ohio.

In fruit it is easily distinguishable from either of the other Amygdaleneae. The capsules are similar to those of *S. nigra* but larger and long pedicelled like those of *S. amygdaloides*.

Salix amygdaloides Anders. Peach-leaved Willow.

Salix amygdaloides grows to medium sized or rarely to a large tree. Its bark and general appearance suggest at once its affinity for the black willow of which it was once considered a variety. Its habit, however, differs very considerably from that of *Salix nigra*. It is generally single-stemmed and very shapely, with clean branches and darker brown, smoother bark. The winter buds are nearly twice as large as those of *Salix nigra*, dark brown above with a much lighter base where they were protected by the petiole of the old leaf in the fall. *Salix amygdaloides* is well-named for when in leaf the tree, at a little distance, often bears a striking resemblance to a peach tree; the twigs and petioles are often reddened and the leaf arrangement is similar to that of a peach tree. Both twigs and leaves are entirely devoid of hairs while young shoots, at least, of the other black willows are pubescent.

The leaves are much broader than in the other members of the *amygdalenae*, often being almost ovate, distinctly broadest below the middle with a rounded base and an attenuate falcate tip, bright green above, glaucous beneath. The venation while of the black willow type begins to approach the regular type, exemplified by *S. alba*; the primaries are close, the marginal vein short, hardly extending as far as the middle of the leaf, and the meshwork, though very fine is much coarser than in *Salix nigra*, while the secondaries are often more or less regular.

The catkins are so similar to those of the black willow that it is difficult to distinguish them in dried specimens. With the carpellate aments the difficulty disappears in fruit but with the staminate it continues in old flowers. The brightening of the bark at flowering time, which is noticeable in all willows renders the twigs in *Salix nigra* very similar to those of the present species and its smaller buds are swollen to about the size of those of the Peach-leaved willow so that they can be used as a diagnostic character no longer. The leaves supporting the catkins are too young to have assumed their characteristic texture and the aments themselves are almost the same. But *Salix amygdaloides* flowers nearly two weeks earlier than *Salix nigra*, which together with the habits should distinguish them in most cases.

Plate II. SALIX AMYGDALOIDES.

The ripe capsules of *Salix amygdaloides* are narrowly long-conic on long pedicels, contrasting with the short pedicelled capsules of *Salix nigra* and giving the aments a very different appearance.

S. amygdaloides is characteristically a swamp plant though it is not absent from river banks. In Ohio its range is over the northern and western parts of the state. Columbus is near its southern limit in central Ohio; further east it does not extend so far south while further west I suspect it may even reach the river. It is a north-western species of which Ohio is near the eastern limit.

While remaining for the most part recognizable in the west, *Salix amygdaloides* loses the glaucescence of the under surface of the leaf while the upper surface brightens till it is almost like *Salix lucida*. The shape of the leaves also changes and becomes shorter and broader. Southwestward it grades into the varieties of *S. nigra* which occupy the region. About St. Louis there is a great complex of the *amygdalenae* in which pure forms of the three constituent species are uncommon and there are all sorts of interconnecting variations. In Ohio we have only two species together and intermediates are rare though several have been collected.

LUCIDAE.

Trees or shrubs, branches shining; leaves often very long acuminate, broadly lanceolate to ovate, thick, glossy, strongly glandular; catkins leafy peduncled, thick and dense, scales caducous, often dentate, filaments pubescent, capsules glabrous, style short, stigmas thick.

Salix lucida Muhl. Shining Willow.

A bush or very rarely a tree 8 m. tall; bark smooth or nearly so; twigs shining orange brown, glabrous; buds rather narrowly ovate, large, (5-10 mm. long) bright reddish brown in spring, duller earlier in the season. Leaves reaching an extreme length of 18 cm. and a breadth of 8 cm., varying from ovate to lanceolate, rounded or narrowed at the base, prominently glandular-serrate, especially on the deciduous stipules, often covered when young with long tawny scattered hairs, becoming glabrous, coriaceous, very glossy above so as to give the plant a very beautiful appearance different from any other willow. The thickness of the leaf makes the rather regular venation difficult to make out. Stam-

Plate II. *Salix amygdaloides*.

All parts typical, natural size except the capsule which is enlarged three times.

Plate III. Salix lucida

nate catkins borne with the leaves; easily recognizable by their large diameter and fine appearance; scales large, conspicuous, crenate or dentate, stamens mostly 3-5, filaments pubescent at the base. Carpellate catkins also large, dense, 5-8 cm. long in fruit, long persistent, scales obovate, slightly pubescent, pedicel nearly half as long as the capsule, stigmas large thick, deeply notched, style short, capsule narrowly cylindric, about 6 mm. long.

Salix lucida is a northern plant occuring in the northern third of the state but not extending to Columbus.

Salix lucida hybridises with *Salix alba* and *S. fragilis* and when all three come together in one plant it creates very great confusion in a group already very difficult to handle. Though hybrids are mostly individual cases and irreducible to any general type, it may be said that hybrids between *S. lucida* and one of the fragiles are likely to have some of the following characteristics. Nearly always the leaves are dull instead of glossy, sometimes they are pubescent like *S. alba*. They are likely to retain somewhat of the prominently glandular character of *S. lucida*. Though they may be almost typical of one of the other species in other respects, they are almost certain to have the large reddish brown winter buds of *S. lucida*. The stamens are [illegible] two but the catkins are likely to be short and thick as in *S. lucida* and dentate scales are frequent.

Salix pentandra L. European Shining Willow.

Salix pentandra, the European species corresponding to our *Salix lucida*, has been detected as an escape in two places in the state.* It is not infrequently cultivated as a basket willow and may be met with anywhere in cultivation.

It is most difficult to distinguish from *S. lucida* and in some forms of the native species they cannot be told apart with certainty. *Salix pentandra*, however, never has the long attenuate leaf tips common in *S. lucida*, nor even on watershoots. Its leaves are rather thinner and not quite so glossy as those of *S. lucida*. It does not grow as rank and does not succeed well in this climate. The [illegible] around Columbus complain that it winter-kills.

I should not advise a beginner in Salicology to try to distinguish the two forms in the [illegible] *Salix lucida* but any form outside the range, with the less acuminate leaves of *S. pentandra*, may be suspected.

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* Sci. O. Nat. 4:19—July, 1902.

Plate III. *Salix lucida*.

Large leaf from rank growth; smaller pair from ordinary twigs; the short broad blunt one from the base of a branch; flowers and fruit typical; natural size; capsule enlarged three times.

Plate IV. Salix fragilis.

FRAGILES, CRACK WILLOWS.

Trees, originally introduced from Europe and though now freely escaped, still largely planted and often found growing in rows (except the Weeping Willow). The bark of the medium-sized branches is smooth, and yellow or greenish as distinguished from the rough brown bark of the Amygdalenae. The leaves of all the species are glaucous beneath and without stipules unless very young. The catkins are borne with the leaves on lateral branches; the stamens are normally only two; the capsules glabrous and green, in flower at least, like the Amygdalenae but unlike the other diandrous willows.

The Fragiles are clearly intermediate between the polyandrous tree-willows and the diandrous shrubs. But among themselves their relationships are not so clear. By hybridisation and the importation of various horticultural varieties the group is very much confused and consists of many very closely similar forms. It has been the despair of many Botanists and one finds more mistakes in the determination of this group than in any other.

Key.

From habit.

- Growing in clumps.
  - Bark of branches green. *S. fragilis.*
  - Bark of branches yellowish green or yellow. *S. alba.*
- Large trees, not in clumps.
  - Branches long, drooping. *S. babylonica.*
  - Branches not pendulous.
    - Large branches and trunk disfigured by many adventitious twigs, a tall tree with a central shaft, branches yellowish. *S. alba.*
    - Without many adventitious twigs, a low broad topped tree without a central shaft, branches green. *S. fragilis.*

From leaves.

- Leaves with a marginal vein, reticulations very fine, venation irregular, leaf narrow, acuminate, often strikingly falcate, sharply serrate. *S. babylonica.*
- Without marginal, reticulations not so fine, venation regular, leaf broader, not acuminate nor falcate.

Plate IV. *Salix fragilis.*

Leafy twig typical of our American form. The single broader leaf resembles more closely the European form, natural size; capsule enlarged three times.

Leaves sharply serrate, pubescent at least when young, glaucescence bluish. *S. alba.*
Leaves distantly blunt-serrate, glabrous, glaucescence greenish. *S. fragilis.*

From capsules.

Capsules long conic, short pedicelled, green or black in drying. *S. fragilis.*
Capsules short, ovoid conic, pedicel very short or none.
Capsules yellowing, catkins often long. *S. alba.*
Capsules green, catkins short. *S. babylonica.*

Salix fragilis. L. Crack Willow.

A tree reaching a height of 25 m. and a trunk diameter of 2.1 m. When in clumps it forms a tall slender tree, but a single individual growing alone branches out so that the head is as thick as high. The bark of the trunk is roughish, gray, that of the smaller branches green and of the twigs sometimes red, winter buds large (7 mm.) seldom well filled out. Leaves reaching a length of 17.5 cm. and a breadth of 4 cm.; acute, narrowed to the base, coarsely serrate with prominent glands, glabrous, greenish glaucous beneath, petiole short, stipules early fugacious, venation regular, showing through the glaucescence as a dark net work, primaries ascending, straight, close together, not arching. The aments being accompanied by leaves are easily identified by the leaf characters; stamens 2, with pubescent filaments, ripe capsules long conic, green, with a short but distinct pedicel.

Salix fragilis is a European species planted extensively along streams to hold the earth or to act as a wind-break. It is also pollarded for its twigs which are valuable in basket making. It is one of the most abundant species in our area. It is found both planted and escaped everywhere. Our American plant is different from the typical European form in having narrower leaves but it is in most cases sufficiently distinct from *S. alba.*

Because of its quick rank growth, shapely habit, and beautiful gray green foliage which turns over very prettily with every breeze *Salix fragilis* is the best of the willows to plant for a shade tree. It is difficult to understand why it has not supplanted *Salix alba* and its varieties long ago. But the nurseries nearly always carry a larger stock of the latter sorts which are much inferior because of their habit of sending out suckers all over their trunks.

Salix alba L. White Willow.

A tree attaining a maximum height of 30 m. with a trunk diameter of 2.5 m. Like *Salix fragilis* often growing in clumps but when single-stemmed it is taller and more slender and has the trunk continued as a central shaft to near the top. It is not clean like that species but is covered with a brush of suckers. Bark of the twigs and branches yellowish green varying to yellow; winter buds smaller (4 mm. long) than those of the crack willow, oblong and well filled out. The leaves reach a length of 13 cm. and a breadth of 3 cm., lanceolate, acute, narrowed to the base, closely and finely serrate, sometimes almost entire, grayish or bluish glaucous, pubescent on both surfaces at least till mature, (hair mostly persistent below) with close, fine, appressed, parallel, gray hairs, stipules deciduous; primary veins close (closer than in *S. fragilis*), straight, ascending, regular, extending to the margin without branching, secondaries conspicuously regular but often forking like the letter Y. Catkins on lateral branches or sometimes supported only by bracts, scales hirsute, deciduous, capsules ovate-conic, not more than 4 mm. long, greenish yellow in fruit, obtuse, glabrous, pedicel very short, style short, stigmas thick.

Salix alba is a European species planted in this country for the same purposes as *S. fragilis*. In most parts of the state it does not seem to escape so readily as that species and hence is not quite as common but may be found planted almost anywhere.

As stated above, most observers have considerable difficulty in separating this species from the preceding. The difficulty is often assigned to their hybridising propensities. But in Ohio at least hybrids are rather rare. I have found that the two species are distinct and separable in nearly all cases though it was only after long study that the ability to distinguish them was acquired. The manuals state that the species in the typical form is rare in this country, the majority of the American forms being the golden osier (var. *vitellina*). It is certainly true that few of our plants are the typical hairy plant of Linneus but study of the European material at Washington leads me to the conclusion that in Europe the typical form is about as scarce as here. Further the extremely bright yellow twigs and glabrous, half shiny leaves of the typical varietal form are scarcer in this country than the pure alba forms. It seems to me good practice in a series of intergrading forms to draw the line between species and variety close to the variety and to call all but nearly typical varietal forms the species simply, if for no other reason to avoid the use of a trinomial.

The variety *vitellina* then, of *Salix alba* includes those plants with bright golden yellow twigs and branches, and leaves soon glabrous and bright green.

Plate V. SALIX ALBA.

The blue willow, *Salix alba coerulea*, has not yet been recognized in Ohio. Indeed there are some willow students of high authority who do not distinguish it at all in this country whatever may be its status in the old world.

As hinted above *Salix alba* hybridises with *Salix fragilis* though not so frequently as might be supposed. It also crosses with *S. lucida* as described under that species.

Salix babylonica L. Weeping Willow.

The Weeping Willow grows into a large graceful tree 20—25 m. tall, easily recognized by its very long drooping twigs, which have a habit peculiar to themselves of sending out numerous short branches at a very acute angle with the main stem. Leaves commonly rather small, 7–10 cm. long, about 1 cm. broad, narrowly lanceolate, long acuminate and often falcate at the tip, narrowed to the base, sharply serrate, glabrous unless very young, greenish glaucous or at least paler beneath, petiole short, stipules apparently absent; primary veins forming regular acute loops which run together into a more or less straight marginal; this together with the very fine reticulations caused by the relative prominence of the tertiaries often gives the leaf a more or less close resemblance to that of *S. nigra*, which, however, is never glaucous as in the present species. Aments on rather short few leaved peduncles, rather dense, not more than 3 cm, long. capsule short conic, glabrous, green, all but sessile, style short.

It is a remarkable fact that the staminate plant of this species is unknown in America. It is sometimes stated that it does not occur at all and it is sufficiently rare to warrant such an assertion but yet in the national herbarium is what I believe to be a genuine specimen of the staminate flowers. It was collected by Coville at Ithaca, N. Y., in 1885 (?). The leaves are similar to those commonly appearing with the carpellate catkins. The aments are short, less than 25 mm. long, densely flowered with a rhachis densely covered with short hairs. The stamens are subtended by a very short ovate scale which is much shorter than in any other of the Fragiles.

Doubtless it is with the Weeping Willow as with the Purple Willow that the absence of one kind of flowers prevents the natural spread of the species and is responsible for the fact that so few plants have escaped when conditions for their growth seem so favorable. But whatever the reason it is certain that the species though commonly planted, escape very rarely. During the last

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Plate V. *Salix alba*.

Leaves and flowers typical, natural size, capsule enlarged three times, photographed and brightened with pencil.

Plate VI. Salix longipes and Salix babylonica.

seven years I have been continually on the lookout for it but have seen less than half a dozen individuals which were not clearly planted. One of these was on the Hocking River near Sugar Grove; the others were along the lake shore in Ashtabula county.

In Europe *Salix babylonica* hybridises freely with *S. fragilis*. But in this country the manuals have not included such a cross. A single plant was discovered at Sandusky during the season of 1903. * The leaves and habit were so exactly intermediate between the two that there could be no doubt of its identity.

At Ashtabula was found a plant which from leaf and habit I take to be a hybrid between the present species and *Salix alba*, which is not reported in the manuals.

LONGIFOLIAE, THE LONG-LEAVED WILLOWS.

The longifoliae comprise a very distinct and compact group of American willows. They have no close affinities with any other group and do not intermingle with any. They have two stamens (a specimen in the Ohio herbarium has three) and light one-colored deciduous scales which show their relationship with both the polyandrous and diandrous willows. Within the group the many described species are difficult to recognize; Bebb, himself, said after he had described two or three of them that he did not know but what they were all one species after all. The group is very easily recognized by the venation of the leaves which is different from any other willow and much resembles that of many Onagraceae, for example the fire weed. There is typically a prominent marginal vein running clear round the leaf, connected with the midrib by a series of distant nearly straight primaries between which there are practically no secondaries and no meshwork, only a few costals running parallel to the primaries. But in young leaves the veins ascend at a much sharper angle and the marginal vein is not so prominent while the secondaries and tertiaries have not yet faded from view so that the above description will not hold. The leaves in some of the species are very long and sometimes so narrow that it is difficult to find any veins at all.

* Ohio Nat. 4:13 Nov. 1903.

Plate VI. *Salix longifolia* (left) and *Salix babylonica* (right).
Typical specimens, natural size; capsules enlarged three times.

Plate VII. SALIX INTERIOR AND SALIX INTERIOR WHEELERI.

Key.

Leaves narrow, not over 1 cm., sometimes very long, secondary, (auxilliary) aments very much younger than the primary; forming dense clumps of slender stemmed shrubs. *S. interior.*

Leaves often 1.5 cm. broad or more, not long in proportion, secondary aments of about the same age as the primary, forming a cymose cluster; low, bushy, not in close clumps; northern. *S. interior wheeleri.*

Salix interior Rowlee. Long-leaved Willow, Sandbar Willow.

(S. longifolia and S. fluviatilis of the manuals in part.)

The characteristic habit of this plant is to grow in clumps about 4 meters high with a great many slender stems coming up very close together from a common root system. These stems are more slender than those of any other of our willows and when the species assumes this habit it may be recognized from a considerable distance. Unfortunately, however, it does not always do so, but sometimes grows by itself as a bush or small tree and then it can best be distinguished by its leaves. The twigs are very slender, thickly branched and straight ascending so that the stems have a peculiar brush-like appearance which gives a pleasing softness to the landscape. The winter buds are small and the twigs resemble those of the black willow more or less closely as the bark is of about the same color. Many of the buds are defective and drop off early in the autumn. The places of such are taken by small lateral buds which develop one on each side of the old scar. This habit when present is characteristic. It is largely responsible for the large number of small branches which come out for there thus arise two twigs instead of one at each node. The leaves are sometimes very long (to 15 cm.) and not more than 1 cm. wide, of almost the same breadth throughout, straight linear-oblong, serrated, but with shallow distant spinulose teeth. When young they are spatulate. The venation is very characteristic except in young leaves as described above. Sometimes they are very hairy even being covered with matted wool persistent until very old, but often they are glabrous and green as soon as they unfold.

Plate VII. *Salix interior* and *Salix interior wheeleri* (marked W).

Leafy branch of the narrow leaved form of *S. interior*, [illegible] two fruiting aments shown, one nearly glabrous, the other with densely tomentose capsules, natural size, capsule enlarged three times. Variety *wheeleri* typical cluster of staminate aments, the densely tomentose leaves in the upper corner are from the form which connect with the species, the larger broad glabrous leaves shown below are the extreme forms of the variety [illegible] from the species natural size.

The flowering season of *Salix interior* is much longer than that of any other of our willows; it begins just after the pussy willows have gone by and continues late into the summer. I have even seen blossoms in October and on Cedar Point they are not uncommon in July and August. The first catkins come out on short peduncles with a few small bracts. Later when the season's twigs have developed, they also bear aments at their tips. Just below these terminal catkins develop other lateral aments which blossom later and so prolong the season. We have no other willow which does this and the presence of these small undeveloped aments is very characteristic. The carpellate aments are generally *but not always* quite lax as they grow older. The flowers have a tendency, sometimes very marked, to appear in fascicles of from three to five on the rachis with a distinct interval between them. This is another characteristic feature present in no other species. The scales are yellow, deciduous, the filaments frequently pubescent. The ovularies at anthesis are scarcely longer than the scales with sessile stigmas on their summits. They vary much in shape being sometimes, especially when very hairy, thick and short with a squarely cut off tip, sometimes nearly rostrate especially when glabrous. The mature capsules are narrowly conic, blunt pointed so as to be almost cylindric if not well fertilised. When well developed they are quite large (1 cm.) sometimes glabrous sometimes tomentose. This variation makes them a puzzling problem and one would suppose there were several species instead of one but there seem to be no lines of cleavage between the different forms.

Salix interior is with the exception of its own variety *wheeleri* and the Texan *S. thurberi* the only representative of the longifoliae east of the Rockies. It extends all oves the Mississippi valley and is occasionally met with east of the Alleghanies. In Ohio it is common everywhere.

Salix interior var. wheeleri Rowlee. Wheeler's Long-leaved Willow.

This variety as I have seen it in Ohio sometimes acquires a slender tree form, but more generally is a low much branched dwarf bush, spreading in the sand by the sprouting of buried stems. These do not as in the species produce a dense clump of stems close together but come up only at distances of a meter or so and the result is a loose clump the members of which appear like independent plants. In extreme forms, the leaves especially the older ones from the axils of which branches come out, are very much broader than in the species (7–10 cm. x 2 cm.), dark green and glabrous with the typical venation of the longifoliae, except that the primaries are ráther closer and more ascending. These extreme forms as they intergrade into the narrow glabrescent leaves of the species pass through a series of forms which

are somewhat narrower but so extremely wooly that neither surface of the leaf can be seen. It was from these that Prof. Rowlee took the type of the variety. These intermediate leaves shade into narrow tomentose forms which connect with the narrow glabrous leaves of the typical species. One might doubt, if he had not studied the plant in the field, that the broad glabrous leaves were the extreme form, were they not accompanied by an extreme in floral development which is more significant than the leaf characters on which Prof. Rowlee separated the variety. This is in the development of the secondary aments at the base of the terminal. In the variety the aments often form clusters of half a dozen, all opening at nearly the same time—a thing which is rarely seen in *S. interior* itself. The flowering period is also distinctly later in the variety than in the species. On Cedar Point it seems to be at its height the first of July and continues into August. Fully 99 % of the plants on Cedar Point are staminate. To what the dearth of carpellate plants is due it is not possible to say at present.

As yet the variety *wheeleri* has been found in Ohio only at Painesville (H. C. Beardslee no. 67, fide Rowlee) and on Cedar Point where it is abundant. It possibly occurs all along the lake shore and possibly for some distance back into the country. But I was unable to find it in Ashtabula county though the conditions seem favorable. Its author limits its range to the basin of the Great Lakes.

CAPREAE.

Low trees or shrubs with leaves ordinarily broad in proportion to their length, generally glabrescent above, mostly tomentose beneath, catkins appearing very early, oftenest in pistillate capsules, in our species, villous.

Key.

From leaves.

Leaves ordinarily very tomentose below especially on the rugose veins, venation strongly sunken above, northern. *S. bebbiana*

Leaves often glabrous, veins not strongly raised on the under surface, nor depressed above, when hairy often with red-brown hairs. *S. discolor*

From flower.

Catkins appearing with the leaves or only a little while before them, small at anthesis, scales yellow or darkened only at the tip, capsules narrowly cylindric, filaments not coarse nor long. *S. lucidula*

Catkins appearing much before the leaves or long persistent, scales dark brown, capsules elongate-conic, filaments coarse, long. *S. discolor*

Plate VIII. SALIX BEBBIANA.

Salix bebbiana Sarg. Bebb's Willow.

A shrub or small tree occasionally reaching a height of 8 meters, with a habit almost exactly like that of *S. discolor* and conspicuously different from that of all of the other shrub willows in that there is scarcely any tendency to sprawl, but the stems all ascend from the root. Leaves generally elliptical, varying from sharply serrate through undulate-serrate to entire or often slightly revolute, generally glabrescent above, wooly below at least on the veins, primaries and secondaries prominently raised on the under surface making them very conspicuous, primaries rather distant, inclined to be crooked and often forking. The whole system of veins strongly sunken from above. Catkins appearing just before or with the leaves, with leafy bracts or, in fruit, on leafy branches; staminate 3.5 cm. long or less; carpellate sometimes 6 cm. in fruit; scales yellow or slightly darkened at the tip, pubescent, *persistent in fruit;* capsule long pedicelled, villous with white silky hair, cylindric, obtuse, sometimes 11 mm. long in fruit.

Salix bebbiana is found across the northern third of the state.

This species in its normal forms is very distinct from *Salix discolor* and can be separated from it withont the least difficulty but the western forms though most keep their flowers like the type, have leaves resembling those of *S. discolor* more or less closely; sometimes even so closely as to be indistinguishable from it. One of these plants from the middle west almost half way between the eastern and western forms of the species Dr. Rydberg has named *S. perrostrata.* Unfortunately, however, the difficulty in separating the two species, though worst in the west, is not confined to that region. Some specimens from Ohio are so nearly intermediate that they can scarcely be determined, but these are rare. There is no danger of any specimen with mature leaves or in fruit being confused with any other species than *S. discolor* for it resembles none, but both kinds of flowers, while the bracts are yet small, resemble those of *S. petiolaris* and the staminate are similar to those of *S. candida.*

Plate VIII. *Salix bebbiana.*

Typical specimens; two fruiting aments one with and the other without [illegible]

Plate IX. SALIX DISCOLOR.

Salix discolor Muhl. Pussy Willow.

The pussy willow is typically a swamp shrub growing in clumps differing from those of *S. sericea* or *S. cordata* in that each plant is usually a close clump, separated from its neighbors by a distinct interval, while those species run over a considerable area in a loose clump. The stems are not ordinarily recumbent but strictly upright and straight. Twigs of swamp plants rank, sometimes almost 10 mm. in thickness varying from glossy to densely tomentose, with very large well filled purple-brown buds. In less luxuriant growth the twigs may be smaller, sometimes wooly, with smaller buds. Leaves varying from ovate to spatulate, coarse serrate with blunt incurved teeth to entire or even slightly revolute, glabrescent above, beneath glabrous and paler to glaucous or sometimes tomentose or pilose. Hair soft and wooly as in *S. bebbiana* or short, straight and ferruginous.

Pussies before anthesis larger than in any other species and consequently this is the favorite species with the children in search of pussies in the spring. At anthesis the staminate with their long coarse filaments are larger than any other of our willows except *S. lucida*; carpellate also very large, sometimes 13 cm. in fruit, scales dark brown, capsules long (8 mm.), rostrate, gray pubescent to glabrate in age, pedicel sometimes nearly as long as the capsule but usually shorter. The flowering time is earlier than any other of our willows and it lasts such a short time that it frequently happens that *Salix discolor* blossoms and goes by before one gets out after it, a difficulty not met with in any other of our willows. When the other pussy willows are found in flower it is generally in fruit so that there is little danger of confusing it with them.

As described above *Salix discolor* includes forms differing from each other very strikingly. But the longer I study them the surer I am that, diverse as they are, all are one *species*. The great differences are all in characters like the shape, surface and pubescence of the leaves, which are subject to considerable variation and are to a great extent the outcome of various environmental conditions. The catkins also vary somewhat but in studying specimens from marked trees taken in flower and leaf I have been able to find no correlation between the separate variations in flower and leaf.

Plate IX. *Salix discolor*.

Leafy twig of the most common form; other leaves shown below from left to right as follows: broad, blunt, tomentose form resembling *S. vagrans* of Europe connecting with *S. bebbiana* (rare); narrow ferruginous form often found on plants which would pass as *S. [illegible]*; long, narrow, nearly entire form, [illegible] twig with winter bud and young pussies; staminate flowers typical; carpellate ament a little narrower than usual; fruiting ament typical except that it is [illegible] long; natural size; capsule enlarged three times.

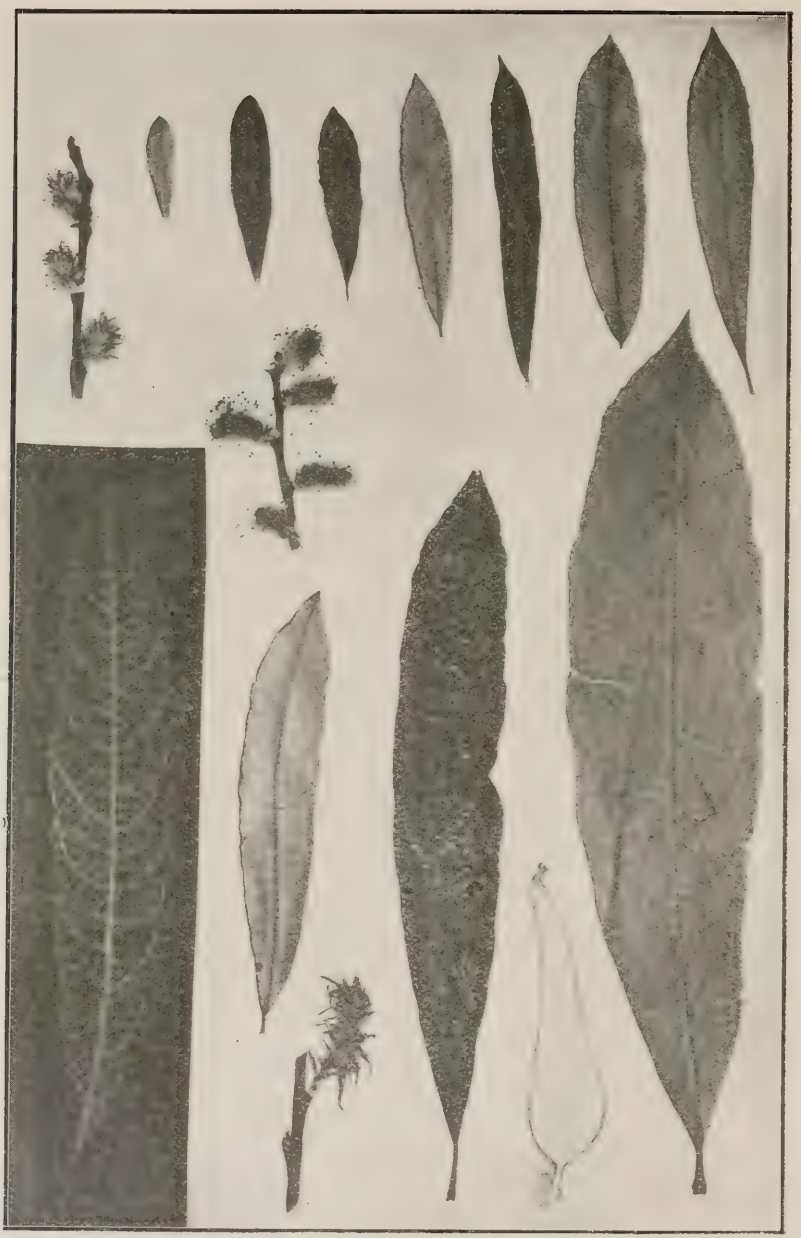

Plate X. SALIX HUMILIS AND VAR. TRISTIS.

Salix eriocephala Michx. of Britton's manual includes those forms with ferruginous hair on the leaves and tomentose twigs.

Salix prinoides Pursh, is a narrow leaved form of the type.

It is common in swamps all over the state.

This species is most difficult to separate from *S. cordata* in leaf but its upright habit and the coarse serration as contrasted with the sprawling habit and sharp-toothed leaves of *S. cordata* are sufficient to distinguish them. As described under *Salix bebbiana* it sometimes connects with that species. Narrow revolute-leaved forms are sometimes found which connect this species with *S. humilis*, probably some of them are hybrids.

Salix humilis Marsh. Prairie Willow.

A shrub not more than 3 meters tall with spreading often recumbent branches. Leaves oblong or spatulate, gradually narrowed to the base, abruptly acute and sometimes mucronate at the tip, mostly revolute, entire to undulate-dentate, puberulent or glabrous above, tomentose, especially on the prominently raised veins beneath. or glabrous and glaucous, primary veins rather distant, inclined to be horizontal, looping or oftener branching and arching, with several costals between them, secondaries quite irregular, catkins born very much as those of *S. discolor*, long before the leaves but smaller than in that species, from short stubby pussies, staminate 2 cm. long or shorter, carpellate occasionally 4.5 cm. in fruit, bracts small or none, scales darkened above, long pilose on the back, glabrous in front, capsules elongated, often rostrate-conic in fruit, hirsute at least when young, pedicelled, sometimes almost 1 cm. long when ripe, style distinct, red.

Salix humilis though common nowhere is generally distributed over the state. It will probably be found growing on dry hillsides in nearly every county.

In most forms *Salix humilis* is easily recognizable in leaf because of the long narrow revolute leaves. In flower it is characterized by the short stubby pussies from which the flowers come. The leaves of the ranker shoots take on an appearance very similar to those of *Salix discolor*. It is from such branches that many of the so-called hybrids of our herbaria came but real hybrids undoubtedly do occur. Sometimes also the present species is very similar to *S. candida*, but ordinarily it is a gray plant while *S. candida* has snowy white wool on the under surface

Plate 8. [illegible]

[illegible]

Plate XI. SALIX SERICEA.

of its leaves contrasting strongly with the rich green of the upper surface. In some hybrids, however, most noteworthily *Salix candida* x. *S. petiolaris* the resemblance is so close as to make it all but impossible to separate the two. But such hybrids usually have a distant scolloped serration derived from *S. petiolaris* which is different from any form of *S. humilis*. At flowering time there will be no difficulty in separating them.

Salix humilis var. tristis (Ait.) Dwarf Gray Willow.

A depauperate form of *S. humilis* with which it is connected by many intermediates. It may be described as smaller and hairier throughout. It is quite low (to 6 dm.) with smaller leaves (to 5 cm. long) more strongly gray tomentose, and catkins sometimes scarcely 5 mm. long. This can hardly be regarded as a distinct species. There is not a single constant character by which the two differ and what differences there are, are such as would be likely to be caused by differences in environment. Such forms should be considered as varieties rather than as species.

SERICEAE.

Swamp shrubs, leaves narrowly elliptic-lanceolate, commonly tapering to both ends, serrate with blunt cartilaginous teeth to entire, glabrous to glaucous, sericeate below when young, generally blackening in drying. Aments born before the leaves, sessile or short peduncled, scales darkened at the tips, pilose, capsules pedicelled, silvery sericeate at least when young.

Key.

From leaves.

Leaves dull above, silvery silky beneath at least until very old, scarcely glaucous. *S. sericea*.

Leaves shining above, glabrous on both sides except when young, pubescence on young leaves mostly ferruginous, quite glaucous below. *S. petiolaris*.

From flowers.

Fruiting catkins dense, sessile, capsule ovoid-conic, obtuse, short pedicelled, sericeate even when ripe, hardly 4 mm. long. *S. sericea*.

Fruiting caktins, looser, short peduncled, capsule becoming cylindric conic, acutish, long pedicelled, nearly glabrous when mature, more than 4 mm. long. *S. petiolaris*.

Plate XI. *Salix sericea*.

Typical leaves, flower and fruit, natural size; ripe capsule drawn at with camera lucida, enlarged five times.

SALIX SERICEA Marsh. SILKY WILLOW.

A shrub seldom 5 m. tall, with straggling branches generally lopping over onto the ground, forming clumps very similar in appearance to those of *Salix cordata*, buds similar to those of that species but without the loose inner membrane, twigs also similar but very brittle at the base. Leaves narrowly lanceolate, cuneate or rounded at the base, sharply serrate to almost entire, rather dark green and glabrous above, typically dull, below subglaucous, silvery sericeate (rarely somewhat ferruginous or glabrate when old) with lustrous hair which reflects the light irregularly at different angles almost like changeable silk; venation very similar to that of *Salix cordata* but the primaries ascend less rapidly toward the margin than in narrow leaves of that species, the looping is more prominent and blunter or sometimes, even the primaries are quite irregular. Catkins opening before the leaves, supported by a few small green bracts or unbracted, 10–30 mm. long, very dense, scales dark and pilose at the tip, light below, anthers generally red, capsule short conic or ovoid, obtuse, silvery sericeate even when ripe, not more than 4 mm. long, style short but distinct, pedicel about half as long as the ripe capsule.

Salix sericea prefers boggy land and is so common that it may be found in almost any swamp in the state but it seldom grows along river banks with *Salix cordata*.

The greatest difficulty in defining *Salix sericea* is to separate it from *S. petiolaris*, see below, and from *S. cordata*. In both cases the carpellate aments are entirely diagnostic and it is with the leafy specimens that the difficulty occurs. The leaves of *Salix cordata* are ordinarily wider than those of *S. sericea* and broadest below the middle while in this species the greatest width is near the middle; the serrations are sharper and finer in *S. cordata* and the leaves of *S. cordata* do not blacken in drying. But most important of all are the silvery hairs below which differentiate it from everything else. In old specimens, however, they are sometimes almost absent and in such cases it frequently becomes almost impossible to separate them.

Salix sericea subsericea, (*Anders.*) *Rydb.* is the name that has been given to the form of the present species which connects it with *S. petiolaris*. It is characterized by leaves much less pubescent than the typical form and less dull or even subglossy on the upper surface so that from leaf characters alone it cannot be distinguished from that species. It is very common in our area, see under *S. petiolaris*.

SALIX PETIOLARIS Smith. SLENDER WILLOW.

A shrub very similar to *Salix sericea* in habit. But typical leaves are quite different from those of that species in general appearance. Unfortunately, however, in this region connecting forms sometimes render it impossible to distinguish the two from the leaves alone. They are rather narrower, margin (sometimes entire) serrate with more prominent, blunt cartilaginous teeth, subglossy above, quite glaucous beneath, or sericeate when young oftenest with ferruginous hair, venation so similar to that of *S. sericea* that it cannot be distinguished unless by the more ascending primaries and the finer reticulations. Carpellate aments short peduncled, becoming somewhat lax in fruit, scales yellow, mostly darkened above, pilose, capsules long pedicelled, acutish, in fruit cylindric conic, more than 4 mm. long.

The *character* of the leaves in the extreme form is very similar to that of the Broad-leaved Willow with which they might be confused were it not for their narrowness. The difficulty in separating them from *S. sericea* comes especially late in the season when that species begins to lose its pubescence and to become more glossy on the upper surface. The catkins sometimes resemble those of *Salix bebbiana* but can be distinguished by the darkened rather than yellow scales. With these exceptions the present species is not likely to be confused with any other in our area.

Salix petiolaris is the western form of *Salix sericea* or rather since that species was later named, it is the eastern form of *S. petiolaris* of which it was made a variety by Andersson. It almost seems as though that were the proper treatment and that we should be doing well to return to Andersson's view but the carpellate aments seem fairly distinct.

We are near the eastern border of the range of *Salix petiolaris*. It occurs rather rarely in Ohio and has been found only in the north-western portion of the state, though it may extend well eastward along the lake shore.

Salix petiolaris gracilis Anders. Frequently one meets with forms of the Slender Willow with even more slender and graceful twigs than the usual form. This variety has been given the name *gracilis* by Andersson. It is characterized by narrower, more sharply serrate leaves and longer pedicels than the typical form. It may perhaps be taken as the extreme development of the type farthest from *S. sericea*. It is to be expected wherever *S. petiolaris* is found.

Plate XII. SALIX CANDIDA AND SALIX PETIOLARIS.

SALIX CANDIDA Fluegge. SAGE WILLOW, HOARY WILLOW.

This little shrub seldom grows more than a meter tall. It may be recognized anywhere by its leaves which are narrowly oblong and revolute, veins deeply depressed on the upper surface and prominent below; under side covered with a thick white tomentum contrasting strongly with the rich dark green of the upper surface, petiole short and stipules lacking. Flowers appearing before the leaves; ovularies densely covered with silvery white wool, nearly sessile, with a very long conspicuous deep rose red style like no other of our species; staminate catkins with few bracts below them and hardly presenting diagnostic characters; small and delicate resembling those of *S. bebbiana* somewhat but easily distinguished from them by the dark colored scales.

Salix candida is quite rare in Ohio. It was first reported by Mr. Moseley from Castalia prairie but has since been found in Wyandot county also. It ranges over the eastern and northern portions of North America. But in the west and north the leaves apparently become broader almost elliptical and not markedly revolute.

Salix candida hybridises with *S. cordata*, with *S. sericea* and with *S. petiolaris*. At Castalia a fine series of hybrids with *S. cordata* and *S. petiolaris* may be found.

CORDATAE.

The cordatae are a group of shrub willows with very variable leaves, characterized by glabrous capsules borne from wooly pussies. A peculiarity of the opening buds is that the inner bud scale grows out beyond the outer, enveloping the base of the ament and looking like the wing of a beetle imperfectly folded under the elytron. This so far as I know occurs in no other group and is therefore an important diagnostic character at a time when the species are particularly hard to separate. In this state the species though variable are fairly well marked but in the west the group is represented by a number of forms whose relationships have not been satisfactorily worked out as yet.

Plate XII. *Salix candida* (left) and *Salix petiolaris* (right.)

S. candida—typical but rather short leaves; other parts typical; natural size, capsule and carpellate flower enlarged three times, photographed and brightened.

S. petiolaris—lost twig in the extreme type farthest from *S. sericea*, with shiny, glaucous, glabrous leaves; two small leaves belonging to the variety *gracilis* in the lower corner; flowers and fruit typical, natural size; capsule enlarged three times.

Plate XIII. Salix cordata.

Key.

From leaves.

Leaves glossy above, heavily glaucous below, mostly broad, ascending so as to show their white under sides, glabrous, northern. *S. glaucophylla.*

Leaves neither glossy nor very glaucous.

Leaves thick, ovate, with emarginate bases, tomentose on both sides, northern. *S. adenophylla.*

Leaves thin, seldom pubescent above, lanceolate, generally distributed. *S. cordata.*

From flowers.

Bracts strongly glandular, before anthesis very villous, aments dense, capsules green, short pedicelled, medium sized, northern. *S. adenophylla.*

Bracts not glandular, tomentum quickly evanescent, pedicel longer.

Bracts green, obscurely serrate or entire, capsules green, small, medium pedicelled. *S. cordata.*

Bracts blackening, glaucescent, capsules large, rostrate, becoming brown, long pedicelled, aments lax; northern. *S. glaucophylla.*

SALIX CORDATA Muhl. HEART-LEAVED WILLOW.

Salix cordata is the botanist's bugbear. It is one of the most common and most variable species with which we have to deal. Its leaves seem to be under no restraint of heredity and may assume almost any form and any character. I have seen them all the way from linear-lanceolate to orbicular, from subglossy to heavily tomentose, from green to glaucous. But various as are the leaf forms they are all united by the flowers and one cannot doubt that they all belong to a single species.

The separation of the bud scales alluded to above is particularly well marked in *Salix cordata* and in the southern portion of the state or anywhere out of the range of the other species will at once differentiate this species from *S.* [illegible] or *S.* [illegible], which it resembles much in early spring.

Leaves very variable but generally of the lanceolate type, broader or narrower but widest below the middle, serration always *sharp* and usually fine. In leaf it is most likely to be confused with *S. discolor* and *S.* [illegible]. From the former it can

Plate XIII. *Salix cordata.*

[illegible] the plate typical, large leaf from very vigorous [illegible] shoot, perhaps indicating some affinity with *S. adenophylla*; upper narrow leaf from [illegible]; flowers and fruit typical, natural size; capsule enlarged three times.

Plate XIV. Salix adenophylla.

be distinguished by its sharp fine serration contrasted with the distant blunt and often coarse teeth of the pussy willow. The habits of the two are sufficientiy different to put aside all confusion when the plants are seen together. From *S. sericea* it can generally be distinguished by the absence of the silvery white pubescence on the under surface. The shape of the leaves is also different, in most cases in that species the leaf is widest near the middle: in this it is widest below the middle. *Salix cordata* also lacks the peculiar leaf habit of *Salix sericea*. The flowers come very early from small pussies. As they mature the carpellate aments come to be supported by large leaves and much of the wool of the pussy drops off from the fruiting rachis. The anthers just before the elongation of the filaments are almost as red as those of *Salix sericea*. The capsules are green and glabrous, the stigmas frequently red.

Salix cordata angustata Anders. includes the narrow leaved forms of the species. In Ohio most plants have leaves wider than those of the typical *angustata* but decidedly narrower than the typical specific form. It is therefore difficult to distinguish two forms in our area and since the leaf variation may be considered as accidental and without significance it is perhaps hardly advisable to separate them.

Salix cordata is abundant all over the state. Its usual habitat is along streams while the other species with a similar habit and leaf are typically swamp plants. This is not to say that the present species never grows in swamps nor that *S. sericea* and *S. discolor* never grow along river banks—for they do—but that they attain their best development in the habitats given and are usually found there.

To increase the difficulty of dealing with *Salix cordata* it hybridises very freely. It forms with *S. candida* a fine series of connecting forms. With *S. sericea* hybrids occur though not so frequently as has been supposed. It is also said to mix with *S. discolor* but I have seen no unquestioned specimens from Ohio.

Salix adenophylla Hooker. Furry Willow.

A straggling shrub of about the same size as *S. cordata* which it resembles most closely. It looks like a xerophytic adaptation of that species. The leaves are thicker, shorter and broader, ovate, more or less tomentose on both sides, with an emarginate base, very sharply serrate or entire; ordinarily in rank growth with the leaves ribbedly crowded on the twigs and

Plate XIV. *Salix adenophylla*.

Typical leaves, flowers and fruit, showing fruiting ament with and without bracts; a leaf from a fruiting ament in the upper corner; natural size; capsule enlarged three times.

Plate XV. Sálix Glaucophylla.

generally accompanied by large stipules. The flowers differ from those of our other species of cordatae in having broader bracts, much woolier before anthesis; in fruit by the denser catkins with shorter pedicelled capsules which are smaller than those of *S. glaucophylla* and rather larger than the average of *S. cordata*.

In typical forms the wooly broad leaves will distinguish it from everything else in our area. It is sometimes difficult to separate, however, from *S. cordata* in its more tomentose forms, and intermediates seem to occur. In shape the leaves are not so different from *S. bebbiana* but they will be quickly distinguished, among other things, by the sharply serrate margins of the present species.

Salix adenophylla is our rarest willow. It is a plant of the Western Great Lake region and reaches its best development in Michigan, being rare east of that state. Until recently it was not supposed to extend into Ohio but I have seen several specimens collected at Erie, Pennsylvania. It should therefore extend the whole length of the Ohio Lake Shore. But it is very scarce indeed. Though I have hunted for it on Cedar Point and in Ashtabula County I have seen from Ohio but a single undoubted specimen which was taken by A. D. Selby on Cedar Point.

SALIX GLAUCOPHYLLA Bebb. BROAD-LEAVED WILLOW.

A shrub sometimes 5 m. tall, growing in clumps like *S. cordata;* leaves mostly broad, ovate or ovate-lanceolate, shiny above except in rank growth, with very fine irregular venation and stiff midribs which hold them up at an acute angle with the stem so as to display the white under surfaces. In character the leaves resemble much the narrower leaves of *S. petiolaris* and like them, when succulent have a strong tendency to blacken in drying. Flowers appearing before the leaves, bracts mostly narrow, glaucescent; staminate aments generally larger than those of *S. cordata* with smaller bracts; carpellate long, lax in fruit, capsules very long (1 cm. or more) glabrous, sometimes rostrate, long pedicelled, turning brown.

Bebb labelled some of the first material of this species he sent out, *Salix cordata* x *S. lucida*. This determination though very far from correct as he himself soon recognized, is descriptive of the species. Its affinity to *Salix cordata* is evident at once from inspection of either leaves or flowers but yet in both there is a strong resemblance to *Salix lucida*. The large thick catkins with the long capsules and the beautiful glossy leaves cannot but suggest that species.

Plate XV. *Salix glaucophylla*

Typical leaves and aments, natural size; capsule enlarged three times.

Plate XVI. Salix purpurea and Salix pedicellaris.

The Broad-leaved Willow is a species of the Great Lake basin and in Ohio is confined to the northern part of the state. It is common along the western portion of the Lake Shore but probably does not extend beyond Cleveland.

Salix glaucophylla at times seems to grade into *Salix cordata* by what are probably a series of hybrids. In other cases it is very difficult to separate from *S. discolor* with which it also probably hybridises.

MYRTILLOIDES. BOG WILLOWS.

Low shrubs with mostly elliptical, glaucous, glabrous leaves strongly reticulate veined and purplish green; aments and bracts usually reddened, small, few flowered; filaments often partially united showing their affinity with the following group; a group of three or four species all very similar to the European *Salix myrtilloides*.

Salix pedicellaris (Anders). American Bog Willow.

A low shrub seldom reaching a height of 1 meter, aereal shoots erect, slender, supported in the sphagnum by long creeping stems which run far down into the bog putting out numerous rootlets along their length. Leaves when fully grown sometimes 9 cm. long and 20–25 mm. broad, but ordinarily smaller, elliptical, oblong, spatulate or rarely obovate, pointed at both ends, entire, slightly revolute, dark purplish-green above, slightly glaucous below, not hairy unless when very young, nearly sessile, venation conspicuously reticulate with meshes large and coarse considering the size of the leaf. Catkins appearing with the leaves, loosely flowered, not more than 25 mm. long in flower, but occasionally 5 cm. in fruit, scale short, often no longer than the nectary, as broad as long, filaments often more or less united; capsules long pedicelled, nearly always glabrous, short conic to cylindric-conic, obtuse, sometimes 8 mm. long in fruit, with a decided tendency to turn red or purple.

Salix pedicellaris is a northern species growing in cold peat bogs where it may be easily recognized by its small size and pe-

Plate XVI. *Salix purpurea* (left) and *Salix pedicellaris* (right).

S. purpurea. Typical branch with opposite and scattered leaves; flowers and fruit typical, the latter from a European specimen; natural size, staminate flower and capsule enlarged three times, photographed and brightened.

S. pedicellaris. Typical summer branch with small ovate leaf from the base of a twig to its left; staminate and carpellate flowers and fruit typical, the latter not ripe; natural size. Staminate flowers and capsules enlarged three times, one of them, marked M, between the leaves of *S. purpurea*.

culiar leaves. It it necessarily quite local in its distribution but probably grows in most of the sphagnum bogs in the state. There are specimens in the state herbarium from Williams and Portage counties and from the Licking Reservoir.

I am informed by Mr. P. A. Rydberg that the typical *S. myrtilloides* of Linneus was a European plant and that it differs slightly but constantly from the American species, hitherto considered as the variety pedicellaris, which should consequently be considered distinct.

As stated above *Salix pedicellaris* is easily distinguished from all the other species with which we have to deal. But more than once I have strongly suspected it of hybridising with *S. discolor* which occupies the same territory. But so far I have not yet been able to satisfy myself of the hybridity and so leave the question in abeyance.

PURPUREAE.

Shrubs, leaves mostly oblong, oblanceolate or linear-oblanceolate, nearly entire, glabrescent, stamens more or less perfectly united into one with 4 anthers, capsules globose-conic, nearly sessile, silky.

Salix Purpurea L. Purple Willow.

A shrub reaching a height of about 3 m. putting forth a dense growth of slender wands from the larger branches. Leaves scattered or opposite, sometimes 10 cm. long and 2 cm. broad, oblong-oblanceolate, oblong or rarely elliptical, mostly broadest above the middle, abruptly acute, generally gradually narrowed to the round base, entire or obscurely serrate, glabrous, dark purplish-green, paler beneath, petioles short, stipules apparently absent. Catkins expanding from pussies, sessile with a few small green bracts, scales more or less pilose on the back, oblong, blunt with conspicuously purpled tips, very concave above and strongly reflexed in the staminate, less so in the carpellate, capsule broadly ovoid, silky, sessile, style very short or none.

Salix purpurea is an Old World species planted in America largely for its twigs which are much used in basket work. It has been long reported in the manuals as escaped in this country but though it is fairly common over the state it is rarely that one sees a clump growing in a place where it would not likely have been planted. It certainly has not esceped to any such degree as have *S. alba* and *S. fragilis*. In America the carpellate plant is very rare and the species is mostly propogated by cuttings. This may account for its inability to spread as in the case of *Salix babylonica*.