SALIX (WILLOWS) IN THE NEW WORLD

A GUIDE TO THE INTERACTIVE IDENTIFICATION

OF NATIVE AND NATURALIZED TAXA

USING INTKEY (DELTA)

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This guide and periodically updated versions of the database are available at:
http://aknhp.uaa.alaska.edu/willow/index.html

An online interactive key using an earlier version of the database::
http://flora.huh.harvard.edu:8080/actkey/actkey.jsp?setId=3001

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THE GENUS SALIX (WILLOWS) IN THE NEW WORLD
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INTRODUCTION

The genus Salix is a large genus of about 100 species in the New World. It is ecologically important as a pioneer species that serves to stabilize riparian habitats while also providing food for many northern mammals and insects. Biologists trying to determine the identity of species often find it necessary to work with fragmentary material. Traditional dichotomous keys often do not serve this purpose. The earliest solution I know to this problem was the Key to the North American Species of *Potamogeton*, written in 1953 by Eugene Ogden (New York State Museum, Circular 31). It is what is now called an interactive key in which the identifier can use whatever characters he finds most useful in an order of his own choosing. Ogden's key did not have the advantage of computerization as does the key presented here. The identification of *Salix* (willows) species often is difficult, not only because the material to be identified may be limited but because of morphological variability, dioecy, and hybridization. These factors make the make written dichotomous keys difficult to write and cumbersome to use. Since the early 1960s I have been using at first punch cards and then computerized solutions to the problem.

In the identification of willows, as well as most other plants, the experienced naturalist comes to know species by "the way they look." This recognition of the 'Gestalt, ' or form of a species, brings into play a host of characteristics. One's perception of the general branching pattern, color, the way the leaves are borne on the shoot, the plant's habitat, etc. all play a part in gestalt recognition. Attempts to put this knowledge into words, however, often fail because so many of these features are intangible. In this interactive key, many more characters are made available for identification than in the usual written keys, but still problems of definition and description remain.

It is important in describing species to define the characters in easily understandable yet unequivocal terms. Over the years, I have drafted and redrafted a list of characters and character states that can be used to describe *Salix*. The character list presented here includes definitions and brief comments on how the characters were recorded. For more details on the characters see Character Notes (Appendix 3) and the Glossary (Appendix 4)

Variability:

(1) *Salix* species are dioecious; this means that flowers of only one sex occur on a single individual. Most floras provide a single key using staminate, pistillate, and vegetative characters. Such keys are frustrating to use and have led many field botanists to ignore staminate or vegetative specimens because such material is impossible to run through such keys. Other floras have provided three separate keys but these keys are very difficult to construct, especially if the number of species in the flora exceeds 25-30 species. Computerized interactive keys go a long way in overcoming these problems.

(2) The flowers are very simple. Staminate flowers consist of stamens and a reduced perianth consisting of one or more nectaries; pistillate flowers consist of an ovary and one or more nectaries. A floral bract subtends each flower. The flowers are aggregated into catkins, which may be sessile on the branch or borne on a short, vegetative shoot. In any one individual, therefore, there are relatively few floral characteristics on which to draw for identification.

(3) Developmental variability poses practical problems. Because of differences in the time of opening of floral and vegetative buds, some specimens may have only flowers, others flowers and juvenile leaves, and yet other may have only leaves. There is also variability due to stage of development. For example, degree of hairiness can change as hairs are lost in age; quantitative characters, such as the length of catkins, flowering branchlets, stipes, and ovaries can change with age; and some structures, e.g. stipules or floral bracts, can be lost. Characters that could be used to identify a specimen may not be present at all stages of development. One way to overcome this and to develop an understanding of the way species vary throughout a single season is to tag plants and to make collections from a single individual at several times during the year.

(4) Most *Salix* species will vary phenotypically in response to moisture, nutrients, shade, and wind. Sometimes normally prostrate species growing in a protected niche may be erect, leaves of a usually small-leafed species may be very large in nutrient rich sites, under shade conditions leaves may be very large. In addition to this phenotypic variability there is also genetic variation. Many characters which at first seem to be diagnostic for a particular species, such as leaf shape, hairiness, toothing, and size, as well as plant stature, size of catkins, hairiness of ovaries, etc., are often distressingly variable. The best way to cope with this variability is to base identifications on "normal" growth or on an assessment of a population rather than on an individual.

(5) Hybridization is an important source of morphological variability. In the past, some botanists have overemphasized hybridization and recognized most specimens as hybrids and backcrosses. The reaction to this has been to minimize hybridization and to allow for very wide character variability. Both extremes are to be avoided. Molecular studies in *Salix* show extensive gene exchange between species. It also shows that such gene exchange, or introgression, is not always accompanied by morphological intermediacy. Many species are made up of geographical races that intergrade where their ranges overlap. This makes it difficult to positively identify every individuals. One should not despair when not every plant can be identified. Hybridization should be suspected if specimens combine the characters of species growing in the same area or if there is evidence of infertility, including aborted ovaries, inviable pollen, and floral teratology.

SOFTWARE AND DATA

The files include the database and program files for the interactive identification of specimens of New World *Salix* using INTKEY are maintained by the Alaska Natural Heritage Program, University of Alaska Anchorage (http://aknhp.uaa.alaska.edu/willow/index.html).

The *Salix* database was written and is maintained by George W. Argus, Curator Emeritus, Canadian Museum of Nature, Ottawa, Canada (argus@post.harvard.edu). The DELTA software, including INTKEY, was written by Michael J. Dallwitz and his associates (CSIRO Division of Entomology, Canberra, Australia). The INTKEY5 version of this software is made available here with the permission of the author. Full DELTA software is available at http://delta-intkey.com. Documentation is presented in: Dallwitz, M.J., Paine, T.A., and Zurcher, E.J. 1993 onwards. User's Guide to DELTA: a general system for processing taxonomic descriptions. 4th ed.

For the interactive identification of New World *Salix*, download from the University of Alaska Anchorage site the following files:

1. The present publication is available as a pdf file. It includes a description of how to use the interactive key to New World *Salix*, a list of taxa included, a *Salix* character list, notes on the characters, a form that can aid the selection of characters to be used in identification, and figures illustrating some taxonomic characters.

2. INTKEY program files.
DELTA.REG - A text file with information on DELTA registration.
DELTA.USE - A text file with information on the limited use of INTKEY.
INTKEY5.EXE - An executable file for a Windows version of INTKEY.
INTKEY4.HLP - The help file for INTKEY.
TOOLBAR.INP - An operation file that prepares the toolbar.
*.BMP - A series of files for toolbar icons

3. *Salix* database files for use in INTKEY.
ICHARS - A machine language character file converted for use by INTKEY.
IITEMS - A machine language file of coded taxon descriptions converted for use by INTKEY
INTKEY.INI - The file the program uses to initiate the *Salix* database.

NOTE: As part of the continuing maintenance of the database the morphological data and nomenclature are often upgraded. Users should periodically check to see if updates are available.

INSTRUCTION FOR INTERACTIVE IDENTIFICATION

To activate the interactive identification program double click on <INTKEY5.EXE.> A shortcut can be dragged to the desktop.

The first screen that will appear is one to select a dataset. Enter <intkey.ini> in the bar headed "Select by name of initialization file" or go to " Browse" and select that name from the directory. The name "*Salix* species" will appear in the list of datasets. Select this name and the first INTKEY screen will appear.

Identifications can be made by using two modes of operation: Normal and Advanced. The developers of Intkey strongly urge that beginners use the Normal mode.

Normal mode. To use the Normal mode for identification select HELP on the tool bar and then INTRODUCTION. Read each of the included files, especially the Introduction and Basic Identification and Description for a general overview of the system.

Advanced mode. Once you are familiar with the Normal mode of identification you will find that the Advanced mode provides greater flexibility. I will describe below how I use Intkey for identification and for general querying of the database. Before beginning to use the Advanced mode, however, make sure you have hard copy of the following files (They are included in the present document.):

1. Taxa Included (Appendix 1). A list of the included taxa with their taxon numbers.
2. Character List (Appendix 2).
3. Data entry form.

The full "User's Guide to the DELTA System" Ed. 4.10, which includes general instruction for the use of INTKEY, is available at http://delta-intkey.com.

In the upper left corner select “File” and then “Advanced Mode.” A second screen will appear with a blue command line at the bottom., Before proceeding, we need to consider two important directives.

IMPORTANT COMMANDS

Set Match. This directive is very important because it controls the way INTKEY will determine what taxa match the characters as they are entered. The program automatically sets match at I 0 U (Inapplicable, Overlap, and Unknown). This means that at each point in an identification the program will include not only those taxa that exactly fit or overlap the entered character state (O), but also those for which the character may be inapplicable(I) or unknown (U). This ensures that possible matches are not eliminated because of lack of data. If you wish, however, to include in the identification only the taxa occurring in a particular province or state then Inapplicables and Unknowns must be excluded; the MATCH directive should be set to Overlap. To do this move the cursor to “Settings” and then to “Set” and then to “Match.” Select from the list of choices “Overlap.” This could also be entered directly on the command line as <SET MATCH O[verlap]>. Once the taxa for a single province or state have been selected then the Match command should be returned to I O U to include taxa for which a character state is Unknown or Inapplicable.

It is sometimes useful to set match to “Exact.” This may be helpful when listing differences between taxa. If match is set to “Overlap” only those characters for which the taxa do not overlap will be listed. But if match is set to “Exact” then those characters for which they overlap will be included. This is useful in evaluating quantitative characters, particularly those that have a very small range of overlap. To list all differences between two or more taxa enter at the prompt <SET MATCH E[xact]. Remember to return the MATCH setting to I O U when identification is resumed, See the HELP menu for further discussion of SET MATCH.

Display numbering on. This directive is used to display the numbering of characters and taxa. Before beginning an identification or listing differences place the cursor on “Settings” and following it to “Display” then “Numbering” and then “On.” Alternatively, it can be entered directly on the command line as <DISPLAY NUMBERING ON>. This will display taxon and character numbers so that later commands to describe a particular taxon or to list differences can be easily entered in the command line.

ENTERING CHARACTERS

Character Selection. The characters used to identifying an unknown are entered as a character number and a character state number separated by a comma in the form 16,6. In this example "16" is the character number for branch color and "6" is the state number for red-brown. More than one state can be entered at the same time. For example all yellow-colored branch states could be entered as 16,1/2/3/4. Entering more than one character state is useful if the specimen displays more than one character state or if the characters displayed by the specimen are not unequivocal. When a character and its state(s) is entered on the command line the program will select, as matches for the unknown, those taxa that have that particular character state(s).

Quantitative characters. Quantitative characters should be used with some caution because, despite all efforts, the full range of quantitative characters may not have been included in the database. With that caveat, however, it should be noted that quantitative characters are usually very useful in identification. If a measurement for an unknown fall within the recorded range for the species there is no problem, but if it fall outside that range, the correct species will

be eliminated. To avoid this, one may enter quantitative data as ±10 percent of the measured value. For example, a petiole that measures 10 mm long could be entered as 60,9-11. I rarely follow this procedure but I am always aware that my unknown could represent an unrecorded extreme and carefully note the species that are eliminated at each point in identification. If at any point in an identification you suspect that a quantitative datum may have resulted in the elimination of a candidate taxon you can delete that character and then describe the remaining taxa for that character. (See the “delete” and “describe” commands below.) If that quantitative character resulted in the elimination make suitable and reenter. To resume without making a change reenter the deleted quantitative value.

USEFUL COMMANDS

Best. If in the course of an identification you are not sure which characters would be most useful in separating the remaining taxa, enter <BEST> in the command line, or select the "Star" icon. The program will offer a list of suggestions beginning with those that will give the best resolution or are the most reliable. To select one of these characters highlight it and press <OK>. You will be presented with a screen showing the character states or a bar on which to enter a quantitative value. From the series of states, select the state that best fits the unknown. To select more than one state simply highlight additional states. If you wish to change an entered character state, reenter the character and the new state.

Delete. If you wish to remove a character that has already been entered, enter in the command line <DEL(ete) 16 [for character 16]> and press <enter>.

In general, the best characters to use in identification are those with the highest discrimination value. In *Salix* this usually includes characters such as general ovary hairiness, plant habit, general leaf toothing, general leaf hairiness, flowering catkin length, number of stamens, style length, stipe length, presence of stipules, etc. Characters such as colors or specific kinds of indumentum (hairiness type) are difficult to describe and even more difficult to interpret. Their use in identification should be avoided if possible. Since general "hairiness" is such an important diagnostic character in *Salix,* the database includes general hairiness characters, scored simply as glabrous vs. hairy, as well as the detailed character states (for example, compare characters 19 and 20).

Describe. When you wish to describe one or more remaining taxa enter <DESCR[ibe] R[emaining]> or click on “Descriptions” and “Remaining.” If more than one taxon, remaining or not, is to be described enter <DESCR (2 18) [taxon numbers 2 and 18] 75 [character number].

Differences. Above the button bar line click on “Descriptions” and follow it to “Differences” and then “Remaining.” Or enter on the command line <DIFF[erences] all [displays all differences]>.

Restart. At any time in the process, you can begin a new identification by entering <REST[art]> or selecting the "traffic sign" icon on the button bar.

PRACTICAL COMMENTS ON IDENTIFICATION

Data Entry Form. The approach I use to identify an unknown is to examine the specimen and record a series of "useful" characters. For this purpose, one could use a sheet such as the Data Entry Form. The observed characters are described and then coded as character number and state for entry on the command line one at a time. Before entering morphological characters, I prefer to

narrow down the possible taxa by entering the state or province of occurrence. This is not essential, but by eliminating superfluous names, it is easier to follow the possible matches during identification. NOTE: Be sure to set match to (O)VERLAP before entering state or province and then setting it back to I O U for identification.

Taxa Remaining. As characters are entered, check the list of TAXA REMAINING to see if likely matches have been eliminated. The list of TAXA REMAINING is displayed automatically when 10 or fewer taxa are left, but a higher number of taxa remaining can be displayed by clicking on “Settings” and then following it to “Set” and “Autotaxa” and entering a the desired number of taxa, usually about 25. All the taxa remaining, however, can be displayed at anytime by entering the command <TAXA R[emaining]>. Continue entering characters and their states until two or three taxa remain. At that point, it can be useful to display all the characters that separate the taxa remaining. See the “differences” directives above.

File Output. The result of these operations can be output to a file. To save the output to a file first enter the command <FILE OUT A.TMP [or other filename>. Then perform the operations such as listing differences or a description. When you quit INTKEY the output will be saved as a file under the designated name. You can save all the work you have done during a particular session as a LOG file. To do so select “File” in the upper left corner, then “log,” and then select a directory and file name, usually “a.log.”

Help. The Help function should be consulted frequently. It not only gives a detailed explanation of each of the commands and settings but also describe the many ways the database can be queried.

A little experimentation with the menu and Help will reveal some of the many functions that this program can perform.

End of determination. Finally, when a name has been selected for the specimen it should be compared with a description, illustration, a correctly identified herbarium specimen.

Quit. To exit INTKEY enter <QUIT>.

APPENDIX 1.
New World *Salix* (Native and Naturalized) (5 July 2007)

1. Salix aeruginosa
2. Salix alaxensis var. alaxensis
3. Salix alaxensis var. longistylis
4. Salix alba
5. Salix amygdaloides
6. Salix arbusculoides
7. Salix arctica
8. Salix arctophila
9. Salix argyrocarpa
10. Salix arizonica
11. Salix athabascensis
12. Salix atrocinerea
13. Salix aurita
14. Salix babylonica
15. Salix ballii
16. Salix barclayi
17. Salix barrattiana
18. Salix bebbiana
19. Salix bonplandiana
20. Salix boothii
21. Salix brachycarpa var. brachycarpa
22. Salix brachycarpa var. psammophila
23. Salix breweri
24. Salix calcicola var. calcicola
25. Salix calcicola var. glandulosior
26. Salix cana
27. Salix candida
28. Salix caprea
29. Salix caroliniana
30. Salix cascadensis
31. Salix chamissonis
32. Salix chlorolepis
33. Salix cinerea
34. Salix columbiana
35. Salix commutata
36. Salix cordata
37. Salix daphnoides
38. Salix delnortensis
39. Salix discolor
40. Salix drummondiana
41. Salix eastwoodiae
42. Salix elaeagnos
43. Salix eriocephala
44. Salix exigua var. exigua
45. Salix exigua var. hindsiana
46. Salix famelica
47. Salix farriae
48. Salix floridana
49. Salix fragilis
50. Salix fuscescens
51. Salix geyeriana
52. Salix glauca var. acutifolia
53. Salix glauca var. callicarpaea
54. Salix glauca var. stipulata
55. Salix glauca var. villosa
56. Salix gooddingii
57. Salix hastata
58. Salix herbacea
59. Salix hookeriana
60. Salix humboldtiana
61. Salix humilis var. humilis
62. Salix humilis var. tristis
63. Salix interior
64. Salix irrorata
65. Salix jaliscana
66. Salix jejuna
67. Salix jepsonii
68. Salix x jesupii
69. Salix laevigata
70. Salix lasiandra var. caudata
71. Salix lasiandra var. lasiandra
72. Salix lasiolepis
73. Salix x laurentiana
74. Salix lemmonii
75. Salix ligulifolia
76. Salix lucida
77. Salix lutea
78. Salix maccalliana
79. Salix melanopsis
80. Salix mexicana
81. Salix microphylla
82. Salix monochroma
83. Salix monticola
84. Salix myricoides
85. Salix myrsinifolia
86. Salix myrtillifolia
87. Salix nigra
88. Salix niphoclada
89. Salix nivalis
90. Salix nummularia
91. Salix orestera
92. Salix ovalifolia var. arctolitoralis
93. Salix ovalifolia var. cyclophylla
94. Salix ovalifolia var. glacialis
95. Salix ovalifolia var. ovalifolia
96. Salix paradoxa
97. Salix pedicellaris
98. Salix x pedunculata
99. Salix pellita
100. Salix x pendulina
101. Salix pentandra
102. Salix petiolaris
103. Salix petrophila
104. Salix phlebophylla
105. Salix planifolia
106. Salix polaris
107. Salix prolixa
108. Salix pseudomonticola
109. Salix pseudomyrsinites
110. Salix pulchra
111. Salix purpurea
112. Salix pyrifolia
113. Salix raupii
114. Salix reticulata subsp. glabellicarpa
115. Salix reticulata subsp. reticulata
116. Salix richardsonii
117. Salix riskindii
118. Salix rotundifolia s.l.
119. Salix rotundifolia var. dodgeana
120. Salix rotundifolia var. rotundifolia
121. Salix x rubens
122. Salix scouleriana
123. Salix x sepulcralis
124. Salix sericea
125. Salix serissima
126. Salix sessilifolia
127. Salix setchelliana
128. Salix silicicola
129. Salix sitchensis
130. Salix x smithiana
131. Salix sphenophylla
132. Salix stolonifera
133. Salix taxifolia
134. Salix thurberi
135. Salix tracyi
136. Salix triandra var. triandra
137. Salix turnorii
138. Salix tweedyi
139. Salix tyrrellii
140. Salix uva-ursi
141. Salix vestita
142. Salix viminalis
143. Salix x wiegandii
144. Salix wolfii var. wolfii
145. Salix wolfii var. idahoensis

APPENDIX 2
Character list for *Salix* identification. (3 July 2007)

DATE OF RECORD
#1. <Date of last revision, date of first entry>/

DOCUMENTATION
#2. Specimen data: <Herbaria, states/provinces used in database>/

#3. Literature data: <literature used in database>/

NOMENCLATURE
#4. <Taxon name and authority>/

#5. <Abbreviated name, section and taxon>/

#6. <Place of publication>/

#7. <Common Name, note source if appropriate>/

#8. Basionym: <Name and citation>/

#9. Synonyms: <Commonly used names>/

#10. <Nomenclatural comments>/

HABIT

#11. Plant: habit:/
1. dwarf shrubs <0.2 m or less, e.g. *S. herbacea*>/
2. low shrubs <0.2-0.5 m, e.g. *S. myrtillifolia*>/
3. mid shrubs <0.6-2.0 m, e.g. *S. humilis*>/
4. tall shrubs <greater than 2.0 m, e.g. *S. discolor*>/
5. trees <Sometimes with several boles, but of "tree" stature, e.g. *S. nigra*>/

#12. plant: height:/ m tall/

#13. stems: habit:/
1. erect/
2. drooping/
3. pendulous <long, hanging>/
4. decumbent <on ground>/
5. trailing <on ground>/

#14. plants: vegetative reproduction:/
1. not colonial/
2. forming colonies by root shoots <e.g. *S. interior*>/
3. forming colonies by layering <e.g. *S. humilis*>/
4. forming colonies by rhizomes <e.g. *S. herbacea*>/
5. forming colonies by stem fragmentation/
6. forming polycormones <hemispheric growth form by sprouting at base of main stem>/

#15. plants: syllepsis: <vegetative shoots arising from buds of the year without a dormaant period>/
1. not sylleptic/
2. sylleptic only following defoliation/
3. sylleptic/

BRANCHES
#16. branches: brittleness: of 1- to 2-year-old stems:/
1. flexible at base <branches not breaking when flexed toward stem>/
2. somewhat brittle at base <many, but not all, branches break when flexed toward stem>/
3. highly brittle at base <all branches break when flexed toward stem>/
4. brittle throughout <branches brittle everywhere along the stem>/

#17. branches: color: of 1- to 2-year-old stems:/
1. yellow/
2. yellow-green/
3. yellow-gray/
4. yellow-brown/
5. gray-brown/
6. red-brown/
7. violet/
8. blackish/
9. brownish/
10. obscured by indumentum/

#18. branches: luster: of 1- to 2-year-old stems:/
1. dull/
2. shiny/
3. highly glossy/

#19. branches: glaucousness: of 1- to 2-year-old stems:/
1. not glaucous <lacking waxy coating>/
2. weakly glaucous <thin but visible when scratched or as scattered crystals>/
3. strongly glaucous <distinct bluish or whitish waxy coating covering all or most of stem.>/

#20. branches: general hairiness: of 1- to 2-year-old stems:/
1. glabrous <or glabrescent>/
2. hairy/

#21. Branches: indumentum type: on 1- to 2-year-old stems:/
1. glabrous <without hairs>/
2. glabrescent <becoming glabrous in age but a few hairs remaining>/
3. puberulent <very sparse, short, fine, straight or wavy, erect or spreading hairs>/
4. pubescent <sparse to dense, short, fine, wavy or straight, spreading hairs>/
5. pilose <very sparse, long, fine, wavy or straight, spreading hairs>/
6. villous <sparse to dense, long, fine, straight or wavy, spreading hairs>/
7. tomentose <dense, short, rather firm, more or less matted, erect or spreading hairs>/
8. woolly <very dense, long, fine, spreading, wavy, more or less matted hairs>/
9. short-silky <sparse to dense, short (less than 0.5 mm), fine, straight or wavy, appressed, shiny hairs>/
10. long-silky <sparse to dense, fine, long (0.5 mm or greater), straight or wavy, appressed, shiny hairs>/
11. velvety <very dense, short, fine, straight, erect hairs of relatively uniform length>/

#22. branches: epidermis flakiness: on 3-4-year old stems:/
1. inconspicuously flaking/
2. conspicuously flaking <peeling in patches or strips>/

#23. branches: epidermis flakiness: on 3-4-year old stems:/
1. in gray patches/
2. in yellow-edged longitudinal splits/
3. in gray-edged longitudinal splits/
4. in minute flakes/

#24. branches: presence of diamond shaped depressions: on old stems:/
1. absent/
2. present/

PEELED WOOD

#25. wood of peeled branches: striae presence: on branches 3-5 years old:/
1. smooth <0, rarely to 3, longitudinal ridges on 1/2 of a 20 cm branch segment>/
2. striate <raised longitudinal ridges, tops flat or arcuate>/

#26. wood of peeled branches: density of striae: on branches 3-5 years old:/
1. sparse <1-10 on one side of 20 cm branch segment>/
2. moderately dense <11-30 on one side of 20 cm branch segment>/
3. very dense <more than 30 on one side of 20 cm branch segment>/

#27. wood of peeled branches: general length of longitudinal striae: on branches 3-5 years old:/
1. short <5 mm or less>/
2. long <greater than 5 mm>/

#28. wood of peeled branches: length of longitudinal striae: on branches 3-5 years old:/ mm <long>/

#29. wood of peeled branches: points or conical projections: on branches 3-5 years old:/
1. absent/
2. present <in pairs or scattered>/

#30. wood of peeled branches: transverse lines: on branches 3-5 years old:/
1. absent/
2. present/

BRANCHLETS

#31. branchlets: color: of stems of the year:/
1. yellowish/
2. yellow-green/
3. yellow-brown/
4. gray-brown/
5. red-brown/
6. violet/
7. blackish/
8. brownish/
9. obscured by indumentum/

#32. branchlets: luster: of stems of the year:/
1. dull/
2. shiny/
3. highly glossy/

#33. branchlets: glaucescence: of stems of the year:/
1. not glaucous <lacking waxy coating>/
2. weakly glaucous <visible when scratched or with isolated crystals>/
3. strongly glaucous <bluish or whitish waxy coating covering all or most of stem.>/

#34. branchlets: general hairiness: of stems of the year:/
1. glabrous <or glabrescent>/
2. hairy/

#35. branchlets: indumentum density: on stems of the year:/
1. sparse/
2. moderately dense <surface 50% visible>/
3. very dense <surface obscured>/

#36. branchlets: indumentum type: on stems of the year:/
1. glabrous <without hairs>/
2. glabrescent <becoming glabrous in age but a few hairs remaining>/
3. puberulent <very sparse, short, fine, straight or wavy, erect or spreading hairs>/
4. pubescent <sparse to dense, short, fine, wavy or straight, spreading hairs>/
5. pilose <very sparse, long, fine, wavy or straight, spreading hairs>/
6. villous <sparse to dense, long, fine, straight or wavy, spreading hairs>/
7. tomentose <dense, short, rather firm, more or less matted, erect or spreading hairs>/
8. woolly <very dense, long, fine, spreading, wavy, more or less matted hairs>/
9. short-silky <sparse to dense, short (less than 0.5 mm), fine, straight or wavy, appressed, shiny hairs>/
10. long-silky <sparse to dense, fine, long (0.5 mm or greater), straight or wavy, appressed, shiny hairs>/
11. velvety <very dense, short, fine, straight, erect hairs of relatively uniform length>/

#37. branchlets: hairs orientation to surface: on stems of the year:/
1. appressed/
2. spreading <divergent>/
3. erect/

#38. branchlets: hairs shape: on stems of the year:/
1. straight/
2. wavy/
3. curved/
4. crinkled/
5. geniculate <abruptly curved near base>/

BUDS

#39. buds: relative size:/
1. monomorphic/
2. dimorphic/

#40. buds: gradation type: <according to size, shape, and position>/
1. alba-type <vegetative and reproductive buds of uniform size and shape>/
2. arctica-type <apical buds large, followed by abruptly smaller set of buds>/
3. caprea-type <vegetative and reproductive buds very different, reproductive toward tip, vegetative below>/
4. transitional type <indeterminate>/

#41. bud scale margins: <outer prophyll> connation:/
1. distinct and imbricate <sharp-pointed cap>/
2. connate <blunt-pointed cap>/

#42. bud scale: inner membranaceous layer: <adnation of, as seen on open bud scales:>/
1. free and separating from outer layer/
2. free but not separating from outer layer/
3. not free from outer layer/

#43. buds: color:/
1. yellow-green/
2. yellow-brown/
3. brown/
4. red-brown/
5. violet/
6. blackish/

#44. buds: hair color:/
1. white/
2. gray/
3. yellowish/
4. ferruginous/
5. white and ferruginous/

CATAPHYLLS

#45. Cataphylls: <1-3 lowermost leaf-like bracts, not green, caducous>/
1. absent/
2. intermediate <i.e. sometimes greenish>/
3. present/

GENERAL LEAF ARCHITECTURE

#46. leaves: phyllotaxis:/
1. opposite or subopposite/
2. alternate/

#47. leaves: persistence:/
1. deciduous in autumn/
2. marcescent <brown and withered, persisting 2 or more years>/

#48. persistent leaves: decay: <skeletonization>/
1. remaining unskeletonized/
2. becoming skeletonized/

#49. persistent leaves: color:/
1. gray-brown/
2. yellow-brown/
3. red-brown/

STIPULES

#50. stipules: proximal leaves:/
1. absent or minute rudiments/
2. foliaceous/

#51. stipules: largest medial leaf blades: on early leaves:/
1. absent/
2. minute rudiments <usually brownish>/
3. foliaceous <green and leaf-like>/

#52. stipules: largest medial leaf blades: on late leaves and vigorous shoots:/
1. absent/
2. minute rudiments <usually brownish>/
3. foliaceous <green and leaf-like>/

#53. stipules: largest medial leaf blades: persistence:/
1. early deciduous/
2. deciduous in autumn/
3. can persist for 2 or more years/

#54. stipules: largest medial leaf blades: length/ mm <long>/

#55. stipules: largest medial leaf blades: apex shape:/
1. caudate/
2. acuminate/
3. acute/
4. convex/
5. rounded/

#56. stipules: glands on adaxial surface:/
1. absent/
2. few/
3. abundant/

#57. stipules: largest medial leaf blades: resinous:/
1. not resinous <stain not left on pressing paper>/
2. resinous <stain left on pressing paper>/

PETIOLES

#58. petioles: transverse section shape: <at midpoint>/
1. flat to convex adaxially <e.g. Sect. *Cinerella*>/
2. shallowly grooved adaxially <e.g. Sect. *Salix*>/
3. deeply grooved adaxially <e.g. Sect. *Chamaetia*>/
4. deeply grooved adaxially, margins covering groove <e.g. *S. gooddingii*>/

#59. petioles: ventricose at base: <flaring around floral buds>/
1. not ventricose/
2. weakly ventricose <slightly flared at base of bud>/
3. strongly ventricose <enclosing bud>/

#60. petioles: length:/ mm <long>/

#61. petioles: leaf length-petiole length ratio: <based on largest medial leaves>/

#62. petioles: glands at distal end: <acropetiolar &-or basilaminar>/
1. not glandular/
2. with spherical glands or lobes/

#63. petioles: glands at distal end <structure>/
1. paired spherical glands/
2. clusters of spherical glands/
3. stalked spherical glands/
4. foliaceous glands/

#64. petioles: glands: position:/
1. at distal end/
2. scattered along petiole/
3. basilaminar <in *Populus*>/

#65. petioles: adaxial surface general hairiness:/
1. glabrous <or glabrescent>/
2. hairy/

#66. petioles: adaxial surface indumentum type:/
1. glabrous <without hairs>/
2. glabrescent <becoming glabrous in age but a few hairs remaining>/
3. puberulent <very sparse, short, fine, straight or wavy, erect or spreading hairs>/
4. pubescent <sparse to dense, short, fine, wavy or straight, spreading hairs>/
5. pilose <very sparse, long, fine, wavy or straight, spreading hairs>/
6. villous <sparse to dense, long, fine, straight or wavy, spreading hairs>/
7. tomentose <dense, short, rather firm, more or less matted, erect or spreading hairs>/
8. woolly <very dense, long, fine, spreading, wavy, more or less matted hairs>/
9. short-silky <sparse to dense, short (less than 0.5 mm), fine, straight or wavy, appressed, shiny hairs>/
10. long-silky <sparse to dense, fine, long (0.5 mm or greater), straight or wavy, appressed, shiny hairs>/
11. velvety <very dense, short, fine, straight, erect hairs of relatively uniform length>/

JUVENILE LEAVES

#67. juvenile leaves: <distal, unfolding leaves> color:/
1. reddish/
2. yellowish green/
3. color obscured by indumentum/

#68. juvenile leaves: general hairiness:/
1. glabrous <or glabrescent>/
2. hairy/

#69. juvenile leaves: indumentum density:/
1. sparse/
2. moderately dense <surface 50% visible>/

3. very dense <surface obscured>/

#70. juvenile leaves: indumentum abaxial surface:/
1. glabrous <without hairs>/
2. glabrescent <becoming glabrous in age but a few hairs remaining>/
3. puberulent <very sparse, short, fine, straight or wavy, erect or spreading hairs>/
4. pubescent <sparse to dense, short, fine, wavy or straight, spreading hairs>/
5. pilose <very sparse, long, fine, wavy or straight, spreading hairs>/
6. villous <sparse to dense, long, fine, straight or wavy, spreading hairs>/
7. tomentose <dense, short, rather firm, more or less matted, erect or spreading hairs>/
8. woolly <very dense, long, fine, spreading, wavy, more or less matted hairs>/
9. short-silky <sparse to dense, short (less than 0.5 mm), fine, straight or wavy, appressed, shiny hairs>/
10. long-silky <sparse to dense, fine, long (0.5 mm or greater), straight or wavy, appressed, shiny hairs>/
11. velvety <very dense, short, fine, straight, erect hairs of relatively uniform length>/

#71. juvenile leaves: indumentum color:/
1. white/
2. gray/
3. yellowish/
4. ferruginous/
5. white and ferruginous/

PROXIMAL LEAVES
#72. proximal leaves: general margin dentition: only for identification/
1. entire/
2. toothed/

#73. proximal leaves: margin dentition:/
1. entire <margin smooth, no glands, teeth, or undulations>/
2. entire and gland-dotted/
3. serrate <uniform, large teeth>/
4. remotely or irregularly serrate/
5. serrulate <uniform, small teeth>/
6. distantly serrulate <very small, widely spaced teeth>/
7. denticulate/
8. crenate/
9. crenulate/
10. undulate/

LARGEST MEDIAL LEAF BLADES
Architecture
#74. largest medial leaf blades: stomatal patterns:/
1. hypostomatous <stomata on abaxial surface only>/
2. hemiamphistomatous <stomata on adaxial surface scattered along veins or at apex>/
3. amphistomatous <stomata uniformly dense on both surfaces>/

#75. largest medial leaf blades: secondary vein architecture:/
1. pinnate <secondaries arising along primary rachis>/
2. first two secondaries arising at or close to a single point at base of leaf and curve toward apex <campylodromous>/

#76. largest medial leaf blades: secondary veins position in mesophyll:/
1. impressed adaxially, protruding abaxially <to abaxial edge of mesophyll>/
2. flat adaxially and abaxially <to middle of mesophyll>/
3. protruding adaxially and abaxially/
4. protruding adaxially, flat abaxially/
5. flat adaxially, protruding abaxially/

Shape
#77. Largest medial leaf blades: general shape:/
1. widest in mid-zone/
2. widest at mid-point/
3. widest toward base/
4. widest toward apex/

#78. largest medial leaf blades: shape: <medial leaves>/
1. linear <10:1, widest in mid-zone>/
2. lorate <6:1, widest in mid-zone>/
3. narrowly oblong <3:1, widest in mid-zone>/
4. oblong <2:1, widest in mid-zone>/
5. broadly oblong <1.5:1, widest in mid-zone>/
6. very broadly oblong <1.2:1 or less, widest in mid-zone>/
7. very narrowly elliptic <6:1 or more, widest at mid-point>/
8. narrowly elliptic <3:1, widest at mid-point>/
9. elliptic <2:1, widest at mid-point>/
10. broadly elliptic <1.5:1, widest at mid-point>/
11. subcircular <1.2:1, widest at mid-point>/
12. circular <1:1, widest at mid-point>/
13. lanceolate <3:1 or more, widest toward base>/
14. narrowly ovate <2:1, widest toward base>/
15. ovate <1.5:1, widest toward base>/
16. broadly ovate <1.2:1, widest toward base>/

17. very broadly ovate <1:1 or less, widest toward base>/
18. narrowly oblanceolate <6:1 or more, widest toward apex>/
19. oblanceolate <3:1, widest toward apex>/
20. obovate <2:1, widest toward apex>/
21. broadly obovate <1.2:1, widest toward apex>/
22. very broadly obovate <1:1 or less, widest toward apex>/

#79. largest medial leaf blades: length:/ mm <long>/

#80. largest medial leaf blades: width:/ mm <wide>/

#81. largest medial leaf blades: length-width ratio:/

#82. largest medial leaf blades: proportional leaf shape:/
1. 4x or less as long as wide/
2. greater than 4x as long as wide/

Base

#83. largest medial leaf blades: base shape: based on proximal 0.25L/
1. cuneate <Margin at base essentially straight.>/
2. slightly decurrent <Margin joins petiole in a concave arc.>/
3. convex <Margin at base curving away from center of blade.>/
4. rounded <Margin at base forming a smooth arc.>/
5. concave <Margin at base curving toward center of blade.>/
6. subcordate <Margin at base slightly lobed, concave at petiole and convex to rounded away from petiole.>/
7. cordate <Margin at base distinctly lobed, sides of lobes toward petiole straight, convex, or concave.>/

#84. Largest medial leaf blades: Base angle <measured from attachment of petiole to 0.25 blade length>/
1. angle less than 90 deg. <acute>/
2. angle greater than 90 deg. <obtuse>/

Margin

#85. largest medial leaf blades: margin revolution:/
1. strongly revolute/
2. slightly revolute/
3. flat/

#86. Largest medial leaf blades margins: ciliation/
1. not ciliate/
2. ciliate/

#87. largest medial leaf blades: margin general toothing:/
1. entire/
2. toothed/

#88. largest medial leaf blades: position of glands: <on entire or toothed margins>/
1. marginal/
2. submarginal <on adaxial surface slightly in from edge>/
3. epilaminal <on adaxial surface well in from edge>/

#89. largest medial leaf blades: margin dentition type:/
1. entire <margin smooth, no glands, teeth, or undulations>/
2. entire and gland-dotted/
3. serrate <closely spaced large teeth>/
4. remotely or irregularly serrate <widely spaced large teeth>/
5. serrulate <closely spaced small teeth>/
6. spinulose-serrulate <closely spaced elongated teeth>/
7. remotely shallowly serrulate <teeth very shallow, widely spaced>/
8. remotely spinulose-serrulate <widely spaced elongated teeth>/
9. crenate <curved indentations>/
10. crenulate <small, curved indentations>/
11. undulate <wavy, up and down, in and out>/

#90. largest medial leaf blades: position of teeth:/
1. all around margin/
2. at proximal end/
3. at distal end/

#91. largest medial leaf blades: teeth or gland number:/ per cm/

#92. Largest medial leaf blades: leaflet-like basal marginal outgrowths/
1. absent/
2. present/

Apex

#93. largest medial leaf blades: apex shape: based on distal 0.25L./
1. acute <Margin at apex with no significant curvature.>/
2. acuminate <Margin at apex distinctly concave and gradually tapering to tip.>/
3. caudate <Margin at apex distinctly concave and gradually tapering to a long, tail-like tip.>/
4. convex <Margin at apex curving away from centre of blade.>/

5. rounded <Margin at apex forming a smooth arc. Subtype of convex.>/
6. retuse <Apex slightly notched, less than 5%.>/
7. emarginate <Apex deeply notched, 5-25%.>/

#94. Largest medial leaf blades: Apex angle <measured from leaf tip to 0.75 blade length>/
1. angle less than 90 deg. <acute>/
2. angle greater than 90 deg. <obtuse>/

Abaxial surface
#95. largest medial leaf blades: abaxial surface glaucescence: <waxy bloom>/
1. not glaucous <lacking waxy coating>/
2. glaucous <bluish or whitish waxy coating>/
3. obscured by indumentum/

#96. largest medial leaf blades: abaxial surface glaucescence density:/
1. a thin waxy bloom <polishes but not whitish>/
2. a thick waxy bloom <stomata sometimes visible through wax as dots>/
3. a very thick waxy bloom <stomata not visible>/

#97. largest medial leaf blades: abaxial surface general hairiness:/
1. glabrous <or glabrescent>/
2. hairy/

#98. largest medial leaf blades: abaxial indumentum density:/
1. sparse/
2. moderately dense <surface 50% visible>/
3. very dense <surface obscured>/

#99. largest medial leaf blades: abaxial surface indumentum type:/
1. glabrous <without hairs>/
2. glabrescent <becoming glabrous in age but a few hairs remaining>/
3. puberulent <very sparse, short, fine, straight or wavy, erect or spreading hairs>/
4. pubescent <sparse to dense, short, fine, wavy or straight, spreading hairs>/
5. pilose <very sparse, long, fine, wavy or straight, spreading hairs>/
6. villous <sparse to dense, long, fine, straight or wavy, spreading hairs>/
7. tomentose <dense, short, rather firm, more or less matted, erect or spreading hairs>/
8. woolly <very dense, long, fine, spreading, wavy, more or less matted hairs>/
9. short-silky <sparse to dense, short (less than 0.5 mm), fine, straight or wavy, appressed, shiny hairs>/
10. long-silky <sparse to dense, fine, long (0.5 mm or greater), straight or wavy, appressed, shiny hairs>/
11. velvety <very dense, short, fine, straight, erect hairs of relatively uniform length>/
12. floccose <scattered tufts of hair>/

#100. Largest medial leaf blades: abaxial surface hairiness/
1. all over/
2. along midrib/
3. at margins/

#101. largest medial leaf blades: abaxial surface hair orientation:/
1. appressed/
2. spreading <divergent>/
3. erect/

#102. largest medial leaf blades: abaxial indumentum color:/
1. white/
2. gray/
3. yellowish/
4. ferruginous/
5. white and ferruginous/

#103. largest medial leaf blades: abaxial surface hair shape:/
1. straight/
2. wavy/
3. curved/
4. crinkled/

#104. largest medial leaf blades: abaxial surface hair relative length:/
1. minute <less than 0.5 mm>/
2. short <ca. 0.5 mm>/
3. long <longer than 0.5 mm>/

#105. largest medial leaf blades: abaxial surface hair texture:/
1. fine/
2. coarse/

Adaxial Surface
#106. largest medial leaf blades: adaxial surface luster:/
1. dull/
2. shiny/
3. highly glossy/

#107. largest medial leaf blades: adaxial surface glaucescence:/
1. not glaucous <lacking waxy coating>/
2. glaucous <bluish or whitish waxy coating>/

#108. largest medial leaf blades: adaxial surface general hairiness:/
1. glabrous <or glabrescent>/
2. hairy/

#109. largest medial leaf blades: adaxial surface indumentum density:/
1. sparse/
2. moderately dense <surface 50% visible>/
3. very dense <surface obscured>/

#110. largest medial leaf blades: adaxial surface indumentum type:/
1. glabrous <without hairs>/
2. glabrescent <becoming glabrous in age but a few hairs remaining>/
3. puberulent <very sparse, short, fine, straight or wavy, erect or spreading hairs>/
4. pubescent <sparse to dense, short, fine, wavy or straight, spreading hairs>/
5. pilose <very sparse, long, fine, wavy or straight, spreading hairs>/
6. villous <sparse to dense, long, fine, straight or wavy, spreading hairs>/
7. tomentose <dense, short, rather firm, more or less matted, erect or spreading hairs>/
8. woolly <very dense, long, fine, spreading, wavy, more or less matted hairs>/
9. short-silky <sparse to dense, short (less than 0.5 mm), fine, straight or wavy, appressed, shiny hairs>/
10. long-silky <sparse to dense, fine, long (0.5 mm or greater), straight or wavy, appressed, shiny hairs>/
11. velvety <very dense, short, fine, straight, erect hairs of
12. floccose <scattered tufts of hair>/

#111. Largest medial leaf blades: adaxial surface hairiness/
1. all over/
2. along midrib/
3. at margins/

#112. largest medial leaf blades: adaxial surface hair orientation:/
1. appressed/
2. spreading <divergent>/
3. erect/

#113. largest medial leaf blades: adaxial surface hair color:/
1. white/
2. gray/
3. yellowish/
4. ferruginous/
5. white and ferruginous/

#114. largest medial leaf blades: adaxial surface hair relative length:/
1. minute <less than 0.5 mm>/
2. short <ca. 0.5 mm>/
3. long <longer than ca. 0.5 mm>/

#115. largest medial leaf blades: adaxial surface hair texture:/
1. fine/
2. coarse/

GENERAL INFLORESCENCE

#116. catkins: flowering: <relative time of flowering and emergence of leaves>/
1. before leaves emerge <precocious>/
2. just before leaves emerge <subprecocious>/
3. as leaves emerge <coetaneous>/
4. throughout the season <sylleptic flowering>/

#117. catkins: position on previous year's shoot:/
1. arising from a subterminal bud/
2. arising from lateral buds/

#118. Catkins: syllepsis: <catkins arising from buds of the year without a dormant period>/
1. not sylleptic/
2. sylleptic/

#119. catkins: number of flowers per catkin <staminate and pistillate>/

#120. catkins: branching:/
1. branched/
2. unbranched/

#121. catkins: axis rigidity <rachis>/
1. lax <more or less pendulous>/
2. rigid <erect>/

STAMINATE CATKINS

#122. staminate catkins: density: <catkins in flower:>/
1. very densely flowered <rachis not visible>/
2. moderately densely flowered <rachis partly visible>/
3. loosely flowered <rachis clearly visible>/

#123. staminate catkins: general shape: <catkins in flower>/
1. slender <greater than 4x longer than wide>/
2. stout <4x or less longer than wide>/
3. subglobose <slightly longer than wide (1.3-1.1x)>/
4. globose <length and width equal>/
5. indeterminate <few-flowered, shape not applicable>/

#124. staminate catkins: length of flowering rachis:/
mm <long>/

#125. staminate catkins: length including peduncle:/
mm <long>/

#126. staminate catkins: width: <of pressed catkin in flower>/ mm <wide>/

#127. staminate catkins: length-width ratio: <of flowering rachis>/

#128. staminate catkins: peduncle length: <distance from proximal flower to distal leaf on flowering branchlet, catkins in flower>/ mm <long>/

#129. staminate catkins: flowering branchlets presence: <catkins in flower>/
1. absent/
2. present/

#130. staminate catkins: flowering branchlets length: <catkins in flower>/ mm <long>/

PISTILLATE CATKINS

#131. pistillate catkins: density: <catkins in flower>/
1. very densely flowered <rachis not visible>/
2. moderately densely flowered <rachis partly visible>/
3. loosely flowered <rachis clearly visible>/

#132. pistillate catkins: general shape: <catkins in flower>/
1. slender <greater than 4x longer than wide>/
2. stout <4x or less longer than wide>/
3. subglobose <slightly longer than wide (1.3-1.1x)>/
4. globose <length and width equal>/
5. indeterminate <few-flowered, shape not applicable>/

#133. pistillate catkins: flowering rachis length:/
mm <long>/

#134. pistillate catkins: length including peduncle:/
mm <long>/

#135. pistillate catkins: width: <pressed catkins in flower>/ mm <wide>/

#136. Pistillate catkins: length-width ratio: <of flowering rachis>/

#137. pistillate catkins: peduncle length: <distance from proximal flower to distal leaf on flowering branchlet: catkins in flower>/ mm <long>/

#138. pistillate catkins: flowering branchlet presence: <catkins in flower>/
1. absent/
2. present/

#139. pistillate catkins: flowering branchlet length: <catkins in flower>/ mm <long>/

#140. pistillate fruiting catkins: persistence:/
1. deciduous by end of growing season/
2. persistent through the winter/

FLORAL BRACTS

#141. floral bracts: color: <staminate and pistillate:>/
1. tawny/
2. light rose/
3. greenish/
4. bicolor <darker at tip>/
5. brown/
6. black/

#142. floral bracts: texture/
1. membranous/
2. not membranous/

#143. floral bracts: shape: <staminate and pistillate:>/
1. widest at proximal end/
2. widest at middle/
3. widest at distal end/

#144. floral bracts: length: <staminate and pistillate:>/
mm <long>/

#145. floral bracts: abaxial surface general hairiness: <staminate and pistillate:>/
1. glabrous/
2. hairy/

#146. floral bracts: abaxial surface indumentum density: <staminate and pistillate:>/
1. sparse/
2. moderately dense <surface 50% visible>/
3. very dense <surface obscured>/

#147. floral bracts: abaxial surface indumentum position: <staminate and pistillate:>/
1. hairy all over/
2. hairy mainly at distal end/
3. hairy mainly at proximal end/
4. ciliate/

#148. floral bracts: abaxial surface hair color: <staminate and pistillate:>/
1. white/
2. gray/
3. yellowish/
4. ferruginous/
5. white and ferruginous/

#149. floral bracts: abaxial surface hair shape: <staminate and pistillate:>/
1. straight/
2. wavy/
3. curly/
4. crinkled/

#150. floral bracts: apex shape: <staminate and pistillate:>/
1. acute <margins slightly curved, form less than right angle>/
2. convex <margins slightly curved, form more than right angle>/
3. rounded <margins forming a smooth arc>/
4. truncate <as if cut at right angles to rachis>/
5. retuse <slightly notched>/

#151. floral bracts apex dentition: <staminate and pistillate:>/
1. entire/
2. bifid/
3. toothed/
4. erose/

#152. pistillate floral bracts: deciduousness:/
1. deciduous after flowering/
2. persistent after flowering/

STAMINATE FLOWERS

Nectaries

#153. staminate flowers: abaxial nectary presence:/
1. absent/
2. present/

#154. staminate flowers: abaxial nectary lobing:/
1. unlobed <appearing as a single unit>/
2. two or more lobes <prominent lobes>/

#155. staminate flowers: abaxial nectary lobe connation: <includes only prominent lobes>/
1. lobes distinct/
2. lobes connate/

#156. staminate flowers: abaxial nectary length: <excluding cup in flowers with cup-shaped nectaries>/
mm <long>/

#157. staminate flowers: adaxial nectary presence:/
1. absent/
2. present/

#158. staminate flowers: adaxial nectary lobing:/
1. unlobed/
2. two or more lobes <distinct lobes>/

#159. staminate flowers: adaxial nectary lobe connation: <includes only prominent lobes>/
1. lobes distinct/
2. lobes connate/

#160. staminate flowers: adaxial nectary shape:/
1. narrowly oblong <slender-rod, widest in mid-zone, length more than 3 times width>/
2. oblong <broad-rod, widest in mid-zone, length 2-3 times width>/
3. transverse-oblong <laterally oblong>/
4. square <about as long as wide>/
5. ovate <egg-shaped, broadest at base, narrowed toward tip>/
6. flask-shaped <more or less abruptly tapering neck>/
7. narrowly ovate <narrow egg-shape>/
8. depressed-ovate <egg-shaped but broader than long>/
9. obovate <inverse egg-shaped widest toward distal end>/
10. triangular <broadest at proximal end>/
11. obtriangular <inverted triangle, narrowest at the proximal end>/
12. irregular <not easily defined shape>/

#161. staminate flowers: adaxial nectary base:/
1. not half-surrounding stamens/
2. half-surrounding base of stamens/

#162. staminate flowers: adaxial nectary length: <excluding cup in flowers with cup-shaped nectaries>/
mm <long>/

#163. staminate flowers: abaxial and adaxial nectaries connation: <into a full or partial cup:>/
1. distinct/
2. connate and cup-shaped <cup shallow or deep; sometimes not connate along one edge>/

Stamens

#164. staminate flowers: stamen number: <number per flower:>/

#165. staminate flowers: anther color:/
1. yellow <including tawny>/
2. purple <dark purple>/
3. purple becoming yellow/
4. reddish <or brownish> becoming yellow/

#166. staminate flowers: anther shape: <after dehiscence:>/
1. ellipsoid/
2. short-cylindrical <3x or less as long as wide>/
3. long-cylindrical <greater than 3x as long as wide>/
4. ovoid <broadest at proximal end>/
5. obovoid <broadest at distal end>/
6. subglobose/

#167. staminate flowers: anther axis shape: <after dehiscence:>/
1. straight/
2. twisted/
3. slightly recurved/
4. strongly recurved/

#168. staminate flowers: anther length: <dry, empty, after dehiscence:>/ mm <long>/

#169. staminate flowers: filament union:/
1. distinct/
2. connate less than half/
3. connate half or more/

#170. staminate flowers: filament general hairiness:/
1. glabrous/
2. hairy/

#171. staminate flowers: filament indumentum position:/
1. hairy all over/
2. hairy on lower half/
3. hairy at base/

PISTILLATE FLOWERS

Nectaries

#172. pistillate flowers: abaxial nectary presence:/
1. absent/
2. present/

#173. pistillate flowers: abaxial nectary lobing: <includes only prominent lobes>/
1. unlobed/
2. two or more lobes/

#174. pistillate flowers: abaxial nectary lobe connation:/
1. lobes distinct/
2. lobes connate/

#175. pistillate flowers: abaxial nectary length: <excluding cup in flowers with cup-shaped nectaries>/ mm <long>/

#176. pistillate flowers: adaxial nectary presence:/
1. absent/
2. present/

#177. pistillate flowers: adaxial nectary lobing:/
1. unlobed <appearing as a single unit>/
2. two or more lobes <distinct lobes>/

#178. pistillate flowers: adaxial nectary lobe connation: <includes only prominent lobes:>/
1. lobes distinct/
2. lobes connate/

#179. pistillate flowers: adaxial nectary shape:/
1. narrowly oblong <slender-rod, widest in mid-zone, length more than 3 times width>/
2. oblong <broad-rod, widest in mid-zone, length 2-3 times width>/
3. transverse-oblong <laterally oblong>/
4. square <about as long as wide>/
5. ovate <egg-shaped, broadest at base, narrowed toward tip>/
6. flask-shaped <more or less abruptly tapering neck>/
7. narrowly ovate <narrow egg-shape>/
8. depressed-ovate <egg-shaped but broader than long>/
9. obovate <inverse egg-shaped widest toward distal end>/
10. triangular <broadest at proximal end>/
11. obtriangular <inverted triangle, narrowest at the proximal end>/
12. irregular <not easily defined shape>/

#180. pistillate flowers: adaxial nectary base:/
1. not half-surrounding stipe/
2. half-surrounding base of stipe/

#181. pistillate flowers: adaxial nectary length: <excluding cup in flowers with cup-shaped nectaries>/ mm <long>/

#182. pistillate flowers: adaxial nectary-stipe length ratio:/
1. shorter than stipes/
2. equal to stipes/
3. longer than stipes/

#183. pistillate flowers: adaxial nectary texture:/
1. swollen/
2. flattened <thick and tongue-like>/
3. thin/

#184. pistillate flowers: connation of abaxial and adaxial nectaries: <note if completely or incompletely cup-shaped and depth of cup>/
1. distinct/
2. connate and cup-shaped <cup shallow or deep; sometimes not connate along one edge>/

Ovaries

#185. pistillate flowers: stipe length:/
mm <long>/

#186. stipes: hairiness:/
1. glabrous/
2. hairy/

#187. pistillate flowers: ovary color:/
1. obscured by hairs/
2. greenish/
3. greenish brown/
4. greenish with red sutures/
5. reddish/
6. mottled green and red/

#188. pistillate flowers: ovary shape:/
1. obclavate <inverse club-shaped>/
2. pyriform <pear-shaped>/
3. ovoid <egg-shaped>/
4. gourd-shaped <lageniform>/
5. obturbinate <inverse top-shaped>/
6. obnapiform <inverse turnip-shaped>/
7. squat flask-shaped <ampulliform>/
8. ellipsoidal <spindle-shaped>/

#189. pistillate flowers: ovary beak shape:/
1. gradually tapering to style <no evident transition>/
2. slightly bulged below style <slight curve to style>/
3. abruptly tapering to style/

#190. pistillate flowers: ovary general hairiness:/
1. glabrous <or glabrescent>/
2. hairy/

#191. pistillate flowers: ovary indumentum density:/
1. in patches or streaks/
2. sparse <surface clearly visible>/
3. moderately dense <surface partly visible>/
4. very dense <surface not visible>/

#192. pistillate flowers: ovary indumentum type:/
1. glabrous <without hairs>/
2. glabrescent <becoming glabrous in age but a few hairs remaining>/
3. puberulent <very sparse, short, fine, straight or wavy, erect or spreading hairs>/
4. pubescent <sparse to dense, short, fine, wavy or straight, spreading hairs>/
5. pilose <very sparse, long, fine, wavy or straight, spreading hairs>/
6. villous <sparse to dense, long, fine, straight or wavy, spreading hairs>/
7. tomentose <dense, short, rather firm, more or less matted, erect or spreading hairs>/
8. woolly <very dense, long, fine, spreading, wavy, more or less matted hairs>/
9. short-silky <sparse to dense, short (less than 0.5 mm), fine, straight or wavy, appressed, shiny hairs>/
10. long-silky <sparse to dense, fine, long (0.5 mm or greater), straight or wavy, appressed, shiny hairs>/
11. velvety <very dense, short, fine, straight, erect hairs of relatively uniform length>/

#193. pistillate flowers: ovary hair orientation to surface:/
1. appressed/
2. spreading <divergent>/

#194. pistillate flowers: ovary hair color:/
1. white/
2. gray/
3. yellowish/
4. ferruginous/
5. white and ferruginous/

#195. pistillate flowers: ovary hair shape:/
1. straight/
2. wavy/
3. crinkled/

#196. pistillate flowers: ovary hair type:/
1. cylindrical/
2. flattened <edges thickened, sometimes refractive>/
3. ribbon-like <flat and refractive>/

#197. pistillate flowers: ovary glaucescence:/
1. not glaucous <lacking waxy coating or obscured by indumentum>/
2. glaucous <bluish or whitish waxy coating>/

#198. pistillate flowers: style connation:/
1. connate/
2. slightly distinct at distal end <less than 0.25 its length>/
3. distinct about half its length <ca. 0.25-0.75 its length>/
4. distinct <ca. to base>/

#199. pistillate flowers: style color:/
1. greenish or tawny/
2. reddish or brownish/

#200. pistillate flowers: style length:/
mm <long>/

#201. pistillate flowers: stigmas: connation/
1. carinal <distinct from neighboring stigmas>/
2. commissural <connate with neighboring stigmas>/

#202. pistillate flowers: stigmas persistence:/
1. persistent/
2. deciduous after flowering/

#203. pistillate flowers: stigmas shape:/
1. with flat, non-papillate abaxial surface and rounded tip <e.g. *S. amygdaloides*>/
2. with flat, non-papillate abaxial surface and pointed tip <e.g. *S. geyeriana*>/
3. slender-cylindrical <length greater than 4x width, e.g. *S. alaxensis*>/
4. broad-cylindrical <length less than 4x width, e.g. *S. petiolaris*>/
5. plump <e.g. *S. myrtillifolia*>/

#204. pistillate flowers: stigma lobe length: <length of papillate portion>/ mm <long>/

Fruits
#205. pistillate flowers: capsule length:/ mm<long>/

#206. pistillate flowers: capsule indumentum:/
1. glabrous <or glabrescent>/
2. hairy/

#207. pistillate flowers: number of ovules per ovary:/

CHROMOSOME NUMBER
#208. 2n = <chromosome number:>/
1. 38 <2x>/
2. 57 <3x>/
3. 76 <4x>/
4. 95 <5x>/
5. 114 <6x>/
6. 152 <8x>/
7. 190 <10x>/
8. 228 <12x>/
9. unknown/

#209. <chromosome number reference> <author and date>/

FLOWERING TIME
#210. flowering: <dates>/

ELEVATION
#211. elevation:/ m.s.m./

NATIVE STATUS
#212. indigenous status in North America:/
1. native/
2. introduced/

#213. cultivated status in North America:/
1. cultivated <only>/
2. naturalized/

DISTRIBUTION
#214. Endemic status <Within FNA area>/
1. E <endemic to FNA area>/
2. Narrow endemic <small range>/

#215. Regional distribution <within FNA area, adapted from A. L. Takhtajan 1986>/
1. Arctic Province <1a>/
2. Canadian Province <1b>/
3. Appalachian Province <3a>/
4. Atlantic and Gulf Coast Province <3b>/
5. North American Prairie Province <3c>/
6. Vancouverian Province <4a>/
7. Rocky Mountain Province <4b>/
8. Great Basin Province <9a>/
9. Californian Province <9b>/
10. Sonoran Province <9c>/
11. Mojavean Subprovince <9c1>/
12. Sonoran Subprovince <9c2>/
13. Chihuahuan Subprovince <9c3>/
14. Tamaulipan Subprovince <9c4>/

#216. World distribution: <FNA order:>/
1. Greenland/
2. St. Pierre and Miquelon/
3. Canada/
4. United States/
5. Mexico/
6. West Indies/
7. Bermuda/
8. Central America/
9. South America/
10. Eurasia/
11. Europe/
12. Asia/
13. Eastern Asia/

#217. distribution in North America: <general>/
1. west of 102nd meridian/
2. east of 102nd meridian/

#218. Canada: <distribution:>/
1. Alta./
2. B.C./
3. Lab./
4. Man./
5. N.B./
6. Nfld./
7. N.W.T./
8. N.S./
9. Nunavut/
10. Ont./
11. P.E.I./
12. Que./
13. Sask./
14. Yukon/

#219. U.S.A.: <distribution:>/
1. Ala./
2. Alaska/
3. Ariz./
4. Ark./
5. Calif./
6. Colo./
7. Conn./
8. Del./
9. D.C./
10. Fla./
11. Ga./
12. Idaho/
13. Ill./
14. Ind./
15. Iowa/
16. Kans./
17. Ky./
18. La./
19. Maine/
20. Md./
21. Mass./
22. Mich./
23. Minn./
24. Miss./
25. Mo./
26. Mont./
27. Nebr./
28. Nev./
29. N.H./
30. N.J./
31. N.Mex./
32. N.C./
33. N.Dak./
34. N.Y./
35. Ohio/
36. Okla./
37. Oreg./
38. Pa./
39. R.I./
40. S.C./
41. S.Dak./
42. Tenn./
43. Tex./
44. Utah/
45. Vt./
46. Va./
47. Wash./
48. W.Va./
49. Wis./
50. Wyo./

#220. Mexico: <distribution:>/
1. A.G.S./
2. Baja Calif./
3. Baja Calif. S./
4. Camp./
5. Chia./
6. Chih./
7. Coah./
8. Col./
9. Dur./
10. D.F./
11. Gua./
12. Guer./
13. Hid./
14. Jal./
15. Mex./
16. Mic./
17. Mor./
18. Nay./
19. N.L./
20. Oax./
21. Pueb./
22. Qro./
23. Q.R./
24. S.L.P./
25. Sin./
26. Son./
27. Taba./
28. Tam./
29. Tlax./
30. Vera./
31. Yuc./
32. Zac./

#221. California Geographical Regions:/
1. Northwestern California Region NW/
2. Cascade Region CaR/
3. Sierra Nevada SN/
4. Great Central Valley Region GV/
5. Central Western California Region CW/
6. Southwestern California Region SW/
7. Modoc Plateau Region MP/
8. East of Sierra Nevada Region SNE/
9. Mojave Desert Region DMoj/

10. Sonoran Desert Region DSon/

#222. California Geographical Subregions:/
1. North Coast Subregion NCo/
2. Klamath Ranges Subregion KR/
3. North Coast Ranges Subregion NCoR/
4. Cascade Range Foothills Subregion CaRF/
5. High Cascade Range Subregion CaRH/
6. Sierra Nevada Foothills Subregion SNF/
7. High Sierra Nevada Subregion SNH/
8. Techapi Mountains Subregion Teh/
9. Sacramento Valley Subregion ScV/
10. San Joaquin Valley Subregion SnJV/
11. Central Coast Subregion CCo/
12. San Francisco Bay Area Subregion SnFrB/
13. South Coast Ranges Subregion SCoR/
14. South Coast Subregion SCo/
15. Channel Islands Subregion ChI/
16. Transverse Ranges Subregion TR/
17. Peninsular Ranges Subregion PR/
18. Warner Mountains Subregion Wrn/
19. White and Inyo Mountains Subregion W&I/
20. Desert Mountains Subregion DMtns/

#223. California Geographical Districts:/
1. Outer North Coast Ranges District NCoRO/
2. High North Coast Ranges District NCoRH/
3. Inner North Coast Ranges District NCoRI/
4. Northern Sierra Nevada Foothills District n SNF/
5. Central Sierra Nevada Foothills District c SNF/
6. Southern Sierra Nevada Foothills District s SNF/
7. Northern High Sierra Nevada District n SNH/
8. Central High Sierra Nevada District c SNH/
9. Southern High Sierra Nevada District s SNH/
10. Outer South Coast Ranges District SCoRO/
11. Inner South Coast Ranges District SCoRI/
12. Northern Channel Islands District n ChI/
13. Southern Channel Islands District s ChI/
14. Western Transverse Ranges District WTR/
15. San Gabriel Mountains District SnGb/
16. San Bernardino Mountains District SnBr/
17. San Jacinto Mountains District SnJt/

CLASSIFICATION

#224. Subg. <Subgenera>/
1. Chamaetia/
2. Longifoliae/
3. Protitea/
4. Salix/
5. Vetrix/

#225. Sect. <Subg. Protitea>/
1. Floridanae/
2. Humboldtianae/

#226. Sect. <Subg. Salix>/
1. Maccallianae/
2. Salicaster/
3. Salix/
4. Subalbae/
5. Triandrae/

#227. Sect. <Subg. Longifoliae>/
1. Longifoliae/

#228. <Classification> Sect. <Subg. Vetrix>/
1. Arbuscella/
2. Argyrocarpae/
3. Canae/
4. Candidae/
5. Cinerella/
6. Cordatae/
7. Daphnella/
8. Fulvae/
9. Geyerianae/
10. Griseae/
11. Hastatae/
12. Helix/
13. Lanatae/
14. Mexicanae/
15. Nigricantes/
16. Phylicifoliae/
17. Sitchenses/
18. Villosae/
19. Viminella/

#229. Sect. <Subg. Chamaetia>/
1. Chamaetia/
2. Diplodictyae/
3. Glaucae/
4. Herbella/
5. Myrtilloides/
6. Myrtosalix/
7. Ovalifoliae/
8. Setchellianae/

#230. <Other comments>/

#231. References for cnotes/

#232. References for chromosome numbers/

Appendix 3
Character Notes (8 July 2007)

Note: The repetition in the following notes is because, in the interactive key, all notes are available on line.

#1. Includes date of last update and date when data were first gathered.
#2. Data for most taxa are based on original study of herbarium specimens and field observations. The herbaria and, sometimes, states or provinces sampled are given. For some species these data are supplemented from published descriptions. In such cases the author and date of publication are cited.
#11. Dwarf shrubs are diminutive plants. The branches, or at least their tips, usually are erect. In many dwarf species, e.g. *Salix rotundifolia*, the leaves and catkins also are diminutive. Other species, e.g. *S. arctica*, may have dwarf stature but leaves and catkins as large as taller shrubs.
#12. Height of shrubs and trees is determined by direct observation or from herbarium specimens. Height for dwarf shrubs is measured in the field or estimated from herbarium specimens by measuring the portion of the plant that appeared to be above the surface of the soil, turf, or moss. For species with trailing branches, height was estimated by measuring the length of catkins and flowering branchlets.
#14. Clones are formed by vegetative reproduction in several ways. (1) Shoots arise directly from roots (soboliferous). Root shoots occur in *S*. subg. *Longifoliae* and *S*. subg. *Chamaetia* (*S. setchelliana*). (2) Above ground branches root after being buried in moss or in fine wind or water borne material (layering). (3) Shoots arise from slender, underground stems or rhizomes (rhizomatous). (4) Some arctic-alpine species form underground stems or rhizomes. (5) Stem fragmentation is when branches or branchlets break off, fall to the ground, and take root. Vegetative reproduction by stem fragmentation is common means in riparian species with brittle branches. Because data on fragmentation are limited, all species with brittle stems are scored as reproducing by stem fragmentation. (6) Polycormones are formed by sprouting at base of main stem to form a hemispheric growth form. Under aggrading conditions the sprouts can root and and form a small clone (Pénzes 1960).
#16. A branch is a shoot in its second year of growth or older. Branch brittleness can be determined by pressing the branch toward the main axis just above the point of attachment. If the flexed branches do not break at the base the branch is flexible. If all branches break at the base the plant is scored as highly brittle. If not all branches break when flexed the branches are somewhat brittle. Branches of *Salix floridana* are highly brittle anywhere along their length, not just at the base.
#19. Glaucous (pruinose) refers to the whitish, grayish or bluish waxy coating that sometimes appears on branches.
#20. This character is included for identification purposes. Plants that are glabrate (i.e. having lost most or all of their hair) as well as those without hair (glabrous) are scored as glabrous.
#21. Indumentum or hair covering terminology is based in part on Hewson (1988). In the database indumentum terminology is expressed in two ways. (1) Collective terms for indumentum type, such as, pilose and villous, are used; and (2) the characters of the hairs (trichomes) that contribute the definition of the collective terms are also described. These include hair density, orientation to the surface, shape, length, color, texture, and luster.
#23. The epidermis of 2 to 4 year old branches has been observed to flake away in three ways. (1) Flaking can occur in irregular, gray sheets which peel from the underlying bark. (2) The epidermis can break into a series of closely spaced, short, longitudinal splits. As a gap is formed, a narrow band of yellowish or grayish epidermis separates around the edges of the split. Species with yellowish epidermis may contrast with the red-brown bark creating a distinctive pattern. This pattern, first noted by Dorn (1975) in *Salix pseudomonticola* also occurs in *S. ballii*, *S.*

myrtillifolia and probably other members of *S*. sect. *Hastatae*. (3) The epidermis can flake in many, minute segments. These plants, at first, do not appear to have a flaking epidermis but on branches 3-4 years old the grayish epidermis can be seen to be minutely fractured.
#24. Diamond willows are characterized by the presence of an elliptic or diamond-shaped depression surrounding a dead branch. The branch and the surrounding cambium was killed by a fungus. *Valsa sordida* is the probable agent but other fungi also may be involved (Lutz 1958).
#25. Striae on decorticated branches should be observed on branches 3-4-year old, or older. The striae are raised, flat- or crested longitudinal ridges emerging from the wood. They are best observed by peeling the fresh bark or, if only dry material is available, by soaking the branch in water until the bark can be peeled. The description of frequency and length of striae was observed by examining one side of the branch. A branch segment 20 cm long, and at least 3-4 years old should be selected for examination. A smooth branch may have no or 1-3 widely scattered striae. The origin and function of striae is unknown, but they may be the point of adventitious roots. The presence or absence of striae have long been used to separate *S*. *cinerea* (striate) and *S*. *caprea* (smooth).
#26. The density of striae can be estimated by observing one side of a 20 cm long branch segment. The presence of 3-10 striae is sparse, 11-30 striae is moderately dense, and more than 30 striae is very dense.
#29. Sharp points or conical, pointed projections on peeled wood are remnants of adventitious roots or an indication of the location of root primordia (Carlson 1950). They often occur in pairs at the base of branches or scattered along the branch. The taxonomic value of this character is not known but it may be an indication of species ability to root.
#30. Some peeled branches display yellowish or brownish transverse lines. These lines are composed of a series of closely spaced, minute points. The function or origin of these lines is unknown as is their taxonomic value.
#31. A branchlet (twig) is a shoot in its first year of growth; it bears the leaves of the year.
#33. The term glaucous (pruinose) refers to the whitish, grayish, or bluish waxy coating that sometimes appears on branchlets.
#34. This character is included for identification purposes. Plants that are glabrate (i.e. having lost most or all of their hair) as well as those without hair (glabrous) are scored as glabrous.
#36. Indumentum or hair covering terminology is based in part on Hewson (1988). In the database indumentum terminology is expressed in two ways. (1) Collective terms for indumentum type, such as, pilose and villous, are used; and (2) the characters of the hairs (trichomes) that contribute the definition
of the collective terms are also described. These include hair density, orientation to the surface, shape, length, color, texture, and luster.
#39. Based on Belyaeva et al. 2005 and Argus 2006. Dimorphic = *caprea*-type.
#40. Bud size and gradation types are best observed on winter twigs or late in the growing season. The three general bud gradation types recognized by Skvortsov (1999) are relatively distinct but there are intermediates. Type 1 (*alba*-type). Plants with *alba*-type bud gradation have buds that are very similar in size and shape along the length of the branchlet. Floral and vegetative buds cannot be distinguished by size or shape. The two distal most buds are usually smaller, the third to seventh buds are the largest, and the next gradually decrease in size toward the proximal end. Type 2 (*arctica*-type). Plants with *arctica*- type bud gradation usually have few buds. The two or three (sometimes up to five) distal buds are the largest (although the first bud may be slightly smaller), below them there is an abrupt change in bud size toward the proximal end. Usually only the larger buds toward the distal end open in the spring. These buds may be either floral or vegetative. Type 3 (*caprea*-type). Plants with *caprea*-type bud gradation are characterized by floral buds that are strikingly different from vegetative buds in size and shape (and sometimes color). The distal two or three buds are usually vegetative, the next three to six (or more) buds mainly are large floral buds, and intermixed with them may be one or two smaller vegetative

buds. Following the zone of floral buds there is an abrupt decrease in bud size that continues to decrease toward the branchlet's proximal end. Type 4 (indeterminate) is bud gradation not easily fit into the other types. Not all taxa have been scored for this character.
#41. Adaxial is the side of a structure facing the axis (ventral); abaxial is the side facing away from the axis (dorsal). In *Salix* the buds are enclosed by a single bud scale which is the result of the connation of two prophylls (Kimura and Sugaya 1965). The abaxial edges of these prophylls are always connate but the adaxial margins can be distinct or connate. If the adaxial margins are connate the bud scale appears as a cap or calyptera. If the adaxial margins are not connate they are described here as distinct and overlapping. This may be best seen in transverse section or by examining the adaxial side of bud scale. The taxonomic significance of distinct or connate bud scale margins is discussed by Chmelar (1978).
#42. The inner epidermal membrane of the mature, opened bud scale may be free from the outer membrane or it may remain adnate to it. If the free inner membrane is free it may completely separate from the outer membrane as the bud opens or it may remain attached to it only along a margins. See also: Chmelar (1978) and Buechler (1992).
#43. Bud characters have not yet been completely incorporated into the database.
#44. Hairs described as ferruginous are rust-colored. The origin of this coloration is not known but in *Salix scouleriana* there can be ferruginous dots at the base of some hairs. These resemble the reddish resin that sometimes occurs on the leaves of *Populus trichocarpa* and *P. balsamifera* and which gives them a ferruginous coloration.
#45. Cataphylls are the first two or three bract-like leaves at the proximal end of the branchlet (Sugaya 1960). They are caducous, lack axillary buds, stipules, and green coloration, and often have the hardness and ciliation of bud scales. In some species they are lost very early and only can be seen on very young shoots. The presence of a scar can be an indication of their presence. Some species sometimes have greenish cataphylls. In other respects (namely, densely hairy abaxially and apex often rounded) they resemble true cataphylls. Species with green cataphylls are treated as intermediates. Cataphylls should not be confused with the inner bud scale membrane which may have the same color and texture. The inner bud scale membrane appears on the same side of the branchlet as the outer bud scale membrane, while the first cataphyll is on the opposite or adaxial side of the branchlet.
#50. Stipules at the base of proximal leaves usually are absent or rudimentary. If they are present then all leaves on the plant will be stipulate.
#51. This character refers to stipules at the base of the early (preformed), normal leaves; not to the proximal leaves (see character 67). Moore (1909) showed that, in some *Salix*, the winter buds do not contain all the leaves that appear on the primary shoots. Those that are present are the preformed leaves and those that are produced as the shoot elongates are the neoformed leaves. Bud dissections need to be done to determine the number of preformed leaves in each species. Until that study is done an indication of the number of preformed leaves can be had by examining the shorter shoots on the plant. On winter twigs or on older branches stipule scars are an indication that foliaceous or rudimentary stipules were present.
#52. Stipules may be absent or rudimentary at the base of the early (preformed), normal leaves but appear at the base of the late (neoformed) leaves. This character refers to stipules at the base of the late leaves. Moore (1909) showed that, in some *Salix*, the winter buds do not contain all the leaves that appear on the primary shoots. Those that are present are the preformed leaves and those that are produced as the shoot elongates are the neoformed leaves. Bud dissections need to be done to determine the number of preformed leaves in each species. Until that study is done an indication of the number of preformed leaves can be had by examining the shorter shoots on the plant. On winter twigs or on older branches stipule scars are an indication that foliaceous or rudimentary stipules were present.
#59. Ventricose is the condition in which the base of the petiole is inflated and encloses a mature floral bud (e.g. *Salix alaxensis*).

#60. Petiole length is measured from the base of the leaf blade to the point of attachment of the petiole to the branchlet.
#62. Petiolar glands may be located on the adaxial surface of the petiole. Usually they appear at the distal end of the petiole just below the leaf blade. Terminology for petiolar gland position is based on Hickey (1973, 1979).
#65. This character is included for identification purposes. Plants that are glabrate (i.e. having lost most or all of their hair) as well as those without hair (glabrous) are scored as glabrous.
#66. The indumentum or hair covering on the petioles is observed on the abaxial surface. Depending on how the specimens are pressed this may be difficult to observe, particularly in species with deeply grooved petioles.
#67. Juvenile leaves are the young unfolding leaves at the apex (distal end) of the branchlets. Juvenile leaf color should be observed on leaves that have just emerged and are still folded around each other.
#68. This character is included for identification purposes. Plants that are glabrate (i.e. having lost most or all of their hair) as well as those without hair (glabrous) are scored as glabrous.
#70. Indumentum or hair covering terminology is based in part on Hewson (1988). In the database indumentum terminology is expressed in two ways. (1) Collective terms for indumentum type, such as, pilose and villous, are used; and (2) the characters of the hairs (trichomes) that contribute the definition of the collective terms are al o described. These include hair density, orientation to the surface, shape, length, color, texture, and luster.
#71. Hairs described as ferruginous are rust-colored. The origin of this coloration is not known but in *Salix scouleriana* there can be ferruginous dots at the base of some hairs. These resembles the same reddish resin that sometimes occurs on the leaves of *Populus trichocarpa* and *P. balsamifera* and which gives the hairs a ferruginous coloration.
#72. The proximal leaves are the first 2-4 smaller leaves at the base of a shoot. They are termed "lower leaves" by Skvortsov (1999). They should not, however, be confused with the 2-3 bract-like cataphylls (see character 42).
Cataphylls are caducous, lack axillary buds and green coloration, and often have the hardness and ciliation of bud scales. The proximal leaves are the first few true leaves. They also are the first leaves that appear on the catkin-bearing shoots, the "flowering branchlets."
#74. Stomata in the adaxial epidermis appear as minute dots under about 30-50× magnification. This character should be observed on the largest mature leaves;
proximal leaves are often amphistomatous when the other leaves are not. Amphistomatous leaves have numerous stomata on the adaxial surface. In some species adaxial stomata are restricted to the leaf apex or to the margins of veins (hemiamphistomatous).
#75. Vein architecture terminology follows Hickey (1973, 1979).
#76. The conditions described as "impressed adaxially" and "flat adaxially" sometimes intergrade. The "impressed" condition is not reliable because it may be an artifact of drying.
#77. The four basic leaf shape classes are elaborated on in character 78.
#78. Leaf shape characters are based, with some minor modification in terminology, on Hickey (1973, 1979). Four main classes of leaf shape are based on the location of the widest point of the leaf: (1) oblong - widest in a zone throughout the middle of the long axis; (2) elliptic - widest at or near the middle of the long axis; (3) ovate - widest between the base and the middle of the long axis; and (4) obovate - widest between the apex and the middle of the long axis. Leaf shape was determined by measuring leaf length and width of one mature, medial leaf on at least 30 specimens.
#83. Leaf base shape terminology is modified from the classification proposed by the Leaf Architecture Working Group (LAWG 1999). Leaf base shape is based on the proximal 25% of the leaf blade length. It is best observed from the adaxial side of the leaf. The blade margins meet the petiole either directly or in a short concave arc. These two conditions are treated separately in LAWG (1999), but because both can be seen on a single branchlet they are treated here as the

same. Shapes described here as convex, rounded, cordate, and subcordate often join the petiole in a short concave arc. The shapes described as cuneate, in which the margin intercepts the petiole directly, and decurrent, in which the margin is concave before joining the petiole, are difficult to separate. In *Salix* most "decurrent" margins are atypical in that they have some vascularization, which is not characteristic of this condition (Kiger and Porter 2001), and usually are very short. In the database decurrent bases are described as "slightly decurrent" unless they extend well down the petiole.

#88. In Salicaceae glands are always associated with leaf teeth but in plants with entire leaves they can appear although no teeth are evident. Glands on margins of entire or toothed leaves may appear on the edge of the blade (marginal), slightly in from the edge as seen from the abaxial surface (submarginal), or well up on the adaxial surface of the leaf blade (epilaminal). The term "submarginal" is used if the blade margin when viewed from its abaxial side has the texture and color of the adaxial surface. I have interpreted this as an indication that the margin is slightly revolute. Sometimes the actual revolution of the margins is evident because the edge of the blade is slightly raised above the abaxial leaf surface; but, in other cases, even though it is not clearly revolute it differs from the abaxial surface in thickness, texture, color, and in the presence of glaucescence. Skvortsov (1999) and Skvortsov and Golysheva (1966) have shown that in some species epidermal cell size and shape differs along the abaxial margin. The anatomy of this character needs to be studied further.

#89. Leaf dentition terminology follows Hickey (1973, 1979). Leaf teeth are defined as a marginal outgrowth or projection of leaf blade tissue. In *Salix*, these protuberances are tipped by a spherical gland. Sometimes species that usually have teeth can have margins that lack projections and thus are entire even though glands may be present. I have usually scored species with this condition as "entire" even if the species typically is toothed, but note that there are glands present. However, I have not been consistent on this point. The definition of "tooth" in *Salix* needs study. Glands on entire leaves are best observed from the abaxial side of the blade.

#91. The number of teeth/cm. was counted at the midpoint of one mature, medial leaf in each of about 20 specimens. If teeth appear only toward the leaf base the number is recorded from the lowermost tooth toward tip. If present only at the leaf apex the number is recorded from lowermost tooth toward tip. If leaf blade is less than 10 mm long, the number recorded in 5 mm is multiplied by 2.

#92. Margins of late leaves sometimes have enlarged teeth or leaf-like outgrowths at proximal end (Ianishevsky 1940).

#95. Abaxial is the side facing away from the axis, dorsal. The term glaucous refers to the whitish or grayish waxy coating that appears on the abaxial, or sometimes adaxial, leaf surfaces. In live material the wax can be polished by rubbing firmly with the ball of the thumb. If present, the area will become greenish. In dried material the wax can be polished by gently scratching or polishing with a dissecting needle. If wax is present it will become shiny green. If it is not present the grayish appearance may be due to air spaces beneath the epidermis.

#97. This character is included for identification purposes. Plants that are glabrate (i.e. having lost most or all of their hair) as well as those without hair (glabrous) are scored as glabrous.

#99. Indumentum or hair covering terminology is based in part on Hewson (1988). In the database indumentum terminology is expressed in two ways. (1) Collective terms for indumentum type, such as, pilose and villous, are used; and (2) the characters of the hairs (trichomes) that contribute the definition of the collective terms are also described. These include hair density, orientation to the surface, shape, length, color, texture, and luster.

#102. Hairs described as ferruginous are rust-colored. The origin of this coloration is not known but in *Salix scouleriana* there can be ferruginous dots at the base of some hairs. These resemble the same reddish resin that sometimes occurs on the leaves of *Populus trichocarpa* and *P. balsamifera* and which gives them a ferruginous coloration.

#106. Adaxial is the side of the leaf facing the shoot axis (ventral).

#107. The term glaucous refers to the whitish or grayish waxy coating that appears on the abaxial, or sometimes adaxial, leaf surfaces. In live material the wax can be polished by rubbing firmly with the ball of the thumb. If present, the area will become greenish. In dried material the wax can be polished by gently scratching or polishing with a dissecting needle. If wax is present it will become shiny green.
#108. This character is included for identification purposes. Plants that are glabrate (i.e. having lost most or all of their hair) as well as those without hair (glabrous) are scored as glabrous.
#110. Indumentum or hair covering terminology is based in part on Hewson (1988). In the database indumentum terminology is expressed in two ways. (1) Collective terms for indumentum type, such as, pilose and villous, are used; and (2) the characters of the hairs (trichomes) that contribute the definition of the collective terms are also described. These include hair density, orientation to the surface, shape, length, color, texture, and luster.
#113. Hairs described as ferruginous are rust-colored. The origin of this coloration is not known but in *Salix scouleriana* there can be ferruginous dots at the base of some hairs. These resemble the same reddish resin that sometimes occurs on the leaves of *Populus trichocarpa* and *P. balsamifera* and which gives them a ferruginous coloration.
#116. The time of flowering of the catkins relative to the emergence of leaves is often described as precocious, coetaneous, or serotinous without stating what structures are involved (Kiger & Porter 2001). To avoid confusion these technical terms have been replaced. *Salix serissima*, which fruits in late summer or early fall, usually is described as serotinous; but it flowers as the leaves emerge, and is coetaneous.
#117. This characters distinguishes between catkins that arise from a subterminal bud, as in *Salix reticulata*, and those that arise from one or more lateral buds.
#120. Catkins are described as branched when one or two proximal flowers develop into small catkins each subtended by a floral bract. These secondary catkins sometimes produce tertiary catkins by the same process (Argus 1964). Branched catkins are known to occur in members of *S.* sect. *Longifoliae* and *S.* sect. *Setchellianae*.
#122. The inflorescence, a catkin, consists of a flower-bearing rachis (a "spike" of unisexual, sessile flowers each subtended by a floral bract) and a stalk or peduncle. The peduncle may bear one or two isolated flowers or one to several empty floral bracts. The catkin may be sessile on the branch or terminate a short flowering branchlet. The flowering branchlet is a vegetative shoot that bears a catkin. It may have three to several leaves that correspond to the first leaves at the proximal end of normal vegetative branchlets. Catkin descriptions are based on flowering catkins. After anthesis staminate catkins do not continue to elongate.
#124. The length of the flower-bearing portion of an inflorescence is measured from the lowermost flower on the continuously flowered portion of the catkin rachis to the distal end of the catkin. Catkin descriptions are based on flowering catkins. After anthesis catkins do not continue to elongate.
#125. A catkin consists of a flowering rachis and its stalk or peduncle.
#126. The width of the flower-bearing portion of a catkin is measured at the midpoint catkin from tips of the spreading stamens. Descriptions of catkins are based on flowering catkins.
#128. Between the flower-bearing axis and the flowering branchlet there is a stalk called the peduncle. It may bear one or two isolated flowers or one-several empty floral bracts. Peduncle length is measured from the proximal flower on the main catkin cluster to the point of attachment of the distal leaf on the flowering branchlet or, if no flowering branchlet is present, to the stem. An abscission layer sometimes appears at the proximal end of the peduncle. Descriptions of catkins are based on flowering catkins.
#129. The flowering branchlet is a short, vegetative shoot which terminates in a catkin. It bears three to several leaves that correspond to the first, usually caducous, leaves at the base of normal vegetative branchlets. In most species that flower before the leaves emerge (precocious) there is no flowering branchlet but sometimes there may be a rudimentary branchlet that bears two or

three caducous prophylls. The flowering branchlet may fall along with the catkin at the end of the growing season. Sometimes, however, an abscission layer may develop between the peduncle and the flowering branchlet. If so, the catkin falls leaving the flowering branchlet attached to the branch. Although there may be minute buds in the axils of leaves on the flowering branchlets they rarely produce shoots in subsequent years. Sorensen (1941) used this difference between normal vegetative shoots and what he termed "floral short shoots" to distinguish these two kinds of shoots. In some *Salix*, namely *S*. sect. *Chamaetia*; *S. rotundifolia, and S. herbacea*, flowering branchlets are not deciduous but are the same as normal vegetative shoots except that they terminate in a catkin.

#130. The length of the flowering branchlet is measured from its point of attachment to the branch to the point of attachment of the distal most leaf.

#131. The inflorescence, a catkin, consists of a flower-bearing rachis (a "spike" of unisexual, sessile flowers each subtended by a floral bract) and a stalk or peduncle. The peduncle may bear one or two isolated flowers or one to several empty floral bracts. The catkin may be sessile on the branch or terminate a short flowering branchlet. The flowering branchlet is a vegetative shoot that bears a catkin. It may have three to several leaves that correspond to the first leaves at the proximal end of normal vegetative branchlets. Catkin descriptions are based on flowering catkins. After flowering pistillate catkins and stipes continue to elongate.

#133. The length of the flower-bearing portion of a catkin is measured from the lowermost flower on the continuous portion of the catkin rachis to the distal end of the catkin. Descriptions of catkins are based on flowering catkins. After fertilization pistillate catkins and stipes usually continue to elongate.

#134. A catkin consists of a flowering rachis and its peduncle.

#135. The width of the flower-bearing portion of a catkin is measured at its midpoint from tips of the stigmas on either side. Descriptions of catkins are based on flowering catkins. After fertilization pistillate catkins and stipes usually continue to elongate.

#137. Between the flower-bearing axis and the flowering branchlet there is a stalk called the peduncle. It may bear one or two isolated flowers or one-several empty floral bracts. Peduncle length is measured from the proximal flower on the main catkin cluster to the point of attachment of the distal leaf on the flowering branchlet or, if no flowering branchlet is present, to the stem. An abscission layer sometimes appears at the proximal end of the peduncle. Descriptions of catkins are based on flowering catkins. After fertilization pistillate catkins and stipes usually continue to elongate.

#138. The flowering branchlet is a short, vegetative shoot which terminates in a catkin. It bears three to several leaves that correspond to the first, usually caducous, leaves at the base of normal vegetative branchlets. In most species that flower before the leaves emerge (precocious) there is no flowering branchlet but sometimes there may be a rudimentary branchlet that bears two or three caducous prophylls. The flowering branchlet may fall along with the catkin at the end of the growing season. Sometimes, however, an abscission layer may develop between the peduncle and the flowering branchlet. If so, the catkin falls leaving the flowering branchlet attached to the branch. Although there may be minute buds in the axils of leaves on the flowering branchlets they rarely produce shoots in subsequent years. Sorensen (1941) used this difference between normal vegetative shoots and what he termed "floral short shoots" to distinguish these two kinds of shoots. In some *Salix* (*S*. sect. *Chamaetia*; *S. rotundifolia*, and *S. herbacea*) flowering branchlets are not deciduous but are the same as normal vegetative shoots except that they terminate in a catkin.

#139. The length of the flowering branchlet is measured from its point of attachment to the branch to the point of attachment of the distal most leaf.

#148. Hairs described as ferruginous are rust-colored. The origin of this coloration is not known but in *Salix scouleriana* there can be ferruginous dots at the base of some hairs. These resembles

the same reddish resin that sometimes occurs on the leaves of *Populus trichocarpa* and *P. balsamifera* and which gives them a ferruginous coloration.
#150. Apex shape terminology follows Hickey (1973, 1979).
#152. Pistillate floral bracts in *Salix* subg. *Protitea*, *Salix*, and *Longifoliae* are deciduous after flowering. For purposes of identification, if any floral bracts on a catkin are deciduous the species should be considered to have deciduous bracts.
#153. Abaxial floral nectaries appear between the stamens and the floral bract. In species described as lacking an abaxial floral nectary one can sometimes appear in the first or second proximal flowers. These species, however, are treated as lacking abaxial nectaries.
#154. Nectaries may be a single undivided structure or may be lobed.
#155. If the nectaries appear as two or more lobes these lobes may be free to the base, in which case they are treated as separate nectaries, or, if they are connate, they are treated as divisions of a single nectary.
#156. The length of the abaxial nectary does not include the length of the cup in species with cup-shaped nectaries.
#157. All *Salix* flowers, except in *Salix* (*Chosenia*) *arbutifolia*, have adaxial nectaries. These nectaries appear between the stamens and the catkin rachis.
#158. Nectaries may appear as a single undivided lobe or may be lobed. The proximal flowers often are atypical in their lobing pattern. These exceptions are included as a note.
#159. If the nectaries appear as two or more lobes these lobes may be free to the base, in which case they are treated as separate nectaries, or, if they are connate at the base, they are treated as divisions of a single nectary. Some authors incorrectly describe divided nectaries as multiple nectaries.
#160. Nectary shapes are based on rehydrated flowers. At least three catkins were studied for each species and nectaries were drawn for three or more flowers. The shape of branched or lobed nectaries was based on the overall nectary shape. If the lobing was very deep, however, the shape described was that of the lobes. The shapes narrowly oblong and narrowly ovate often intergrade.
#162. The length of the adaxial nectary does not include the length of the cup in species with cup-shaped nectaries.
#164. *Salix* usually have two to seven stamens. The presence of one stamen may be the result of coalescence of filaments, as in *S. purpurea*, which has two anthers at the distal end of what appears to be a single filament, or to the loss of a stamen, as in *S. sitchensis*, in which case there is a single filament terminated by a single anther.
#165. The color of the external surface of anthers is based on mature or dehisced anthers. Yellow-colored anthers grade from golden-yellow into tawny or pale brown. Purple-colored anthers vary from dark to pale purple, or sometimes pale reddish to brown. Anthers that are red in life may dry purple. The purple color sometimes grades into yellow in age. If the inner and outer walls of the locules sometimes are not the same color then color is based on the external locule wall.
#166. Anther shape is based on dehisced anthers. Undehisced anthers are plumper than dehisced anthers, but because too few specimens have undehisced anthers they are not used in the description. Cylindrical anthers have been recognized as short- or long-cylindrical; the separation between them is at about 3× as long as wide.
#167. The axis of the dehisced anthers is usually straight but in some species (e. g. *Salix* subg. *Longifoliae*) it often is strongly recurved. Intermediate conditions are recognized by the anthers being partially recurved or twisted.
#168. Anther length is based on dehisced anthers.
#173. Nectaries may appear as a single undivided lobe or may be lobed. The proximal flowers often are unusual in their lobing pattern. These exceptions are included as a note.
#174. If the nectaries appear as two or more lobes these lobes may be free to the base, in which case they are treated as separate nectaries, or, if they are connate at the base, they are treated as divisions of a single nectary. Some authors describe divided nectaries as multiple nectaries.

#175. The length of the abaxial nectary does not include the length of the cup in species which have cup-shaped nectaries.
#176. All *Salix* flowers, except in *Salix* (*Chosenia*) *arbutifolia*, have adaxial nectaries. These nectaries appear between the pistil and the catkin rachis.
#177. Nectaries may appear as a single undivided lobe or may be lobed. The proximal flowers often are atypical in their lobing pattern. These exceptions are included as a note.
#178. If the nectaries appear as two or more lobes these lobes may be free to the base, in which case they are treated as separate nectaries, or, if they are connate at the base, they are treated as divisions of a single nectary. Some authors incorrectly describe divided nectaries as multiple nectaries.
#179. Nectary shapes are based on rehydrated flowers. At least three catkins were studied for each species and nectaries were drawn for three or more flowers. The shape of branched or lobed nectaries was based on the overall nectary shape. If the lobing was very deep, however, the shape described was that of the lobes. The shapes narrowly oblong and narrowly ovate often intergrade.
#180. The length of the adaxial nectary does not include the length of the cup in species with cup-shaped nectaries.
#181. The length of the adaxial nectary does not include the length of the cup in species which have cup-shaped nectaries.
#183. Nectaries may be distinctly swollen, and almost as thick as wide, or they may be flat. Flat nectaries may be thick and rigid or thin and flexible. Thin nectaries sometimes appear to be collapsed thin walled nectaries that may have been swollen when nectar was being secreted. For that reason only swollen and flat conditions are recognized. Thick and thin states are given in parentheses. Further study of live material is needed. This character is only scored for adaxial pistillate floral nectaries.
#185. The stipe (gynophore) is the stalk of the pistil, this structure in *Salix* is sometimes called a pedicel. It was shown by Fisher (1928: 384) and Sugaya (1960) that the nectaries are reduced perianth and that the stalk of the pistil is a stipe.
#186. Stipe hairiness is observed on flowering or fruiting ovaries. Hairiness can be very dense or sparsely so. The hairs sometimes also appear on the base of the ovary. I have not noted variability within a catkin but often there is variability within a species. I am not sure if this character is useful taxonomically but further study is indicated.
#187. Ovary color is based on flowering specimens. Color varies from green to red. Although it would be ideal to record color on living specimens that is impractical and color has been based on herbarium specimens. This, however, creates problems because in drying some young ovaries may become brownish or reddish. It is possible that red ovaries in species scored for both green and red, are an artifact of drying. Because of the variability in this character may be of limited use.
#188. Ovary shapes are based on Stearn (1966 Fig. 32).
#190. This character is included for identification purposes. Plants that are glabrate (i.e. having lost most or all of their hair) as well as those without hair (glabrous) are scored as glabrous.
#192. Indumentum or hair covering terminology is based in part on Hewson (1988). In the database indumentum terminology is expressed in two ways. (1) Collective terms for indumentum type, such as, pilose and villous, are used; and (2) the characters of the hairs (trichomes) that contribute the definition of the collective terms are also described. These include hair density, orientation to the surface, shape, length, color, texture, and luster.
#194. Hairs described as ferruginous are rust-colored. The origin of this coloration is not known but in *Salix scouleriana* there can be ferruginous dots at the base of some hairs. These resemble the same reddish resin that sometimes occurs on the leaves of *Populus trichocarpa* and *P. balsamifera* and which gives them a ferruginous coloration.
#197. The term glaucous refers to the whitish or grayish waxy coating that sometimes can be observed on glabrous ovaries.

#198. Each pistil has two styles, one for each carpel. They are usually connate but sometimes variously distinct varying from slightly separated at the distal end to entirely separate.
#199. Styles usually are the same color as the ovary. In some cases, however, the style, and sometimes the sutures, may be red but the ovary green. Only two color states are recognized because green styles often dry to tawny or light brown and red styles dry to a dark brown.
#200. Style length does not include the stigma.
#201. At the distal end of each of the two styles at the distal end of the pistil is a two-lobed stigma. The stigmatic lobes are often joined proximally into a U-shape or may be slightly separated at the proximal end by a non-papillate segment. The two lobes may be free from the neighboring lobes and are then described as carinal, or they may be connate to the neighboring lobes, in whole or in part, and are then described as commissural. If the two styles are free from each other, in whole or in part, the stigmatic lobes will not be adjacent and cannot be joined to their neighbors and thus will be separate (carinal). However, if the two styles are connate their stigmas can be adjacent and may be either connate (commissural) or remain distinct (carinal). The carinal condition is the normal one and varying degrees of union between the two stigmas can occur (Weberling 1990: 187-188).
#203. The two-lobed stigmas vary in size and shape. In general, papillae are borne on the adaxial surface and the abaxial surface is non-papillate. I am tentatively recognizing five, often intergrading, types. Types 1 and 2 are characterized by a flat, non-papillate abaxial surface with rounded or pointed tip, respectively. Types 3 and 4 are characterized by appearing as completely papillose cylinders. The structure of the cylindrical form, however, needs further study to determine if it is also flat but with strongly revolute margins. Type 3 is more than 4x as long as wide and type 4 is less than 4x as long as wide. Type 5 is characterized by stigmas that appear as four, plump, papillose lobes. All stigma data are based on herbarium specimens. Because stigma preservation is not always good a comparative study of live material is needed. See also Hjelmquist (1948:155-157).
#204. The length of the stigma is determined by measuring the papillate portion of the lobe or branch. The nonpapillate portion at the base of the stigmatic lobes, if present, is considered to be the distal end of the style.
#206. This character is included for identification purposes. Plants that are glabrate (i.e. having lost most or all of their hair) as well as those without hair (glabrous) are scored as glabrous.
#207. The number of ovules is based on the funicles usually visible in opened capsules. The number of ovules per ovary is followed by the sample size in angle brackets and the number of ovules per carpel.
#209. Full chromosome number references appear in character 210.
#216. General world distribution in Flora North America order.
#221. The California geographical Regions (Hickman 1993).
#222. The California geographical Subregions (Hickman 1993).
#223. The California geographical Districts (Hickman 1993).
#224. Classification based on Argus (1997 and Flora North America, in prep.).
#231. References cited in cnotes.

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#232. For references for chromosome numbers see Argus 1997, or Argus, G. W. 2005. Guide to the interactive identification of native and naturalized New World *Salix* using Intkey (DELTA). Privately published.

APPENDIX 4
Glossary (28 February 2007)

Abaxial. The side away from the axis. Dorsal.
Abaxial floral nectaries. Nectaries located between the stamens or ovary and the floral bract.
Acuminate. Margin between apex and 0.75 blade length distinctly concave basally and gradually tapering to tip apically.
Acute. Margin between apex and 0.75 blade length forming an angle less than 90° and essentially straight. Straight.
Adaxial. The side of a structure toward the axis. Ventral.
Adaxial floral nectaries. Nectaries located between the stamens or ovary and the axis.
Adnate. Fusion of dissimilar structures.
***alba*-type bud gradation**. Buds are similar in size and shape along the entire branchlet length. Floral and vegetative buds cannot be distinguished by size or shape (Skvortsov 1999).
Amphistomatous. Stomata uniformly distributed on both leaf surfaces.
***arctica*-type bud gradation**. There are usually few buds. The distal two or three are the largest abruptly changing to smaller buds at proximal end. The large distal buds, which open in spring, may be floral or vegetative (Skvortsov 1999).
Branch. A shoot in at least its second year of growth.
Branchlet. The current year's shoot; bearing leaves.
Broadly elliptic. A plane shape, L:W 1.5:1, widest at middle.
Broadly oblong. A plane shape, L:W 1.5:1, widest in the mid-zone.
Broadly obovate. A plane shape, L:W 1.2:1, widest toward apex.
Broadly ovate. A plane shape, L:W 1.2:1, widest toward base.
Caducous. Falling off early.
***caprea*-type bud gradation**. The floral buds are strikingly different in size and shape from vegetative buds. The large floral buds are sometimes intermixed with smaller vegetative buds (Skvortsov 1999).
Carinal. Applied to stigmas in which the lobes are associated with a single carpel; not jointed across the suture or commissure.
Catkin. Inflorescence a spike of unisexual flowers without conspicuous perianth.
Caudate. Margin between apex and 0.75 blade length distinctly concave basally and gradually tapering to a long tail-like tip apically. Subtype of acuminate.
Circular. A plane shape, L:W 1:1, widest at middle.
Concave. Margin between base and 0.25 blade length curves toward center of blade.
Connate. Fusion of like structures.
Convex. Margin between base and 0.25 blade length or apex and 0.75 blade length curves away from centre of blade. Obtuse.
Commissural. Applied to stigmas when the lobes of one carpel are connate to those of the other carpel. Joined across the suture or commissure.
Cordate. Margin between base and 0.25 blade length with rounded projections with the sides toward petioles straight or convex. Subtype of convex.
Crenate. Teeth of shallow, rounded notches.
Cuneate. Margin between base and 0.25 blade length essentially straight.
Decurrent. Margin between base and 0.25 blade length concave basally and straight distally, extending along petiole. Subtype of concave.
Depressed-ovate. A plane shape, egg-shaped but broader than long.
Distal. Toward the tip of a structure, away from point of attachment.
Distinct. Not connate.
Dwarf shrubs. Plants 0.1 m or less, e.g. *S. reticulata*.
Elliptic. A plane shape, L:W 2:1, widest at middle.

Emarginate. Apex deeply notched, 5-25% leaf length.
Entire. Margin forming a smooth line, lacking teeth or undulations.
Ferruginous. Rust-colored.
Flask-shaped. With a more or less abruptly tapering neck.
Floccose. Covered with tufts of soft woolly hairs that tend to rub off.
Flowering branchlet. A short, vegetative shoot which terminates in a catkin.
Free. Not adnate.
Glabrous. Without hairs.
Glabrate. Becoming glabrous in age.
Glabrescent. The process of becoming glabrous in age but a few hairs remaining.
Glaucous. With a whitish waxy coating which may be polished by rubbing or scratching.
Globose. Solid shape in which length and width are equal; spherical.
Gourd-shaped. Lageniform.
Hairs. Filamentous epidermal outgrowths. Trichomes.
Hemiamphistomatous. Stomata on leaf adaxial surface only at apex and scattered along veins, but uniformly distributed on abaxial surface.
Hypostomatous. Stomata uniformly distributed on abaxial leaf surface.
Indumentum. General hairiness.
Juvenile leaves. Young unfolding leaves at distal end of branchlets.
Lanceolate. A plane shape, L:W 3:1 or more, widest toward proximal end.
Largest mature leaves. The normal well developed leaves, usual medial on the branchlet.
Linear. A plane shape, L:W 10:1, widest in the mid-zone.
Lobate. Margin between base and 0.25 blade length with rounded projections with the sides toward petioles concave. Subtype of concave.
Long-silky. Densely covered with fine, long (0.5 mm or more long), straight, appressed, shiny hairs.
Lorate. A plane shape, L:W 6:1, widest in the mid-zone. Ligulate.
Low shrubs. Plants 0.15-0.5 m, e.g. *S. myrtillifolia*.
Mid shrubs. Plants 0.6-2.0 m, e.g. *S. humilis*.
Moderately dense. Surface 50% visible.
Narrowly elliptic. A plane shape, L:W 3:1, widest at middle.
Narrowly oblanceolate. A plane shape, L:W 6:1 or more, widest toward apex.
Narrowly oblong. A plane shape, L:W 3:1, widest in the mid-zone.
Narrowly oblong nectary. A slender-rod, 4 or more times longer than wide.
Narrowly ovate. A plane shape, L:W 2:1, widest toward base.
Non-glaucous. Lacking a waxy coating.
Oblanceolate. A plane shape, L:W 3:1, widest toward distal end.
Oblong. A plane shape, L:W 2:1, widest in the mid-zone.
Oblong nectary. A broad-rod, 2-3 times longer than wide.
Obovate. A plane shape, L:W 2:1, widest toward distal end. Inverse egg-shaped.
Obclavate. Broadest at proximal end. Inverse club-shaped
Obnapiform. Broadest at proximal end. Inverse turnip-shaped.
Obtriangular. A plane shape. Inverted triangle narrowest at the proximal end.
Obturbinate. broadest at proximal end. Inverse top-shaped.
Obtuse. Forming an angle of greater than 90°.
Ovate. A plane shape, L:W 1.5:1, widest toward proximal end. Egg-shaped.
Ovoid. A solid shape widest toward proximal end. Egg-shaped.
Papillae. Soft superficial glands or prouberances.
Papillate. With papillae.
Papillose. Covered with papillae, as in stigmas.
Pear-shaped. Pyriform.

Peduncle. The naked stalk Between the flower-bearing axis and the flowering branchlet or the branch.
Pilose. Very sparsely covered with long, soft, wavy or straight, spreading hairs. Shaggy.
Polycormone. Vegetative reproduction by sprouting at base of main stem to form a hemispheric growth form.
Proximal. Toward the base of a structure, near point of attachment.
Proximal leaves. The first 2-4 leaves at the base (proximal end) of a branchlet or all leaves on a flowering branchlet.
Puberulent. Covered with very sparse, minute, soft, straight or wavy, erect or spreading hairs, scarcely visible to the unaided eye.
Pubescent. Densely covered with short, soft, spreading hairs. Not used for general hairiness.
Remotely denticulate. Widely spaced, small, slender teeth extending more or less at right angle to axis.
Remotely or irregularly serrate. Widely separated, uniform teeth with an inclined axis.
Retuse. Apex slightly notched, less than 5% leaf length.
Root shoot. Shoots arising from roots. (rhizoblast).
Rounded. Margin between base and 0.25 blade length or apex and 0.75 blade length forming a smooth arc. Subtype of convex.
Rudimentary. Used to describe stipules that appear as minute brownish lobes.
Serrate. Uniform large teeth with their axes inclined toward the distal end.
Serrulate. Uniform small teeth with their axes inclined toward the distal end.
Short-silky. Densely covered with short (less than 0.5 mm), soft, straight, appressed, shiny hairs.
Silky. Densely covered with short or long, soft, straight, appressed, shiny hairs.
Silky-villous. Describes an indumentum that is a combination of appressed, straight, shiny hairs and spreading, straight, shiny hairs.
Slender. More than 4× longer than wide.
Sparse. Surface little obscured.
Spindle-shaped. Ellipsoidal.
Sprout shoot. Vigorous shoots often arising from the basal parts of the plant. Also compensatory growth arising after defoliation, suckers or offshoots. (baseoblast)
Square. About as long as wide.
Squat flask-shaped. Ampulliform.
Stipe. The stalk of an ovary.
Stout. Structure less than 4× longer than wide.
Strongly glaucous. Conspicuous bluish or whitish waxy coating.
Subcircular L:W 1.2:1, widest at middle.
Subcordate. Margin between base and 0.25 blade length slightly lobed, grading from convex to rounded apically to concave as it meets petiole. Similar to concavo-convex.
Subglobose. Slightly longer than wide (1.3-1.1×). Subspherical.
Sylleptic. Buds of the year emerging without a dormant period.
Tall shrubs. Plants greater than 2.0 m, e.g. *S. discolor*.
Tomentose. Densely covered with short, rather firm, more or less matted or intertwined, hairs erect or spreading.
Transverse-oblong. A plane shape, L:W 2:1, widest in the mid-zone but broader than long.
Trees. Plants of "tree" stature, sometimes with several boles.
Triangular. Broadest at proximal end.
Undulate. Wavy, up and down, in and out.
Velvety. Densely covered with short, soft, straight, erect hairs of relatively uniform length.
Very broadly oblong. A plane shape, L:W 1.2:1 or less, widest in the mid-zone.
Very broadly obovate. A plane shape, L:W 1:1 or less, widest toward apex.
Very broadly ovate. A plane shape, L:W 1:1 or less, widest toward base.

Very densely. Surface obscured.
Very narrowly elliptic. A plane shape, L:W 6:1 or more, widest at middle.
Villous. Somewhat densely covered with long, soft, straight or wavy, spreading hairs.
Weakly glaucous. Wax visible only when scratched or as isolated crystals.
Woolly. Very densely covered with long, soft, spreading, wavy, more or less matted or intertwined hairs.

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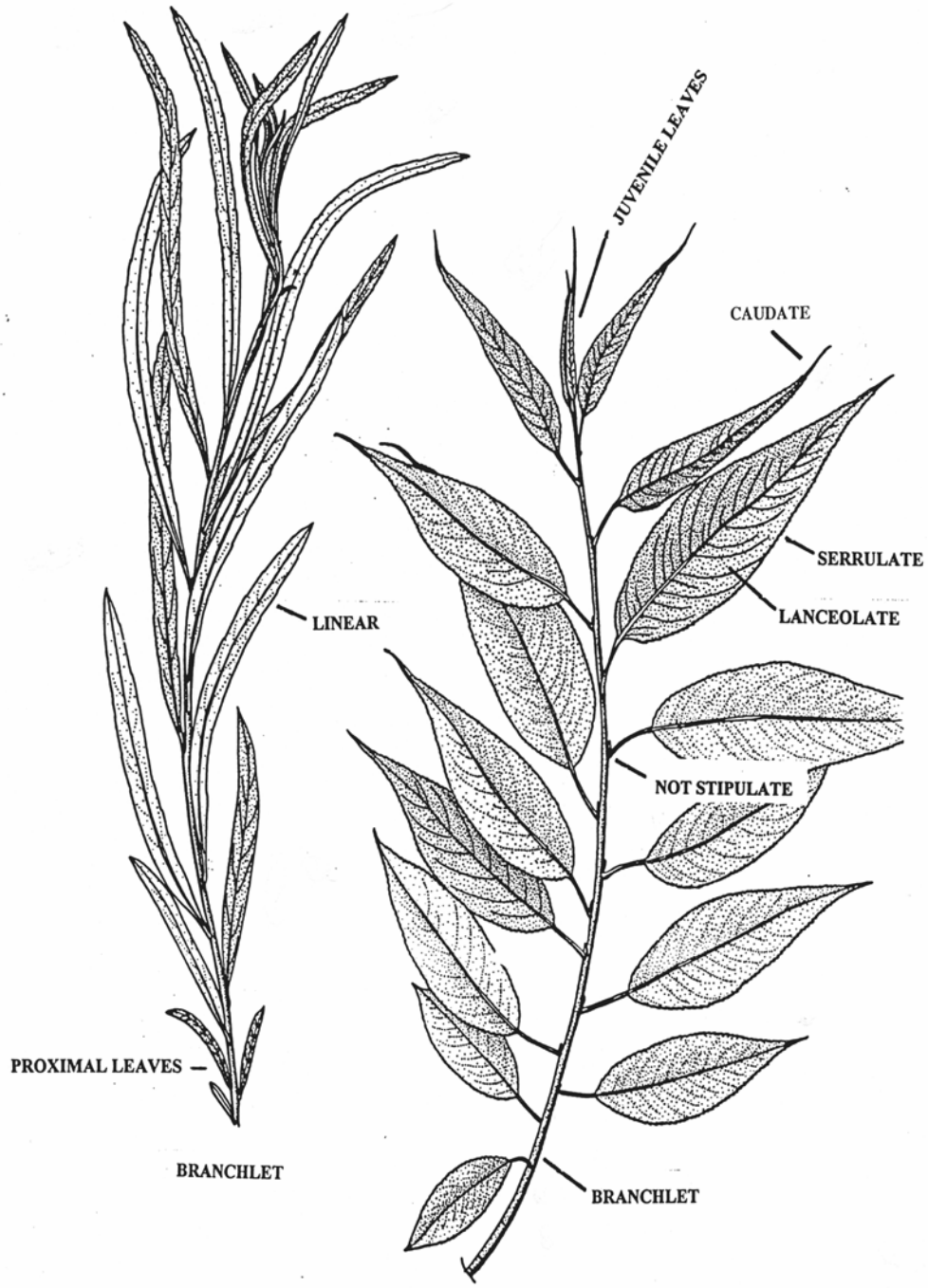
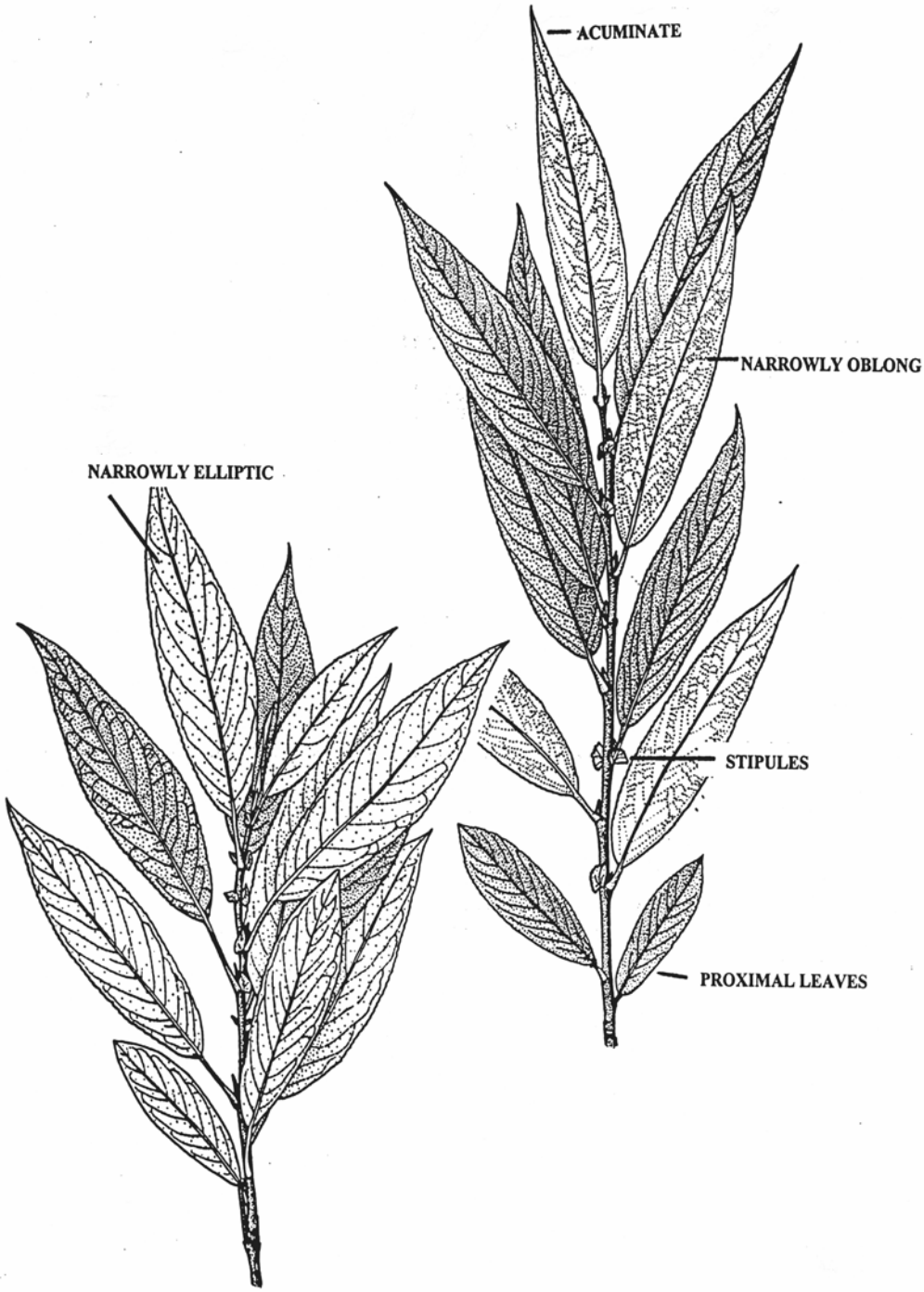


SALIX MORPHOLOGY
FIG. 1

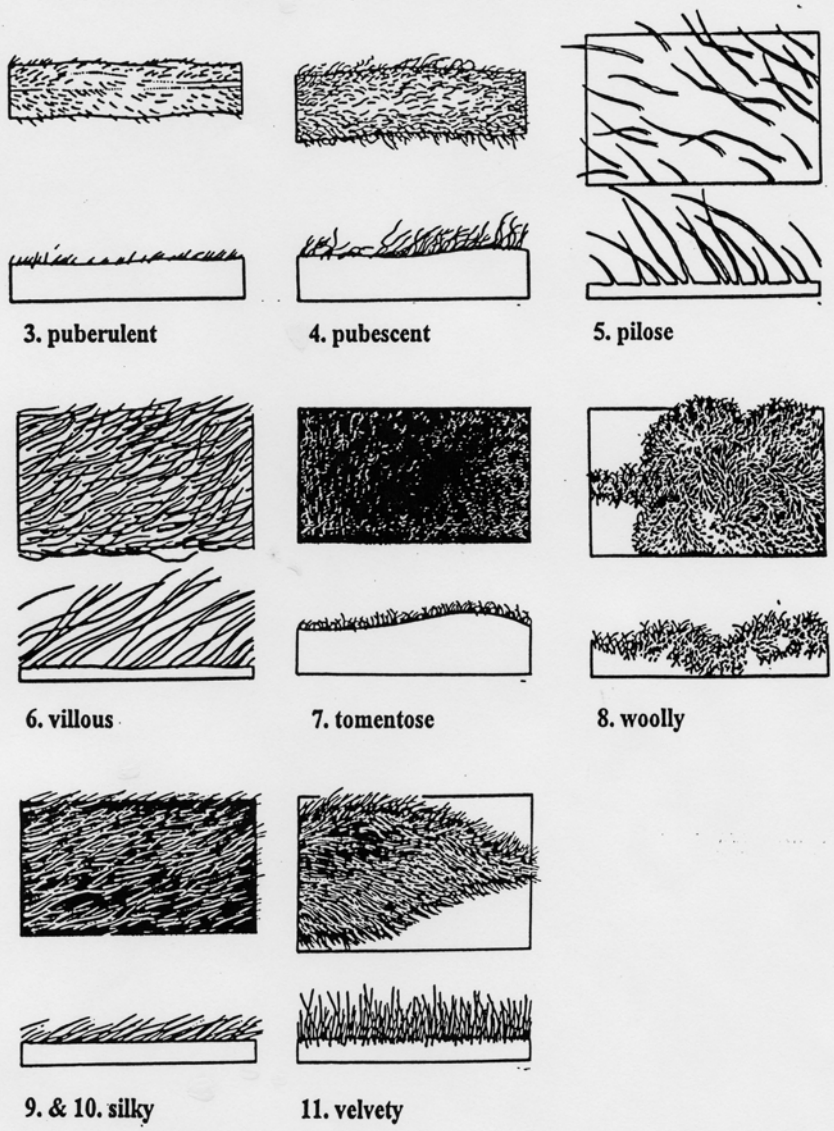


SALIX MORPHOLOGY
FIG. 2

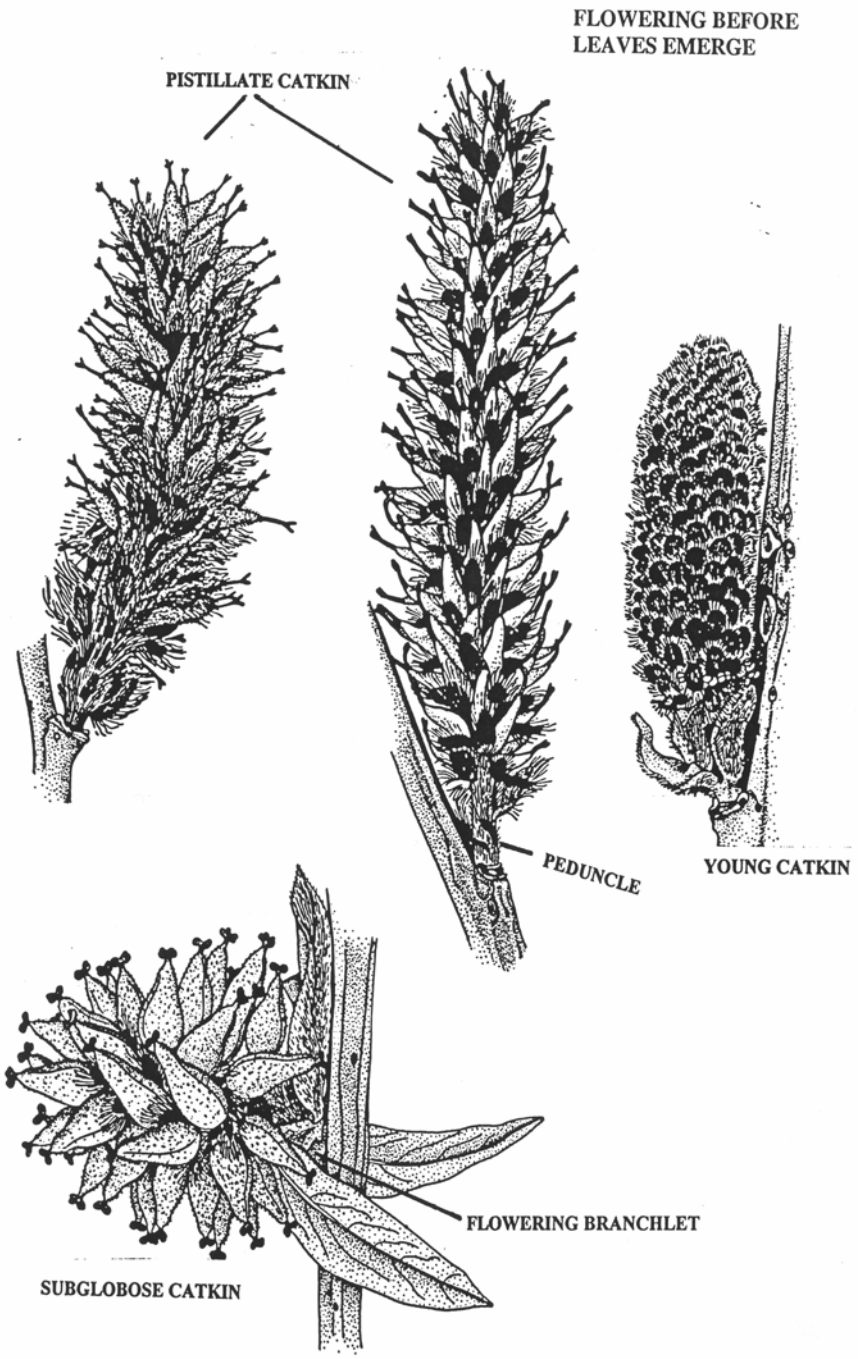
INDUMENTUM TYPES IN *SALIX*.
Illustrations from Hewson, 1988.

1. glabrous. Without hairs.

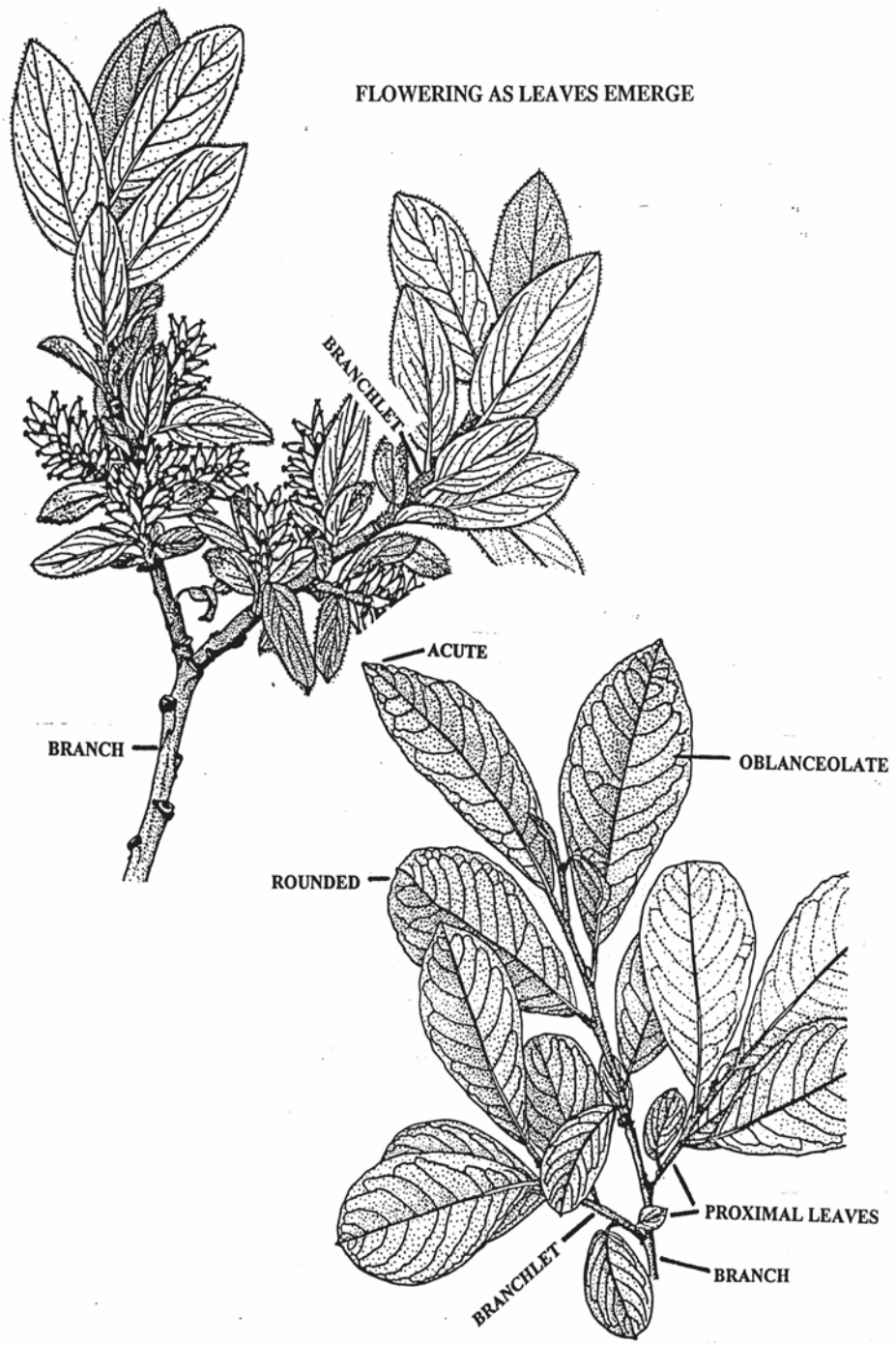
2. glabrescent. Becoming glabrous but a few hairs present.



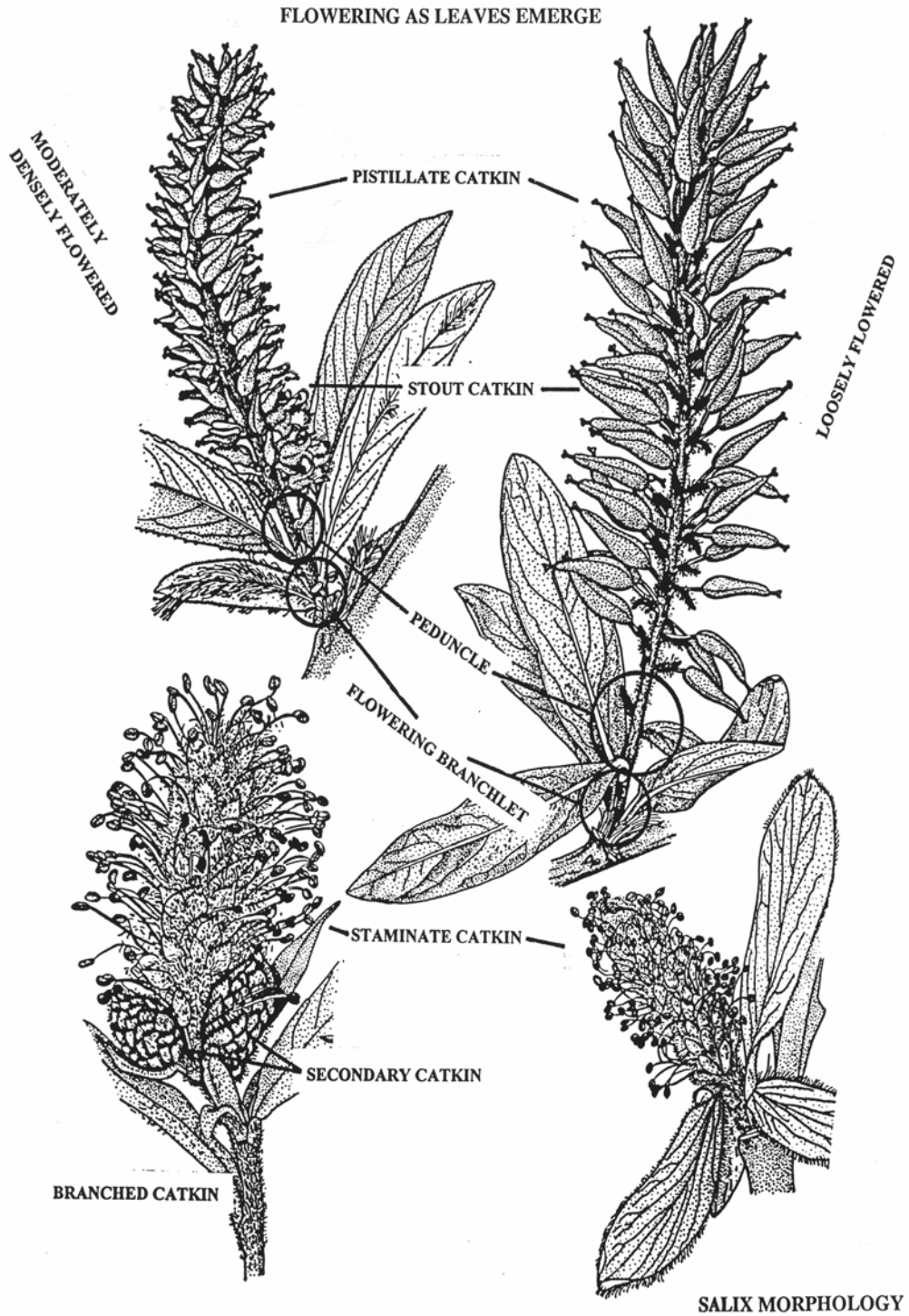
SALIX MORPHOLOGY
FIG. 3



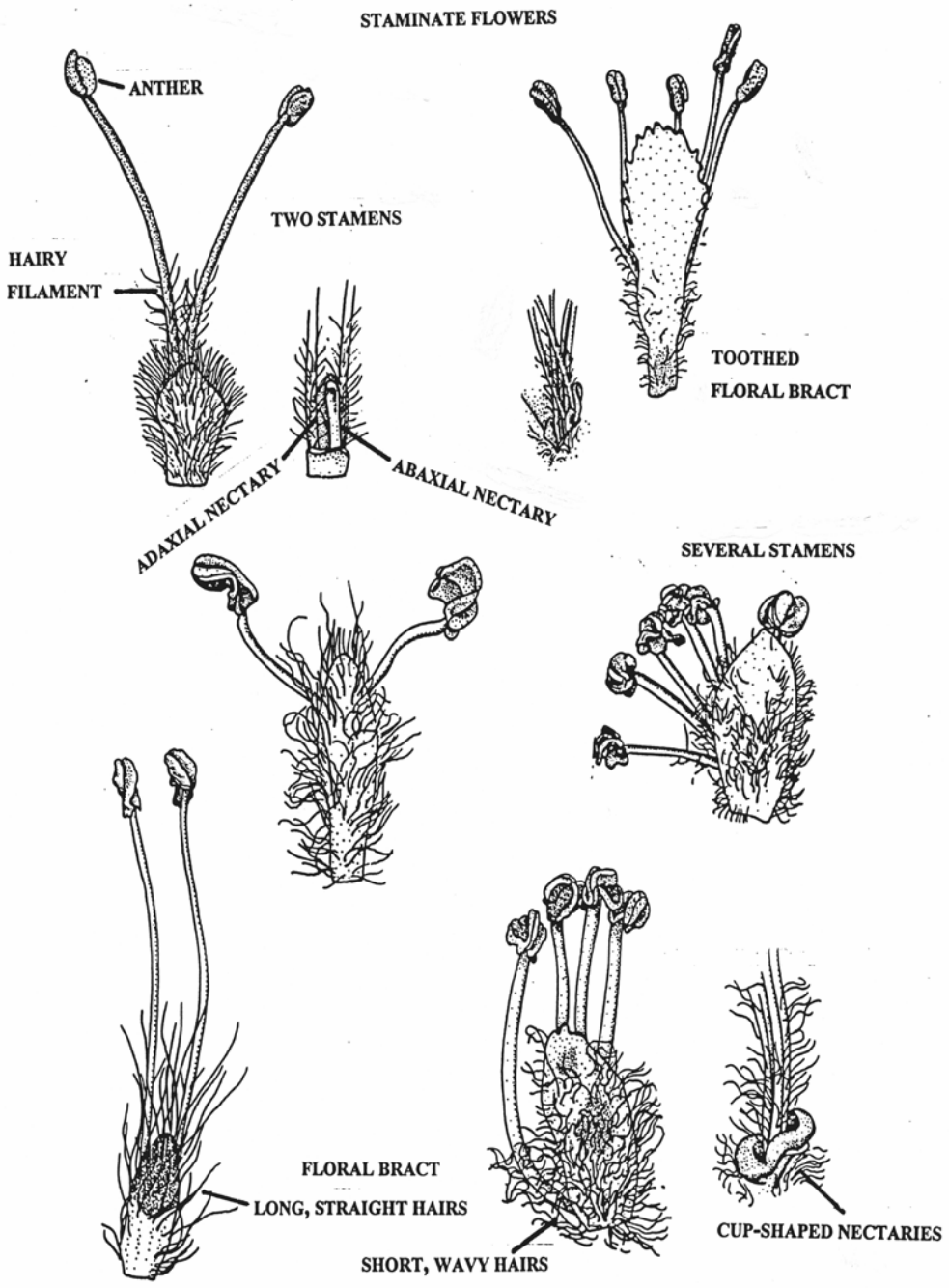
SALIX MORPHOLOGY
FIG. 5



SALIX MORPHOLOGY
FIG. 6

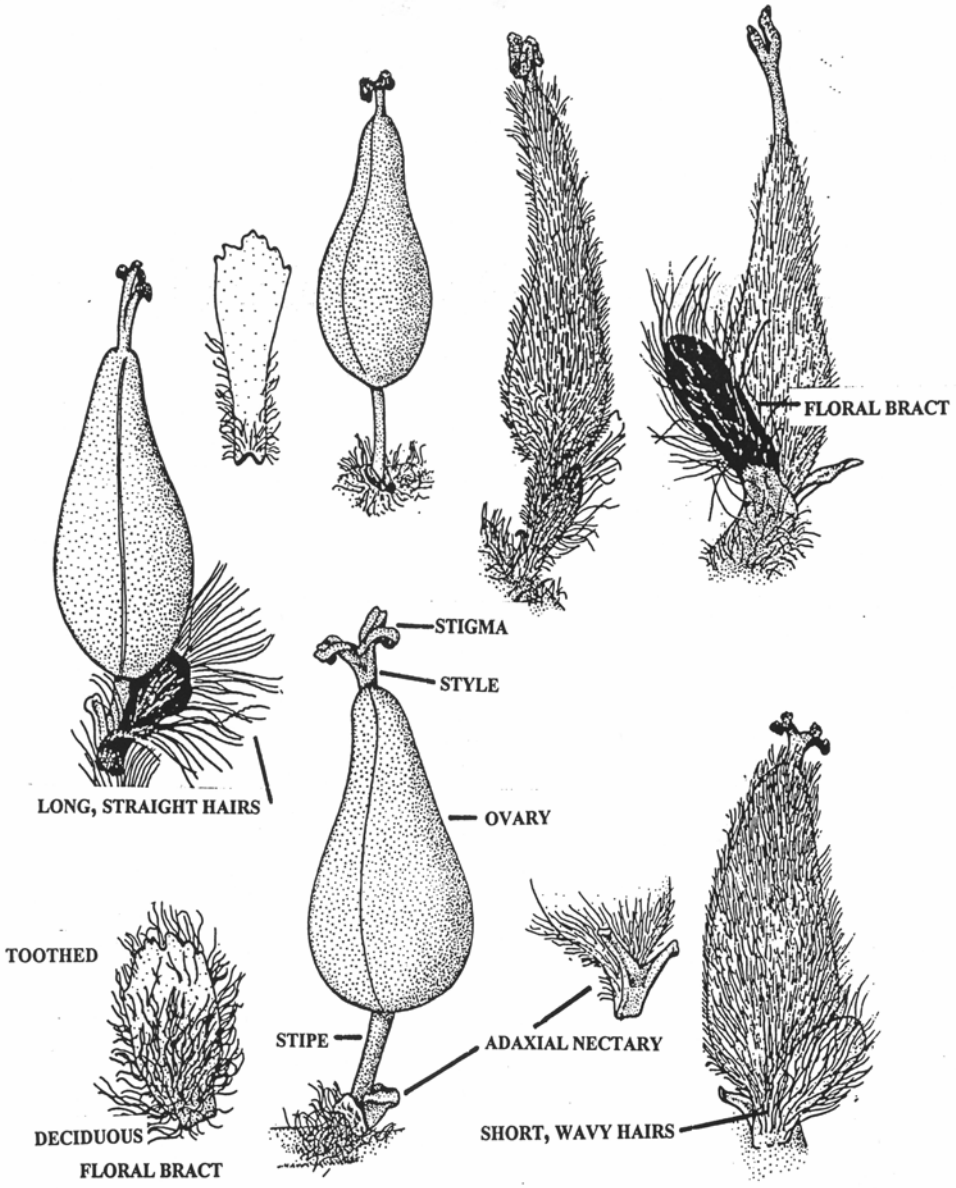


SALIX MORPHOLOGY
FIG. 7

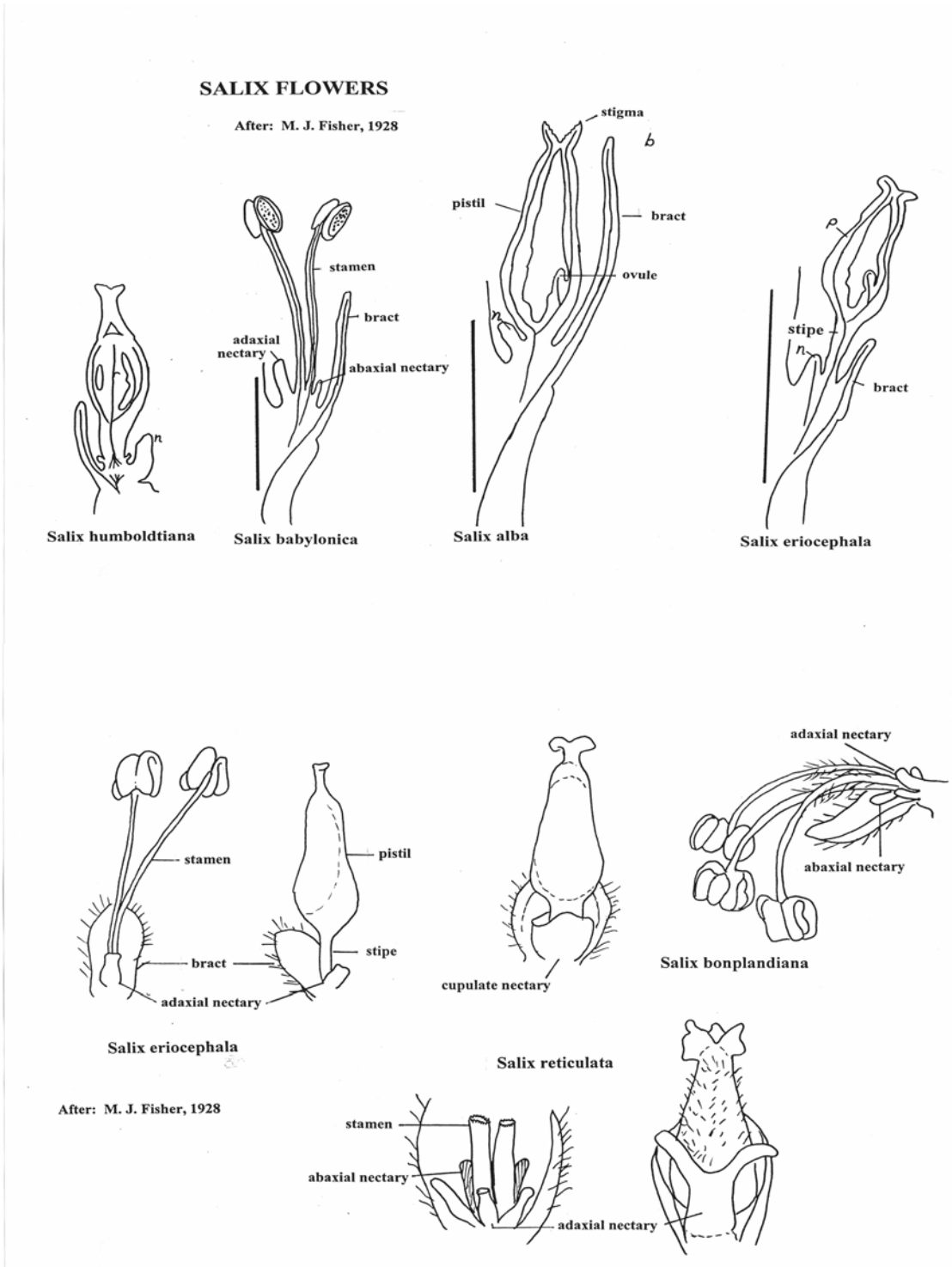


SALIX MORPHOLOGY
FIG. 8

PISTILLATE FLOWERS



SALIX MORPHOLOGY
FIG. 9


SALIX FLOWERS
After: M. J. Fisher, 1928
stigma
b
pistil
bract
ovule
stamen
bract
adaxial nectary
abaxial nectary
n
p
stipe
n
bract
Salix humboldtiana
Salix babylonica
Salix alba
Salix eriocephala
stamen
bract
adaxial nectary
pistil
stipe
Salix eriocephala
cupulate nectary
adaxial nectary
abaxial nectary
Salix bonplandiana
Salix reticulata
After: M. J. Fisher, 1928
stamen
abaxial nectary
adaxial nectary