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Plants of North Dakota

Manual



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Title page: *Symphoricarpos* (Caprifoliaceae) with fruits.

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Contents

Foreword	5
Chapter 1. Key to plant families	6
Step one. Most remarkable big families	6
Step two. Unusual plants: cactus, woody, water, spore plants	7
Step three. Group 11: Choices, Choices...	16
Appendix A. Flower formulas	25
Appendix B. Alternative key to the most frequent families	27
Chapter 2. Manual to the commonly cultivated trees and shrubs	29
Appendix A. Glossary	36
Chapter 3. Manual to the Compositae	38
Group Key	38
Group A	39
Group B	39
Group C	39
Group D	40
Group E	40
Group F	41
Group G	43
Group H	45
Group J	46
<i>Solidago</i> L. and <i>Oligoneuron</i> Small. (Goldenrods)	49
<i>Artemisia</i> L. (Sagebrush, Sage, Wormwood)	50
<i>Symphotrichum</i> Nees (American Aster)	50
<i>Helianthus</i> L. (Sunflower)	54
<i>Heterotheca</i> Cassini, false goldenaster	55
Chapter 4. Manual to the genera of Gramineae	57
Group Key	57
Group A	58
Group B	59
Group C	61
Group D	63
Groups E, F, G	66
Group F	67
Group G	68
Chapter 5. Manual to Cyperaceae	70
Key to Genera	70
Chapter 6. Manual to the Labiatae s.l.	71
Key to Genera	71
<i>Plantago</i> L., plantain	75

Chapter 7. Manual to the Polygonaceae	76
Key to Genera	76
<i>Eriogonum</i> Michaux, wild buckweat	76
<i>Fagopyrum</i> Mill., buckweat	77
<i>Fallopia</i> Adans., false buckweat	77
<i>Persicaria</i> (L.) Mill., smartweed	77
<i>Polygonum</i> L., knotweed	79
<i>Rumex</i> L., dock	79
Chapter 8. Manual to Amaranthaceae	82
Key to Genera	82
<i>Amaranthus</i> L., amaranth	83
<i>Atriplex</i> L., saltbush	83
<i>Chenopodium</i> L., goosefoot	84
Chapter 9. Manual to Salicaceae	86
Key to Genera	86
<i>Populus</i> L., poplar, cottonwood	86
<i>Salix</i> L., willow	87
Chapter 10. Manual to Pteridophyta	90
Key to Classes	90
Key to Lycopodiopsida, clubmosses and spikemosses	90
Key to Equisetopsida, (<i>Equisetum</i> , horsetails)	90
Key to Ophioglossopsida (<i>Botrychium</i> , moonworts)	93
Key to Pteridopsida, true ferns	93
Some useful literature	96

Foreword

This manual is the companion to “Flora of North Dakota. Illustrated Checklist” (http://ashipunov.info/shipunov/fnddb2/shipunov20170614_flora_of_north_dakota_illustrated_checklist.pdf) of the same author.

On the one hand, it is **largely incomplete** because it does not include many important plant groups (like sedge family or keys to grasses below genera); on the other hand, it covers many important taxa (like aster family or buckwheat family), and especially those which are available in the fall and also those which understanding changed significantly from the times of the “Flora of Great Plains”.

It also includes the original family key which is different from most of existing keys of this kind: it is much shorter and allows to determine important families on the first steps.

Other keys are at least partly compilation, information was taken from the “Flora of North America” (<http://efloras.org>), “Manual of Montana Vascular Plants” (Lesica, 2012), “Flora of Colorado” (Ackerfield, 2012) and of course “Flora of Great Plains” (1986).

Chapter 1

Key to plant families

As a rule, you should have plant with stems, leaves and flowers at hands. In some cases, you must also have fruits (Cruciferae, Umbelliferae) and underground parts (Cyperaceae, Gramineae). Plants with fruits only (instead of flowers) are sometimes also possible to identify, but that will require many guesses. It is not possible, however, to determine plants without reproductive structures with keys below. Moreover, as far as I know, there are no such keys for North American flora (except one key for grasses) and only few in the other parts of the world. Exception are woody plants which sometimes are identifiable if only vegetative shoots (stems with leaves and buds) are available.

If you think that your plant belongs to one of 10 most widespread North Dakota plant families, you may want to ignore “big” step key below and go directly to the last appendix with a “short” key.

Step one. Most remarkable big families

Compare your plant with each description. If there is no correspondence, **go** to the second step. It is safe enough to go directly to Step Two, or even to Step Three (if the plant is a “typical” herbaceous flowering plant). In the last case, however, you might want to come back here again (when advised in the text).

Group 1. Herbaceous plants, sometimes also shrubs. Leaves alternate or opposite, without stipules. Small flowers gathered in the **flower-like inflorescence** with the receptacle and involucre bracts (modified leaves enveloping the inflorescence). Stamens fused. Fruit seed-like achene, frequently with hairy or toothed attachment developed from sepals. $\ast \vee \uparrow K_{0\vee 5} C_{(5\vee 3)} A_{(5)} G_{(2)}$, or unisexual, or sterile¹ Family **Compositae (Asteraceae)**.

Check carefully. What they think is a single flower, could actually be an inflorescence! If this “flower” is made of multiple but similar parts, that is a first sign of Compositae.

Group 2. Herbaceous plants, usually perennial with **underground rhizomes**. Stems green, upright, bear **linear leaves** with parallel venation and sheaths (sometimes leaves reduced). Flowers simplified, **not showy**, with bract scales and scaly simple perianth (if any), in various inflorescences. Fruit dry.

1. Stem is **hollow** between **filled nodes**. Leaves flat, folded lengthwise, without keel. Flowers in spikelets, every flower usually has 2 flower scales. Fruit seed-like. $\uparrow P_{2\vee 3} A_{[3-1]\vee 6} G_{(2)}$ or unisexual Family **Gramineae (Poaceae)**.
 - Stem is not hollow between filled nodes. Leaves flat, non-flat or reduced. There is one flower scale, if two, then flowers are not in spikes 2.
2. Flowers in spikes. Leaves (if present) with sharp keels. Stem sometimes with three edges. Tepals are frequently reduced into scales or hairs. Fruit is a nutlet. $\uparrow \vee \ast P_{0-6} A_{3\vee 2} G_{(3\vee 2)}$ or unisexual Family **Cyperaceae**.
 - Flowers solitary or in small clusters. Leaves tubular or flat, without keels. Perianth is not reduced. Fruit is a capsule. $\ast P_{3+3} A_{[3+3]\vee 3} G_{(3)}$ Family **Juncaceae**.

¹Fruit and formula data provided to make identification more efficient, but they are **not** absolutely necessary for identification and does not take part in keys.

= Flowers either in terminal spadices or in round heads. Leaves without keels, more or less flat. Perianth reduced, scaly or hairy. Fruit is a nut. $*P_{3-6}A_3 \vee *P_{3-6}G_1$ Family **Typhaceae**.
(genera *Typha* and *Sparganium*)

Group 3. Herbaceous plants. Leaves whole, with whole margin, opposite, mainly with only one central vein visible (hypohydromous). Flowers white or pink, in **dichotomously branched inflorescences**. Fruit is a capsule. $*K_{5\vee(5)}C_{5\vee 0}A_{5\vee 10}G_{(3\vee 5)}$ Family **Caryophyllaceae**.

Group 4. Herbaceous plants, sometimes also trees or shrubs. Leaves alternate, compound, with stipules. Flower usually with keel and banner (“papilionate”). Fruit is a **pod** (legume), with two valves and no central wall. $\uparrow K_{(5\vee 3)}C_{[1,2,(2)]\vee(1,2,2)}A_{[1,(4+5)]\vee(10)}G_1$ Family **Leguminosae (Fabaceae)**.
There are few remarkable exceptions from the typical papilionate flower. For example, *Amorpha* has only one petal ($\uparrow K_{(5)}C_1A_{(10)}G_1$), whereas *Gleditsia* and *Dalea* have “normal”, usually 5-merous flowers (for example, *Dalea* flower formula is $*K_{(5)}C_5A_{(5)\vee(9-10)}G_1$). However, structure of pistil and fruit is stable within legumes.

Group 5. Herbaceous plants, rarely sub-shrubs. Many representatives have pubescent, quadrangular stem with opposite (sometimes alternate) leaves having pungent smell of essential oils when crushing. In flowers, the most typical combination of characters is 5 fused sepals, 4 or 5 petals making **two flower lips**, 4 stamens and 2-celled superior ovary. Fruit is a capsule or consists of several (usually four) nutlets. $\uparrow \vee *K_{(5)}C_{(2,3)\vee(5)\vee(4)}A_{[2,2]\vee 2}G_{(2\times 2)\vee(2)\vee(1)}$ Family **Labiatae s.l. (Lamiaceae)**.
Here family is understood in the radically broad way, it includes plants which are typically listed under Scrophulariaceae, Plantaginaceae, Lentibulariaceae, Orobanchaceae, Phrymaceae, Pedaliaceae, Bignoniaceae, Verbenaceae and some other families. In most of these cases, their previous affiliations are listed below.

Group 6. Herbaceous plants, rarely sub-shrubs. Leaves alternate. Inflorescence is a panicle, flowers are typically **cross-shaped**, yellow or white (sometimes purple). Fruit is usually a silique, with two valves and central wall with seeds. $*K_4C_4A_{2+4\vee\infty}G_{(2)}$ Family **Cruciferae (Brassicaceae)**.
Here family is understood in the broad way, it includes plants which are typically listed elsewhere under Capparaceae (*Cleome* and *Polanisia*). These two genera have triple or palmate leaves, multiple stamens and pistil on the pedicel (gynophore).

Group 7. Herbaceous plants. Stem is hollow. Leaves, as a rule, heavily dissected, alternate, contain essential oils (careful, some representatives are poisonous when digested!). Flowers small, with minute calyx, white or yellow-green petals, gathered into **double umbels** (sometimes also into heads). Anthers come out of the disk located on the top of ovary. Fruit is a segmented schizocarp of two mericarps. $*\vee \uparrow K_5C_5A_5G_{(2)}$
..... Family **Umbelliferae (Apiaceae)**.

Another remarkable family is herbaceous (in North Dakota) **Polygonaceae**. Most of its representatives are easily recognizable by the presence of simple leaves with **ocrea**: leathery or filmy “sleeve” growing upwards along the stem from the base of leaf. Stem nodes usually swollen. Flowers small, usually in dense inflorescences. Fruit is a three-edged nut. $*P_{(4\vee 5)\vee 3-6}A_{5-9}G_{(3)}$ Family **Polygonaceae**.

Step two. Unusual plants: cactus, woody, water, spore plants

If the plant is not “unusual”, go to the third step.

- A. Cacti: stem succulents with spines and areoles. Fruit is a berry. $*K_{\infty}C_{\infty}A_{\infty}G_{(\infty)}$ Family **Cactaceae**.
– Not cacti B.

- B. Woody plants, their perennial aboveground stem stem accumulates secondary tissues, at least at the base **Group 8** (go to p. 8)
 – Herbaceous plants C.
- C. True water plants—completely submerged into water or floating on the water surface, only flowers some- times are above the level of water **Group 9** (go to p. 12)
 – Terrestrial plants (they might grow in water but in that case their stems are not carried with water) ... D.
- D. Plants which never have flowers, reproducing with spores **Group 10** (go to p. 14)
 This key includes only vascular plants so mosses are not covered. If the plant has no flowers, this does not mean that it is a spore plant. Please find sporangia first.
 – Seed plants **Group 11** (go to p. 16)

Group 8. Woody plants. Trees, shrubs, sub-shrubs (plants woody only at the base), and woody vines.

Woody species of the described above Step One “most remarkable big families” Leguminosae (*Amorpha*, *Caragana*, *Halimodendron* and others) and Compositae (*Artemisia*, *Gutierrezia* and others) are **not** included below. This key also does not include tools for identification trees and shrubs in winter, without leaves. Please see recommended literature in the end of the manual.

Therefore, if not sure, **check** Step One for Leguminosae and Compositae, and if not, **go back** here.

1. Leaves are needle-like or scale-like 2.
 – Leaves typical, blade-like 5.
2. Plants without flowers, they bear cones instead (which sometimes are berry-like). Frequently, plants are evergreen and rich of resins 3.
 – Plants with small pink flowers in spikes, no cones. Deciduous, no resins. Leaves 1–2 mm size, scale-like, alternate. Fruit is a capsule with hairy seeds. *K₅C₅A₅₊₅G₍₃₎ Family **Tamaricaceae**.
 (genus *Tamarix*)
3. Needles or scales opposite or whorled, brachyblasts absent Family **Cupressaceae**.
 – Needles alternate or arranged in groups on the short shoots (brachyblasts) 4.
4. Needles with the middle vein visible from above. Cones are red, berry-like Family **Taxaceae**.
 (genus *Taxus*)
 Sometimes cultivated in North Dakota.
 – Needles without visible middle vein or with middle vein visible only from beneath. Cones are woody Family **Pinaceae**.
- 5 (2). Palmoids (rosette woody plants, Corner model): unbranched short woody stem bears multiple long sharp linear leaves. Fruit is a capsule. *P₃₊₃A₃₊₃G₍₃₎ Family **Asparagaceae**.
 (genus *Yucca*)
 Sometimes, yuccas (*Yucca*) are treated as members of Agavaceae.
 – Not palmoids 6.

6. Follow the table below:

	Leaves simple, whole or lobed	Leaves compound
Leaves alternate 7. 27.
Leaves opposite (or whorled) 31. 40.

Leaves simple, whole or lobed, alternate.

7. Woody vines 8.
 – Trees, shrubs, sub-shrubs 11.
8. Venation acrodromous. Flowers in umbels. Fruit is a berry. $*P_{3+3}A_{3+3}G_{(3)}$ Family **Smilacaceae**.
 (genus *Smilax*)
 – Venation pterodromous 9.
 = Venation actinodromous (best seen at the base of leaf) 10.
9. Flowers in racemes. Leaves are always whole. Fruit is a three-valved capsule which opens to release seeds covered with brightly colored red aril. $*K_{(4)}C_4A_4G_{(3)}$ Family **Celastraceae**.
 (*Celastrus scandens*)
 – Flowers solitary or in dichasia (dichotomously branched inflorescences). Leaves sometimes lobed or dissected. Fruit is a berry. $*K_{(5)}C_{(5)}A_5G_{(2)}$ Family **Solanaceae**.
- 10 (8). Leaves with pilose or toothed margins, whole or lobed. Tendrils present. Fruit is a berry. $*K_5C_5A_5G_{(2)}$ Family **Vitaceae**.
 – Leaf margins without small teeth (but leaves are sometimes lobed). No tendrils. Fruit is a multiple drupe. $*P_{[0\vee3]+3+3}A_{3+3}G_{3\vee6}$ Family **Menispermaceae**.
- 11 (7). Leaves 2-ranked (i.e., most of leaves on the terminal branches are more or less in one plane), with asymmetric base 12.
 – Leaves are not 2-ranked and with asymmetric base 13.
12. Fruit is a solely winged nut. $*P_{(4-6)}A_{4-6}G_{\underline{1}}$ Family **Ulmaceae**.
 (genus *Ulmus*)
 – Fruit is a drupe. $*P_{(5)}A_5G_{\underline{1}}$ Family **Cannabaceae**.
 (genus *Celtis*)
- 13 (11). Leaves with actinodromous venation, usually wide, more or less heart-shaped 14.
 – Leaves more narrow, venation different 16.
14. Shrubs, sometimes spiny. Fruit is a berry. $*K_{(5\vee4)}C_{5\vee4}A_{5\vee4}G_{(2)}$ Family **Saxifragaceae**.
 (genus *Ribes*)
 Currants and gooseberries (*Ribes*) are sometimes considered as members of Grossulariaceae.
 – Trees, no spines 15.
15. Leaves whole. Inflorescence with few showy bisexual flowers and a sole conspicuous bract. Fruit is a nut. $*K_5C_5A_{\infty}G_{(3)}$ Family **Malvaceae**.
 (genus *Tilia*)
 Sometimes, lindens (*Tilia*) are listed under its own family, Tiliaceae.
 – Leaves whole or lobed. Inflorescences unisexual, catkins (male) or heads (female) without bracts. Fruit is a compound drupe. $P_4A_4 \vee P_4G_{(2)}$ Family **Moraceae**.
 (genus *Morus*)
- 16 (13). Semi-desert and dry prairie shrubs with narrow leaves, hyphodromous (sometimes also pterodromous) or apodromous venation and usually winged fruits 17.
 – Plants with the combination of characters different from the above 18.
17. Leaves not succulent, covered with at least few trichomes, with hyphodromous (or pterodromous) venation. Fruit is a nut, sometimes winged. $*P_{3-5}A_{1-5}G_{(2)}$ or unisexual Family **Amaranthaceae**
 In the past, woody genera of this family were placed in Chenopodiaceae.
 – Leaves curved, succulent, glabrous, apodromous. Fruit is a winged nut. $P_1G_{(2)} \vee A_{2-4}$
 Family **Phytolaccaceae**.
 (*Sarcobatus vermiculatus*)
 These plants were formerly treated in the family Chenopodiaceae, and now frequently in its own family, Sarcobataceae.

- 18 (16). Small spiny shrubs. Leaves concentrated in multiple groups along the stem. Flowers 3-merous, in racemes. $*K_{3+3}C_{3+3}A_{3+3}G_{\underline{1}}$ Family **Berberidaceae**.
(genus *Berberis*)
– Not barberries: plants with the combination of characters different from the above 19.
19. Plants dioecious (there are male and female plants). Leaves often narrowly lanceolate, with stipules. Buds are either sticky from resin, or covered with one cup-shaped scale. Fruit is a bivalved capsule containing hairy seeds. $A_{3-20} \vee G_{(2)}$ Family **Salicaceae**.
– Not willows or poplars: plants with the combination of characters different from the above 20.
20. Leaves, annual stems and fruits covered with shining, flat trichomes. Ovary inferior. Fruit is a drupe. $*P_{(2-4)}A_4G_{(\bar{2})}$, or unisexual Family **Elaeagnaceae**.
(genus *Elaeagnus*)
– Not silverberries: plants with the combination of characters different from the above 21.
21. Leaves with under-folded margins. Small, evergreen, sometimes creeping shrubs. Leaves also with hairs and/or dotted glands. Fruit is a capsule (*Ledum*) or berry (*Arctostaphylos*). $*K_{(5)}C_{(5)\vee 5}A_5G_{(5)}$ Family **Ericaceae**.
In cultivation, one may find also a common boxwood, *Buxus sempervirens* from Buxaceae (fruit is a capsule, flower $P_4A_4 \vee P_{2-4}G_{(3)}$). Boxwoods always have smooth leaves, without hairs or glands.
– Not ericoid shrubs: leaves without under-folded margins 22.
22. Trees, sometimes shrubs with unisexual non-conspicuous flowers in catkins or small clusters. Fruit is either acorn or nut, winged or not winged. Ovary inferior 23.
– Flowers more or less showy, bisexual. Fruits are not nuts or acorns 24.
23. Leaves pinnately lobed, lobes unequal. Buds covered with multiple tiling scales. Male catkins loose. Fruit is a nut-like acorn. $*P_{(5-9)}A_{5-10} \vee *P_{\infty}G_{(\bar{2})}$ Family **Fagaceae**.
(genus *Quercus*)
– Leaves whole or only slightly lobed, with serrate or toothed margin. Buds with few scales. Male catkins dense. Fruit is a nut, with or without wing. $P_{0\vee 2\vee(4)}A_{4-12} \vee P_{0\vee(\infty)}G_{(\bar{2})}$ Family **Betulaceae**.
- 24 (27). Leaves with well developed stipules. Fruit is a pome (apple-like) or drupe (cherry-like). $*K_{(5)}C_5A_{\infty}G_{\underline{1}} \vee G_{(\bar{2}-5)}$ Family **Rosaceae**.
– Leaves without stipules, fruit is a drupe or capsule 25.
25. Secondary veins are not arcuate. Fruits are capsules or drupes 26.
– Secondary veins arcuate. Shrubs or small trees. Fruit is a black or red drupe. $*K_{(4\vee 5)}C_{4\vee 5}A_{4\vee 5}G_{(2)}$ Family **Rhamnaceae**.
26. Small prairie shrubs or sub-shrubs. Fruit is a three-celled capsule. $*K_{2+3}C_5A_{\infty}G_{\underline{3}}$ Family **Cistaceae**.
– Small forest shrubs. Fruits are red drupes, typically gathered in small clusters. $*P_{(4)}A_8G_{(2)}$ Family **Thymelaeaceae**.
(genus *Dirca*)
= Small prairie sub-shrubs. Fruit are nuts, in terminal involucrate umbels or heads. $P_{(6)}A_9G_{(3)}$ Family **Polygonaceae**.
(genus *Eriogonum*)

* * *

Leaves compound, alternate.

- 27 (6). Woody vines with tendrils. Leaves triple or palmately compound or dissected. Fruit is a berry. $*K_5C_5A_5G_{(2)}$ Family **Vitaceae**.
– Not grapes: shrubs (sometimes creeping, but in that case without tendrils) or trees 28.
28. Leaves double pinnate or triple and then pinnate. Fruit is a berry. $*K_{0\vee 5}C_5A_5G_{(\bar{5})}$... Family **Araliaceae**.
(genus *Aralia*)

- Leaves triple or once pinnate 29.
 - 29. Leaves with well developed stipules. Fruit is a multiple nut (*Dasiphora*, *Rosa*), or multiple raspberry-like drupe (*Rubus*). $*K_{(5)}C_5A_{\infty}G_{\underline{1}} \vee G_{(2-5)}$ Family **Rosaceae**
 - Leaves without well developed stipules 30.
 - 30. Stems spiny. Leaves pinnate. Fruit is a multiple follicle. $*C_{4-5}A_{4-5} \vee C_{4-5}G_{2-5}$ Family **Rutaceae**. (*Zanthoxylum americanum*)
 - Stems are not spiny. Leaves pinnate or triple. Fruit is a drupe. $*K_{(5)}C_5A_5G_{\underline{1}}$ or unisexual Family **Anacardiaceae**.
- One may also come to this point identifying woody plants from legume family (Leguminosae).

* * *

Leaves simple, whole or lobed, opposite (or whorled).

- 31 (6). Leaves and annual stems covered with shiny, flat trichomes. Fruit is a drupe. $*P_{(2-4)}A_4G_{(\underline{2})}$, or unisexual Family **Elaeagnaceae**. (genus *Shepherdia*)
 - Not silverberries or buffaloberries: flat shiny trichomes absent 32.
 - 32. Venation actinodromous, leaves usually wide 33.
 - Venation pterodromous 34.
 - 33. Leaves lobed or toothed. Fruit is a double winged, schizocarpic. $* \vee \uparrow K_5C_5A_{5-12}G_{(2 \vee 3)}$ Family **Sapindaceae**. (genus *Acer*)
- Maples (*Acer*) are sometimes listed under its own family, Aceraceae.
- Leaves large, heart-shaped, whole, with smooth margin. Fruit is a capsule. $\uparrow K_{(2)}C_{(4-5)}A_{3,2}G_{(2)}$ Family **Labiatae s.l.** (genus *Catalpa*)
- Usually, *Catalpa* is listed under Bignoniaceae.
- 34 (32). Leaf margin smooth (or serrate but in this case flowers zygomorphic) 35.
 - Leaf margin toothed or serrate, flowers actinomorphic 38.
 - 35. Secondary veins are arcuate 36.
 - Secondary veins are not arcuate 37.
 - 36. Stamens opposite to petals. Leaf veins not sunken. Fruit is a superior drupe. $*K_{(4 \vee 5)}C_{4 \vee 5}A_{4 \vee 5}G_{(2)}$ Family **Rhamnaceae**.
 - Stamens alternate with petals. Leaf veins sunken. Fruit is an inferior drupe. $*K_{(4)}C_4A_4G_{(\underline{2})}$ Family **Cornaceae**.
 - 37 (35). Stamens two. Fruit is a bivalved capsule. $*K_{(4)}C_{(4)}A_2G_{(2)}$ Family **Oleaceae**. (genus *Syringa*)
 - Stamens 4 or 5. Fruit is a berry. $\uparrow K_{(5)}C_{(5)}A_{5 \vee 4}G_{(\underline{2})}$ Family **Caprifoliaceae**.
 - = Stamens (and perianth) multiple. Multiple pistils are within the cup-shaped receptacle (like in *Rosa*). Fruit is a multiple nut. $*P_{\infty}A_{\infty}G_{\underline{\infty}}$ Family **Calycanthaceae**. (*Calycanthus floridus*)
 - 38 (34). Petals free. Fruit is a drooping capsule with hanging, colored arillate seeds. $*K_{(4)}C_4A_4G_{(2)}$ Family **Celastraceae**. (genus *Euonymos*)
 - Petals fused 39.
 - 39. Fruit is a capsule. Flowers with multiple stamens. $*K_{4 \vee 5}C_{4 \vee 5}A_{\infty}G_{(\underline{4})}$ Family **Hydrangeaceae**. (genus *Philadelphus*)

- Fruit is a drupe. Flowers small, with 5 stamens. $*K_{(5)}C_{(5)}A_5G_{-(2)-}$ Family **Adoxaceae**.
(genus *Viburnum*)

Sometimes, one can find *Viburnum* under Caprifoliaceae or Viburnaceae.

* * *

Leaves compound, opposite (or whorled).

- 40 (6). Leaves palmately compound. Fruit is a three-celled spiny capsule. $*\vee\uparrow K_5C_5A_{5-12}G_{(2\vee3)}$
..... Family **Sapindaceae**.
(genus *Aesculus*)
- Sometimes, *Aesculus* (buckeyes) listed under Hippocastanaceae.
- Leaves double dissected or double compound. Fruit is a multiple nut. $*K_4C_4A_\infty G_\infty$
..... Family **Ranunculaceae**.
(genus *Clematis*)
 - = Leaves triple or pinnate 41.
41. Leaves rigid, with spiny margins, pinnate. Flowers 3-merous, in racemes. $*K_{3+3}C_{3+3}A_{3+3}G_1$
..... Family **Berberidaceae**.
(genus *Mahonia*)
- Leaves not spiny 42.
42. Leaves triple or pinnate, usually with no more than 5 leaflets. Fruits schizocarpic, with two wings. $*P_{(5)}A_{4-6}\vee$
 $*P_5G_{(2)}$ Family **Sapindaceae**.
(*Acer negundo*)
- Leaves odd-pinnate, typically with more than 5 leaflets 43.
43. Woody vines with orange or red, trumpeted, showy flowers. Fruit is a capsule. $\uparrow K_{(5)}C_{(5)}A_4G_{(2)}$
..... Family **Labiatae s.l.**
(*Campsis radicans*)
- Usually, these plants are listed under Bignoniaceae. There is also small tree of that group (*Tecoma stans*) under cultivation. It has similar leaves and similarly looking but yellow flowers.
- Trees, leaves odorless. Fruit is a winged 1-seeded nut. $K_{0\vee4}A_2G_{(2)}$ or unisexual Family **Oleaceae**.
(genus *Fraxinus*)
 - = Shrubs, leaves with unpleasant odor. Fruit is a drupe. $*K_{(5)}C_{(5)}A_5G_{-(2)-}$ Family **Adoxaceae**.
Sometimes, one can find *Sambucus* (elderberry) under Sambucaceae or Caprifoliaceae.

Group 9. True water plants. Completely submerged into water or floating on the water surface, only flowers sometimes are above the level of water.

Some families of plants which grow both in water and on land are repeated again on the next step (Group 11). Therefore, if not sure, **check** below and **also** on Step Three.

1. There are always leaves floating on the water surface 2.
Please note that its this subgroup, one duckweed species, *Lemna trisulca*, typically floats just **below** the water surface.
 - All leaves are usually submerged, they might raise on or above water only in the time of flowering 9.
2. Minuscule plants “made” of floating leaf-like modified shoots and also (usually) roots. Fruit is a capsule (but flowering is really rare). $A_1\vee G_1$ Family **Araceae**.
(genera *Lemna* (1 root), *Spirodela* (multiple roots) and *Wolffia* (no roots))
 - Larger plants with leaves floating on the surface of water 3.
3. Floating leaves lobed or dissected. Fruit is a multiple nut. $*K_5C_5A_\infty G_\infty$ Family **Ranunculaceae**.
(species of *Ranunculus*)
 - Floating leaves are whole 4.

4. Leaf base heart-shaped, large. Flowers solitary. Fruit is berry-like. $*K_{4-6}C_{\infty}A_{\infty}G_{(\infty)} \vee G_{-(\infty)-}$ Family **Nymphaeaceae**.
 – Leaf base is not heart-shaped 5.
5. Flowers lacking. Leaves scaly. Plant small, moss-like Family **Azollaceae**.
 (genus *Azolla*)
 Does not occur in North Dakota but found in neighboring territories.
 – Flowers present. Leaves not scaly. Plants larger 6.
6. Flowers solitary, axillary. Leaves opposite. Fruit schizocarpic, splits in 4 fragments. $A_1 \vee G_{(2 \times 2)}$ Family **Labiatae s.l.**
 (genus *Callitriche*)
 Water-starworts (*Callitriche*) are frequently treated as members of Calitrichaceae or Plantaginaceae.
 – Flowers in heads or spikes 7.
7. Leaves linear, sheathed (grass-like). Fruit is a nut. $*P_{3-6}A_3 \vee *P_{3-6}G_1$ Family **Typhaceae**.
 (genus *Sparganium*)
 Sometimes, bur-reeds (*Sparganium*) are treated as its own family, Sparganiaceae.
 – Leaves petiolate, more or less elliptic 8.
8. Leaf venation pterodromous. Flowers pink. Fruit is a nut. $*P_5A_5G_{(3)}$ Family **Polygonaceae**.
 (*Persicaria amphibia* [*Polygonum amphibium*])
 – Leaf venation acrodromous. Flowers green or brown. Fruit is a multiple nut. $*P_4A_4G_4$ Family **Potamogetonaceae**.
 (genus *Potamogeton natans*)
- 9 (1). Leaves whole 10.
 – Leaves variously segmented 21.
10. Leaf margins with prominent teeth, leaves opposite or whorled by 3. Fruit is a drupe. $P_1A_1 \vee G_1$ Family **Hydrocharitaceae**
 (genus *Najas*)
 Waternymphs (*Najas*) are sometimes treated under Najadaceae.
 – Leaves with smooth or serrate margin 11.
11. Leaves in rosettes 12.
 – Leaves not in rosettes 14.
12. Leaves quill-shaped, with minute axillary attachments—ligules. No flowers, sporangia located at the inner side of leaf bases Family **Isoëtaceae**.
 (genus *Isoëtes*)
 – Leaves without sporangia at bases 13.
13. Leaves petiolate, narrowly lanceolate. Fruit is a capsule. $*K_{(5)}C_{(5)}A_{4 \vee 2}G_{(2)}$ Family **Labiatae s.l.**
 (genus *Limosella*)
 Mudworts (*Limosella*) are usually listed under Scrophulariaceae.
 – Leaves linear, undulate, without petioles. Fruit is a capsule. $*K_{(3)}C_3G_{\bar{3}} \vee *K_{(3)}C_3A_2$ Family **Hydrocharitaceae**.
 (*Vallisneria americana*)
- 14 (12). Leaves alternate 15.
 – Leaves opposite 16.
 = Leaves whorled 18.
15. Flowers in aerial or underwater spikes, green or brown. Leaves linear, hypodromous or thread-like. Fruit is a multiple nut. $*P_4A_4G_4$ Family **Potamogetonaceae**.

- Flowers in small underwater clusters. Leaves thread-like. Fruit is a multiple nut where individual nuts sit on very long stalks. A_2G_4 Family **Ruppiaaceae**.
(genus *Ruppia*)
- = Flowers solitary, aerial, yellow. Leaves linear, parallelodromous. Fruit is a capsule. $*P_{3+3}A_{2,1}G_3$
..... Family **Pontederiaceae**.
(*Heteranthera dubia*)
- Podostemum ceratophyllum*, hornleaf riverweed (Podostemaceae) is registered for North Dakota but herbarium material is wanted. Superficially, it is similar to the representatives of families above but in fact, its “leaves” are modified shoots. Flowers of riverweed are radically simplified, $A_2G_{(2)}$. Fruit is a capsule.
- 16 (14). Flowers axillary, solitary 17.
– Flowers in racemes. Fruit is a two-celled capsule. $\uparrow K_{(4)}C_{(4)}A_2G_{(2)}$ Family **Labiatae s.l.**
(*Veronica anagallis-aquatica*)
Speedwells (*Veronica*) are frequently listed under Scrophulariaceae or Plantaginaceae.
17. No perianth. Leaves opposite. Fruit schizocarpic, splits in 4 fragments. $A_1 \vee G_{(2 \times 2)}$... Family **Labiatae s.l.**
(genus *Callitriche*)
Water-starworts (*Callitriche*) are frequently treated as members of Calitrichaceae or Plantaginaceae.
- Flowers with double perianth. Fruit is a capsule. $*K_{2-4}C_{2-4}A_{3-8}G_{(2-4)}$ Family **Elatinaceae**.
(genus *Elatine*)
- 18 (14). Leaf whorls consist of three thread-like leaves. Fruit is a multiple drupe. $A_1 \vee G_1$
..... Family **Potamogetonaceae**.
(genus *Zannichellia*)
Sometimes, horned pondweeds (*Zannichellia*) are treated as the family of its own, Zannichelliaceae.
- Leaves are not thread-like, 3–13 in a whorl 19.
19. Flowers with very long calyx tube. Leaves sometimes paired but mostly 3–7 per node. $*K_{(3)}C_3G_{\bar{3}} \vee$
 $*K_{(3)}C_3A_{7-9}$ Family **Hydrocharitaceae**.
(genus *Elodea*)
- Flowers axillary, small. Leaves 3–many in the whorl 20.
20. No perianth. Fruit is a nut $\uparrow(A_1G_{\bar{1}})$ Family **Labiatae s.l.**
(genus *Hippuris*)
Mare’s-tails (*Hippuris*) are frequently listed under Hippuridaceae or Plantaginaceae.
- Perianth double. Fruit is a capsule. $*K_4C_4A_8G_{(2)}$ Family **Elatinaceae**.
(genus *Elatine*)
- 21 (9). Leaves with bubbles, carnivorous plant. Fruit is a capsule. $\uparrow K_{(2)}C_{(2)}A_2G_{(2)}$ Family **Labiatae s.l.**
(genus *Utricularia*)
Bladderworts (*Utricularia*) are usually listed as members of Lentibulariaceae. By the way, their “leaves” are modified shoots.
- Leaves without bubbles 22.
22. Leaves whorled 23.
– Leaves opposite, fan-shaped. Fruit is a multiple nut. $*P_{3+3}A_{3+3}G_{\bar{3}}$ Family **Cabombaceae**.
(*Cabomba carolineana*)
- = Leaves alternate. Fruit is a multiple nut. $*K_5C_5A_{\infty}G_{\infty}$ Family **Ranunculaceae**.
(species of *Ranunculus*)
- 23 (21). Flowers axillary. Leaves dichotomously dissected, rough, toothed. Roots absent. Fruit is a nut. $A_1 \vee G_{\bar{1}}$
..... Family **Ceratophyllaceae**.
– Flowers in the aerial spikes. Leaves pinnately dissected, soft. Roots present. Fruit shizocarpic, consists of
4 nutlets. $*K_4C_4A_{4+4} \vee *K_4C_4G_{\bar{4}}$ Family **Haloragaceae**.
(genus *Myriophyllum*)

Group 10. Terrestrial spore plants.

-
1. Leaves well developed, multiple (up to 3 times) pinnate, or clover-like with 4 lobes2.
 - Leaves scale-like, needle-like or reduced into teeth3.
 2. Leaves spirally folded in bud. Sporangia typically gathered in sori located on the back side of leaves (sometimes, there are specialized generative leaves) Family **Polypodiaceae**.
 This family understood here in the extreme broad way. However, modern classifications of ferns recognize multiple families: (1) **Aspleniaceae**: *Asplenium*, *Athyrium*, *Cystopteris*, *Gymnocarpium*, *Onoclea*, *Thelypteris*, *Woodsia*; (2) **Dennstaedtiaceae**: *Pteridium*; (3) **Marsileaceae**: *Marsilea*; (4) **Osmundaceae**: *Osmunda*; (5) **Polypodiaceae**: *Dryopteris*; (6) **Pteridaceae**: *Cheilanthes*, *Pellaea*.
 - Leaves are not folded spirally, they are divided into vegetative and generative parts. Sporangia are not gathered in sori Family **Ophioglossaceae**.
 3. Leaves needle-like or scale-like. Shoot branches dichotomously4.
 - Leaves reduced into teeth, usually black or filmy. Stem articulated Family **Equisetaceae**.
 4. Leaves with minute axillary attachments—ligules. Sporangia in 4-sided spikes
 Family **Selaginellaceae**.
 - Leaves without ligules. Sporangia in cylindrical spikes Family **Lycopodiaceae**.

Step three. Group 11: Choices, Choices...

Note. Read statements below, then summarize numbers of points from only those statements which describe your plant. Then go to the group which your sum indicates.

Statements:

- | | |
|--|-----------|
| (α) All flowers zygomorphic or asymmetric | 1 point |
| (β) Perianth simple or absent ² | 2 points |
| (γ) Petals (not tepals) fused in at least a short tube | 4 points |
| (δ) There are more than 12 stamens and/or more than 1 pistil | 8 points |
| (ϵ) Ovary inferior or half-inferior | 16 points |

Results:

0 points	Group 11A	(go to page 16)
1 point	Group 11B	(go to page 18)
2 or 3 points	Group 11C	(go to page 18)
4 or 5 points	Group 11D	(go to page 20)
8, 9, 10 or 11 points	Group 11E	(go to page 22)
12 points	Group 11F	(go to page 23)
16 points	Group 11G	(go to page 23)
18 points	Group 11H	(go to page 23)
17 or 19 points	Group 11I	(go to page 23)
20 points	Group 11J	(go to page 24)
21 points	Group 11K	(go to page 24)
24 points	Group 11L	(go to page 24)

Group 11A. Flowers actinomorphic, with double perianth, free petals, 12 or less stamens, one pistil, superior ovary: *K_aC_bA_c≤12G_(d).

If you skip the Step One, carnation family (Caryophyllaceae) and cabbage family (Cruciferae), as well as prairie clover (*Dalea*) from Leguminosae, will fall under this group. If not sure, **check** Step One for Leguminosae and Caryophyllaceae, and if not, **go back** here.

²Please note that spurges (*Euphorbia*) from Euphorbiaceae have unisexual flowers without perianths which, however, gathered into flower-like inflorescence with perianth-like bracts, male and female flowers. Milky sap in all parts of these plants might help to identify them.

1. Plants without chlorophyll. Fruit is a 4–5-celled capsule. $*K_{4\vee5}C_{4\vee5}A_{4\vee5+4\vee5}G_{(4\vee5)}$. . . Family **Ericaceae**.
(genus *Monotropa*)
– Plants with chlorophyll 2.
2. Stamens 3–7 3.
– Stamens 10–12 11.
3. Stamens 7. Fruit is a 1-celled capsule. $*K_7C_7A_7G_{(7)}$ Family **Primulaceae**.
(genus *Trientalis*)
Not found in North Dakota but presents in neighboring territories.
– Stamens 3–6 4.
4. Plant with a root leaf rosette 5.
– Root leaf rosette absent 6.
5. Typically, there is one stem leaf; rosette leaves glabrous. Fruit is a 3-celled capsule. $*K_{(5)}C_5A_{5+5}G_{(3)}$
. Family **Celastraceae**.
(genus *Parnassia*)
Grass of Parnassus (*Parnassia*) is sometimes listed under Saxifragaceae or Parnassiaceae.
– No stem leaves; rosette leaves covered with sticky glands. Fruit is a 3-celled capsule. $*K_5C_5A_5G_{(3)}$
. Family **Droseraceae**.
(genus *Drosera*)
- 6 (4). Small (several cm) coastal or water plants, flowers sit in leaf axils. Fruit is 3–4-celled capsule.
 $*K_{2-4}C_{3\vee4}A_{3-8}G_{(3\vee4)}$ Family **Elatinaceae**.
(genus *Elatine*)
– Plants usually bigger, flowers on pedicels 7.
7. Stem climbing. Fruit is a berry. $*K_5C_{(5)}A_5G_{(2)}$ Family **Vitaceae**.
– Stem upright. Fruit is a capsule or berry 8.
8. Flowers 3-merous 9.
– Flower 4–5-merous. Leaves simple. Fruit is a 8–10-celled capsule. $*K_{4\vee5}C_{4\vee5}A_{4\vee5}G_{(4\vee5)}$
. Family **Linaceae**.
(genus *Linum*)
= Flower with 2 sepals, 5 petals and 3 carpels (correspond with 3 stigmas). Leaves simple. Fruit is a 1-celled
capsule. $*K_{(2)}C_{(5)}A_{4-6}G_{(3)}$ Family **Montiaceae**.
(genus *Phemeranthus*)
Sometimes, *Phemeranthus* is treated as a member of Portulacaceae.
Species of *Dalea* (prairie clover) might fall here, they have compound leaves with stipules.
9. Leaves dissected. Plant small, usually just several cm. Fruit schizocarpic, has 3 nutlets. $*K_3C_3A_{3\vee6}G_{(1\times3)}$
. Family **Limnanthaceae**.
(*Floerkea proserpinacoides*)
– Leaves whole. Plant more than several cm 10.
10. Flowers blue or purple, in umbels. Stamens hairy. Fruit is 3-celled capsule. $*K_3C_3A_{3+3}G_{(3)}$
. Family **Commelinaceae**.
(genus *Tradescantia*)
– Flowers solitary, red or white. Stamens glabrous. Fruit is a berry. $*K_3C_3A_3G_{(3)}$
. Family **Melanthiaceae**.
(genus *Trillium*)
Trilliums (*Trillium*) are sometimes listed under Trilliaceae or Liliaceae.
- 11 (2). Stigmas 5, sometimes short 12.
– Stigmas 1 or 2 13.

12. Leaves simple, but frequently palmately dissected. Fruit is a 5-celled capsule. $*K_5C_5A_{[5+5]V(5)}G_{(5)}$ Family **Geraniaceae**.
 - Leaves triple. Styles 5. Fruit is a 5-lobed capsule. $*K_5C_5A_{(5+5)}G_{(5)}$ Family **Oxalidaceae**.
 (genus *Oxalis*)
 = Leaves pinnate. Fruit schizocarpic, with 5 spiny nutlets. $*K_5C_5A_{5+5}G_{(5)}$ Family **Zygophyllaceae**.
 (*Tribulus terrestris*)
- 13 (11). One style with globose stigma 14.
 - Two styles. Fruit is a 2-celled capsule. $*K_5C_5A_{10}G_{(2)}$ Family **Saxifragaceae**.
14. 10 stamens, flower 5-merous. Fruit is a 5-celled capsule. $*K_{(5)}C_5A_{10}G_{(5)}$ Family **Ericaceae**.
 (Subfamily Pyroloideae: genera *Orthilia* and *Pyrola*)
 - 12 stamens, flower 6-merous or 4-merous. Fruit is a 2- or 4-celled capsule.
 $*K_{(6+6)V(4)}C_{6V4}A_{[6+6]V6V[4+4]}G_{(2V4)}$ Family **Lythraceae**.
 (genera *Lythrum* and *Ammania*)

Group 11B. Flowers zygomorphic or asymmetric, with double perianth, free petals, 12 or less stamens, 1 pistil, superior ovary: $\uparrow \vee \nabla K_a C_b A_{c \leq 12} G_{(d)}$.

If you skip the Step One, most of legumes (Leguminosae) will fall under this group. If not sure, **check** Step One for Leguminosae, and if not, **go back** here.

1. 10 or more stamens. Ovary open on top. Fruit is an open capsule. $\uparrow K_{4-6}C_{4-6}A_{10-\infty}G_{(3)}$ Family **Resedaceae**.
 (genus *Reseda*)
 - Stamens less than 10 2.
2. Three stamens fused in two blades, each blade bears 3 anthers. Fruit is a silique. $\uparrow K_2C_{1,3}A_{2 \times 1,5}G_{(2)}$ Family **Papaveraceae**.
 (subfamily Fumarioideae)
 Sometimes, members of this group treated as separate family, Fumariaceae.
 - Androecium is different from the above 3.
3. Corolla has 3 petals, two of them are bigger than the third one. Fruit is 3-celled capsule. $K_3C_{1,2}A_{3,3}G_{(3)}$ Family **Commelinaceae**.
 (genus *Commelina*)
 - Petals are not like above 4.
4. Stamens 5 5.
 - Stamens 3 or 8 6.
5. Stamens are fused by filaments. One of sepals petal-like, with spur. Stem transparent. Fruit is 5-celled capsule. $\uparrow K_{1,2}C_{1,2,2}A_{(5)}G_{(5)}$ Family **Balsaminaceae**.
 (genus *Impatiens*)
 - Stamens do not fuse with filaments. Calyx all green. Corolla with spur. Fruit is 3-celled capsule.
 $\uparrow K_5C_{[1,4]V0}A_{2,3}G_{(3)}$ Family **Violaceae**.
- 6 (4). Stamens free. Flowers orange or yellow. Leaves peltate. Fruit schizocarpic, with 3 nutlets.
 $\uparrow K_{1,4}C_{2,3}A_8G_{(3)}$ Family **Tropaeolaceae**.
 (genus *Tropaeolum*)
 These South American plants are sometimes cultivated as ornamentals.
 - Stamens fused. Flowers white or blue. Leaves narrow. Fruit is 2-celled capsule. $\uparrow K_{2,3}C_{[1,2]V[1,4]}A_{(8)}G_{(2)}$ Family **Polygalaceae**.
 (genus *Polygala*)

Group 11C. Perianth simple or absent, stamens 12 or less, pistil 1, ovary superior: $P_{a \vee 0} A_{b \leq 12} G_{(c)}$.

If you skip the Step One, graminoid families (Gramineae, Cyperaceae and Juncaceae) will fall under this group. If not sure, **check** Step One for Gramineae, Cyperaceae and Juncaceae, and if not, **go back** here.

1. Annuals or perennials without rhizomes. Leaves palmate (or at least deeply palmate or triple lobed), rough. Flowers green or brown, unisexual, usually surrounded with bracts. Fruit is a nut. $P_5 A_5 \vee P_1 G_{(2)}$ Family **Cannabaceae**.
 - Rhizomatous, semi-aquatic or helobious herbaceous plants. Leaves triple lobed or whole. Inflorescences are heads or spadices. Flowers without perianth or with non-conspicuous perianth 2.
 - = Plants different from both descriptions given above 4.
2. Leaves triple lobed or elliptic. Bract of the spadiceous inflorescence large, non-green. Fruit is a berry. $*A_6 G_{(3)}$ Family **Araceae**.
 - Leaves linear. Inflorescence is different from the above 3.
3. Inflorescence is a spadix, deviated with a sharp angle from the axis. Bract green, leaf-like. Fruit is a berry. $*P_6 A_6 G_{(3)}$ Family **Acoraceae**.
 - Inflorescence is a terminal spadix or round head. Fruit is a nut. $P_{0 \vee 3-6} A_{3 \vee (3)} \vee P_{0 \vee 3-6} G_1$ Family **Typhaceae**.
(genera *Typha* and *Sparganium*)
- 4 (1). Unisexual flowers without perianth are located in axils of opposite leaves. Stems are weak. Fruit schizocarpic, consists of 4 nutlets. $A_1 \vee G_{(2 \times 2)}$ Family **Labiatae s.l.**
(genus *Callitriche*)
 - Water-starworts (*Callitriche*) are frequently treated as members of Calitrichaceae or Plantaginaceae.
 - Plants with combination of characters different from the above 5.
5. Leaves with an ocrea—leathery or filmy “sleeve” growing upwards along the stem from the base of leaf. Stem nodes usually swollen. Fruit is a nut. $P_{(4 \vee 5) \vee 3-6} A_{5-9} G_{(3)}$ Family **Polygonaceae**.
 - Leaves without ocrea 6.
6. Perianth corolla-like, colored 7.
 - Perianth calyx-like or absent 15.
7. Flowers 4–5-merous. Leaf venation pterodromous, hyphodromous or apodromous (veins not visible). Fruits are nuts or capsules. 8.
 - Flowers 3-merous. Leaf venation acrodromous or parallelodromous. Fruits are berries or capsules ... 10.
 - = Flowers 3-merous. Leaf venation pterodromous, hyphodromous or apodromous. Flowers in terminal involucrate umbel- or head-like inflorescences. Fruits are nuts. $P_{(6)} A_9 G_{(3)}$ Family **Polygonaceae**.
(genus *Eriogonum*)
8. Flowers in the involucrate inflorescences, sometimes (*Mirabilis*) reduced into one flower but then involucre covers this flower from outside. Perianth fused, with tube. Pistil 1-carpellate. Fruit is a nut. $*P_{(4-5)} A_{4-5} G_1$ Family **Nyctaginaceae**.
 - Flowers solitary, axillary 9.
9. Flowers white. Fruit is a 3-celled capsule³. $*P_{(5)} A_5 G_{(3)}$ Family **Molluginaceae**.
(genus *Mollugo*)
 - Flowers pink, at least in the center. Fruit is a 1-celled capsule. $*P_5 A_5 G_{(5)}$ Family **Primulaceae**.
(*Glaux maritima*)
- 10 (7). Leaves 2-ranked (in one plane), linear, most of them concentrated at the base of stem. Fruit is a capsule. $*P_{3+3} A_{3+3} G_3$ Family **Tofieldiaceae**.
(*Triantha glutinosa*)

³You might also come here if you take the inflorescence of spurge (*Euphorbia* from Euphorbiaceae) as a bisexual flower with simple perianth

- Leaves not two-ranked 11.
- 11. Fruit is a berry of different colors, but not bright orange or red. Flowers are white, often in racemes (paired in *Polygonatum*, solitary in *Leucocrinum*). Plants with horizontal rhizomes (but *Leucocrinum* has no stem). * $P_{4\vee(6)}A_{3+3}G_{(3)}$ Family **Asparagaceae**.
In the past, some genera of Asparagaceae were members of Liliaceae or Convallariaceae.
- Fruit is a capsule or bright orange or red berry. Flowers not white or sometimes white (*Prosarthes*), in racemes, umbels, or solitary, or paired. Plants with bulbs, sometimes rhizomatous 12.
- 12. At least some (usually most) photosynthetic leaves are attached to the vertical part of stem 13.
- All photosynthetic leaves concentrated near stem base, stem leafless except for bracts 14.
- 13. Plants bulbous (if rhizomatous, then fruit is bright orange or red berry). Flowers not drooping and yellow. Fruit is a capsule or berry. * $P_{3+3}A_{3+3}G_{(3)}$ Family **Liliaceae**.
- Plants with rhizomes, fruit is a drooping green capsule. Flowers drooping, yellow. * $P_{3+3}A_{3+3}G_{(3)}$ Family **Colchicaceae**.
(genus *Uvularia*)
- 14 (12). Diversely colored flowers (and fruits) in umbels. Leaves with onion or garlic smell. Fruit is a capsule. * $P_{3+3}A_{3+3}G_{(3)}$ Family **Amaryllidaceae**.
(genus *Allium*)
- Onions (*Allium*) are frequently listed under Alliaceae.
- Flowers white-green, in racemes. Leaves without onion or garlic smell (careful, some species are poisonous when digested!). Fruit is a capsule. * $P_{3+3}A_{3+3}G_{(3)}$ Family **Melanthiaceae**.
(genus *Zigadenus*)
- Deathcamas (*Zigadenus*) is sometimes listed under Liliaceae.
- 15 (6). Fruit schizocarpic with 3 or 2 nutlets. Milky sap is frequently present in all parts of plants. Flowers in dense inflorescences (cyathia) surrounded with bracts, $A_1 \vee G_{(3)}$ Family **Euphorbiaceae**.
- Fruit is a capsule or nut. Milky sap absent. Flowers not in cyathia 16.
- 16. Leaves opposite, if alternate then covered with stinging hairs or at least coarse “velcro” hairs. Flowers in relatively short but branched inflorescences starting from leaf axils (sometimes inflorescences reduced into groups of few flowers). Fruit is a nut. * $P_{4\vee5}A_{4\vee5} \vee *P_{4\vee0}G_1$ or bisexual Family **Urticaceae**.
- Leaves mostly alternate, other characters are not as above 17.
- 17. Stems climbing. Leaves with acrodromous venation. Flowers in umbels. Fruit is a berry. * $P_{3+3}A_{3+3}G_{(3)}$ Family **Smilacaceae**.
(genus *Smilax*)
- Stems upright. Leaves and flowers different from above 18.
- 18. Leaves linear, grooved, with sheaths. Fruit is a 3-celled capsule. * $P_3A_3P_3A_3G_{(3)}$ Family **Juncaginaceae**.
(genus *Triglochin*)
- Leaves without sheaths 19.
- 19. Flowers usually small, few millimeters in diameter. Carpels completely fused. Fruit is a nut. * $P_{3-5}A_{1-5}G_{(2)}$ or unisexual Family **Amaranthaceae**
In the past, some genera (they frequently have fleshy leaves) of this family were placed in Chenopodiaceae.
- Flowers bigger (more than 5 mm in diameter). Carpels partly free. Fruit is a 5–7-celled capsule. * $P_5A_{10}G_{(5-7)}$ Family **Haloragaceae**
(*Penthorum sedoides*)
- Ditch stonecrop (*Penthorum sedoides*) is frequently listed under Crassulaceae or Penthoraceae.

Group 11D. Perianth double, petals fused in at least short tube, pistil one, ovary superior, stamens 12 or less: $K_a C_{(b)} A_{c \leq 12} G_{(d)}$.

If you skip the Step One, most of the expanded mint family (Labiatae s.l.) will fall under this group (some of its most deviated representatives are mentioned below). If not sure, **check** Step One for Labiatae, and if not, **go back** here.

1. Stem climbing. Fruit is a capsule. $*K_{(5 \vee 4)} C_{(5 \vee 4)} A_{5 \vee 4} G_{(2)}$ Family **Convolvulaceae**.
– Stem does not climb 2.
2. Fruit schizocarpic, consists of 4 nutlets. Stem and leaves are usually covered with rough hairs. $* \vee \uparrow K_{(5)} C_{(5)} A_5 G_{(2 \times 2)}$ Family **Boraginaceae**.
– Fruit and pubescence are different from the above 3.
3. Stamens opposite to petals. Style 1. Fruit is a capsule. $*K_{(5 \vee 4 \vee 7)} C_{(5 \vee 4 \vee 7)} A_{5 \vee 4 \vee 7} G_{(5 \vee 4 \vee 7)}$
..... Family **Primulaceae**.
– Stamens alternate with petals. Number of styles varies 4.
4. Stamens completely or partly fused 5.
– Stamens completely free (however, they can fuse with corolla tube) 6.
5. Three stamens fused in two blades, each blade bears 3 anthers. Fruit is a silique. $\uparrow K_2 C_{1,3} A_{2 \times 1,5} G_{(2)}$
..... Family **Papaveraceae**.
..... (subfamily Fumarioideae)
Sometimes, members of this group treated as separate family, Fumariaceae.
- Stamens 8, fused, each stamen with one anther. Fruit is 2-celled capsule. $\uparrow K_{2,3} C_{[1,2] \vee [1,4]} A_{(8)} G_{(2)}$
..... Family **Polygalaceae**.
..... (genus *Polygala*)
- 6 (4). Corolla dry, filmy. Fruit is a capsule opening with round slit. $*K_{4 \vee 3} C_{(4)} A_4 G_{(2)}$... Family **Labiatae s.l.**
..... (genus *Plantago*)
Most frequently, plantains (*Plantago*) are treated as members of Plantaginaceae.
- Corolla is not dry 7.
7. Ovary 1-celled, ovules (and then seeds) are attached to its walls. Leaves glabrous, either triple or whole, from linear to elliptic with central vein and arcuate lateral veins 8.
Good character which also unite this subgroup is an extreme bitter taste of their leaves but since in the other subgroup, representatives of Solanaceae could be poisonous, this is not recommended for the identification.
- Ovary 2–3-celled, leaves usually different from the description above 9.
8. Leaves opposite, simple, some attached to the stem. Petals glabrous. Fruit is a 2-valved capsule.
 $*K_{(5 \vee [4-7])} C_{(5 \vee [4-7])} A_{4-7} G_{(2)}$ Family **Gentianaceae**.
– Leaves alternate, triple, in root rosette. Petals hairy. Fruit is a 2-valved capsule. $*K_{(5)} C_{(5)} A_5 G_{(2)}$
..... Family **Menyanthaceae**.
..... (genus *Menyanthes*)
- 9 (7). Style with 3 lobes. Fruit is 3-celled capsule. $*K_{(5)} C_{(5)} A_5 G_{(3)}$ Family **Polemoniaceae**.
– Style with 1 lobe or styles 2 10.
10. Inflorescence is a cincinnus, sometimes dense, round-shaped. Styles 2. Fruit is 2-celled capsule.
 $*K_{(5)} C_{(5)} A_5 G_{(2)}$ Family **Hydrophyllaceae**.
Sometimes, (some) genera of this family are treated under Boraginaceae.
- Inflorescence is not a cincinnus, style 1 11.
11. Leaves usually alternate. Flower tube usually relatively short, does not have attachments covering its entrance. Stamens 5. Flowers slightly asymmetric because planes of symmetry are different between perianth and ovary. Fruit is a berry or capsule. $*K_{(5)} C_{(5)} A_5 G_{(2)}$ Family **Solanaceae**.

- Leaves usually opposite. Flower tube usually relatively long, with attachments covering the entrance. Stamens 4. Sometimes, flowers slightly asymmetric because some petals might be bigger than others. Fruit is a capsule. $*K_{(5)}C_{(5)}A_4G_{(2)}$ Family **Labiatae s.l.**
(genus *Verbena*)

Most frequently, verbenas (*Verbena*) are listed in Verbenaceae.

Group 11E. Petals (if any) free, pistils more than one and/or stamens more than 12, ovary superior: $[K_aC_b] \vee P_c[A_{d>12}G_{(e)\vee e}] \vee [A_dG_e]$

1. Leaves with sheaths, venation acrodromous or parallelodromous. Flower 3-merous 2.
 - Leaves with actinodromous or pterodromous venation, without sheaths. Flower usually 5-merous 4.
 - = Leaves pitcher-shaped, carnivorous. Flower with umbrella-like style covering the whole center of flower including multiple stamens. Fruit is a capsule. $*K_5C_{0\vee 5}A_{\infty}G_{(5)}$ Family **Sarraceniaceae.**
(*Sarracenia purpurea*)

Was not found in North Dakota but known in western Minnesota (Lake Itasca).
2. Venation acrodromous (leaves more or less elliptic). Pistils many. Perianth double. fruit is a multiple nut. $*K_3C_3A_{6\vee\infty}G_{\infty}$ Family **Alismataceae.**
 - Venation parallelodromous (leaves linear). Pistils 3 or 6. Perianth simple or double 3.
3. Pistils 3, perianth simple, non-conspicuous. Fruit is a multiple follicle. $*P_{3+3}A_{3+3}G_3$ Family **Scheuchzeriaceae.**
(genus *Scheuchzeria*)
 - Pistils 6, perianth double, showy. Fruit is a multiple follicle. $*K_3C_3A_9G_6$ Family **Butomaceae.**
(genus *Butomus*)
- 4 (1). Pistil 1, perianth double 5.
 - Pistils more than 1 or one (in this last case, perianth always simple) 10.
5. Flower zygomorphic. Ovary open on top. Fruit is an open capsule. $\uparrow K_{4-6}C_{4-6}A_{10-\infty}G_{(3)}$ Family **Resedaceae.**
(genus *Reseda*)
 - Flower actinomorphic 6.
6. Stamens more or less fused into one column or three bundles. Leaves with actinodromous venation (most visible at the base) 7.
 - Stamens free. Venation diverse 8.
7. Stamens fused into one column. Style 1. Leaves alternate. Fruit is a capsule, multiple follicle or schizocarpic. $*H_{0\vee 3-8\vee(3-8)}K_5C_5A_{(\infty)}G_{(\infty)\vee\infty}$ Family **Malvaceae.**
 - Stamens fuse in 3 bundles. Styles 3. Leaves opposite. Fruit is a capsule. $*K_5C_5A_{3\times\infty}G_{(3)}$ Family **Hypericaceae.**
(genus *Hypericum*)
- 8 (6). Leaves glabrous, with toothed or lobed margins, sometimes almost dissected. Fruit is a capsule or siliqua. $*K_2C_4A_{\infty}G_{(2)}$ Family **Papaveraceae.**
 - Leaves with smooth margins, hairy or glabrous 9.
9. Leaves succulent. Perianth simple. Fruit is a capsule. $\uparrow P_{(4\vee 5)}A_{\infty}G_{(3-8)}$ Family **Aizoaceae.**
(*Tetragonia tetragonioides*)
 - Leaves not succulent. Perianth double. Fruit is a capsule. $*K_{2+3}C_5A_{\infty}G_{(3)}$ Family **Cistaceae.**
- 10 (4). Leaves succulent. Numbers of pistils and sepals equal. Fruit is multiple follicle. $*K_{(5-20)}C_{5-20}A_{10-40}G_{5-20}$ Family **Crassulaceae.**

Was not found in North Dakota but occur in all neighboring territories.

 - Leaves are not succulent. Number of pistils bigger then number of petals 11.

11. Leaves with stipules. Calyx with calycle (epicalyx). There is also hypanthium (expanded flower receptacle under calyx). Fruit is multiple follicle, multiple nut or multiple drupe.

* $H_{(5\vee4\vee0)}K_{(5\vee4)}C_{5\vee4\vee0\vee6}A_{4-\infty}G_{1-\infty}$, or sometimes unisexual Family **Rosaceae**.

– Leaves without stipules. Calyx without calycle, deciduous. Hypanthium absent, but receptacle can be conically enlarged. Fruit is multiple nut or multiple follicle. * $\vee \uparrow [K_{3-15}C_{2-25}] \vee [P_{5-6}]A_{5-\infty}G_{1-\infty}$

..... Family **Ranunculaceae**.

Sometimes, sepals and stamens are petal-like, and petals become nectaries.

Group 11F. Flowers actinomorphic, perianth double, petals fused into at least short tube, pistils more than 1, ovary superior: * $K_a C_{(b)} A_c G_{d>1}$.

Leaves opposite. Plants with milky sap. Two pistils but styles fuse at least on top. Fruit is a double follicle.

* $K_{(5)}C_{(5)}A_5G_2$ Family **Apocynaceae**.

Some genera of Apocynaceae were in the past in their own family, Asclepiadaceae (they differ by having pollinia, like orchids).

Group 11G. Flowers actinomorphic, perianth double, petals free, stamens 12 or less, pistil 1, ovary inferior: * $K_a C_b A_{c \leq 12} G_{(\bar{d})}$.

If you skip the Step One, umbel family (Umbelliferae) will fall under this group. If not sure, **check** Step One for Umbelliferae, and if not, **go back** here.

1. Flower 2–4-merous. Leaves simple. Fruit is a 2–5-celled capsule. * $K_{2\vee4}C_{2\vee4}A_{2\vee[4+4]}G_{(\overline{2-5})}$ Family **Onagraceae**.

– Flower 5-merous. Leaves double pinnate or triple and then pinnate. Fruit is a berry. * $K_{0\vee5}C_5A_5G_{(\overline{5})}$... Family **Araliaceae**.

(*Aralia nudicaulis*)

Group 11H. Flowers actinomorphic, perianth simple or absent, stamens 12 or less, pistil 1, ovary inferior or half-inferior: * $P_{a\vee0}A_{b \leq 12} G_{(\bar{d})} \vee G_{-(d)-}$.

1. Leaves linear2.
– Leaves not linear3.

2. Leaves two-ranked. Flowers blue or light blue. Fruit is a 3-celled capsule. * $\vee \uparrow P_{(3+3)}A_3G_{(\overline{3})}$ Family **Iridaceae**.

– Leaves not two-ranked. Flowers yellow. Fruit is a 3-celled capsule. * $P_{3+3}A_{3+3}G_{(\overline{3})}$ Family **Hypoxidaceae**.

(*Hypoxis hirsuta*)

3 (1). Flowers lay almost on the ground, solitary, green-purple. Stamens 12. Fruit is a capsule. * $P_{(3)}A_{12}G_{(\overline{3})}$ Family **Aristolochiaceae**.

(*Asarum canadense*)

– Flowers above the ground, axillary or in inflorescences4.

4. Flowers white. Fruit is a nut. * $P_{(5\vee4)}A_{5\vee4}G_{(\overline{2})}$ Family **Santalaceae**.

– Flowers green. Fruit is a drupe. * $P_{(2\vee3)+(4\vee5)}A_{[4\vee5] \times 2}G_{-(2)-}$ Family **Adoxaceae**.

(*Adoxa moschatellina*)

Was not found in North Dakota but occurs in most neighboring territories.

Group 11I. Flowers zygomorphic or asymmetric, perianth any (simple, double or absent), stamens 12 or less, pistil 1, ovary inferior: $\uparrow \vee \downarrow \dots A_{b \leq 12} G_{(\bar{d})}$.

1. No perianth. Fruit is a nut $\uparrow (A_1 G_{\overline{1}})$ Family **Labiatae s.l.**
(genus *Hippuris*)

Mare's-tails (*Hippuris*) are frequently listed under Hippuridaceae or Plantaginaceae.

- Perianth presents 3.
- 2. Perianth with a lip, stamen 1 or 2. Venation not pterodromous. Fruit is 1-celled capsule with tiny seeds. $\uparrow P_{3\vee[(2),1]+2,1}(A_{1\vee 2}G_{\overline{3}})$ Family **Orchidaceae**.
- No lip. Stamens 8. Venation pterodromous. Fruit is 2-celled capsule. $\uparrow K_4 C_{1,3} A_{4+4} G_{\overline{2}}$ Family **Onagraceae**.

Group 11J. Flowers actinomorphic, perianth double, petals fused into at least short tube, stamens 12 or less, pistil 1, ovary inferior: $*K_a C_{(b)} A_{c \leq 12} G_{\overline{d}}$.

If you skip the Step One, some of aster family (Compositae) will fall under this group. If not sure, **check** Step One for Compositae, and if not, **go back** here.

- 1. Stems with tendrils. Flowers unisexual. Fruit is a berry. $*K_{(5)} C_{(5)} A_{(5)} \vee *K_{(5)} C_{(5)} G_{\overline{(3-5)}}$ Family **Cucurbitaceae**.
- No tendrils. Flowers bisexual 2.
- 2. Leaves alternate. Stem upright. Fruit is 2–3–5-celled capsule. $*K_{(5)} C_{(5)} A_5 G_{\overline{(2\vee 3\vee 5)}}$ Family **Campanulaceae**.
- Leaves opposite. Stem creeping. Fruit is a nut. $*K_{(5)} C_5 A_{2,[3\vee 2]} G_{\overline{2}}$ Family **Caprifoliaceae**.
(genus *Linnaea*)
- = Leaves whorled. Stem upright. Fruit schizocarpic with 2 mericarps. $*K_{0\vee(4\vee 5)} C_{(4\vee 3\vee 5)} A_{4\vee 3\vee 5} G_{\overline{2}}$ Family **Rubiaceae**.

Group 11K. Flowers zygomorphic or asymmetric, perianth double, petals fused into at least short tube, stamens 12 or less, pistil 1, ovary inferior: $\uparrow \vee \nabla K_a C_{(b)} A_{c \leq 12} G_{\overline{d}}$.

If you skip the Step One, most of aster family (Compositae) will fall under this group. If not sure, **check** Step One for Compositae, and if not, **go back** here.

- 1. Leaves whole. Inflorescence is a raceme. Fruit is a capsule. $\uparrow K_{(5)} C_{(2,3)} A_{(5)} G_{\overline{3}}$... Family **Campanulaceae**.
Sometimes, members of Campanulaceae with zygomorphic flowers are treated under Lobeliaceae.
- At least some leaves compound or dissected. Inflorescences are not racemes 2.
- 2. Flowers in heads surrounded with modified bracts, individual flowers with external calyx. Fruit is an achene enclosed into modified external calyx. $\uparrow E_{(4\vee 8)} K_{(5\vee 3)\vee 0} C_{(4\vee 5)} A_4 G_{\overline{2}}$ Family **Caprifoliaceae**.
(genus *Knautia*)
Frequently listed under Dipsacaceae.
- Flowers in paniculate inflorescences, individual flowers without external calyx, asymmetric. Fruit is an achene with hairy attachment. $\nabla K_0 C_{(5-3)} A_3 G_{\overline{2}}$ Family **Caprifoliaceae**.
(genus *Valeriana*)

Frequently treated within its own family, Valerianaceae. Valerians (*Valeriana*) was not found in North Dakota but occur in most neighboring territories.

Group 11L. Flowers actinomorphic, perianth double or simple, stamens more than 12, ovary inferior: $*[K_a C_b] \vee P_c A_{d > 12} G_{\overline{e}}$.

Flowers of cactus family (Cactaceae) also correspond with description of this group. If not sure, **check** Step Two for Cactaceae, and if not, **go back** here.

Plants with alternate rough leaves covered with bristles making them “natural velcro”. Fruit is a capsule. $*K_{(5)} C_{5\vee 10} A_{\infty} G_{\overline{(\infty)}}$ Family **Loasaceae**
(genus *Mentzelia*)

Appendix A. Flower formulas

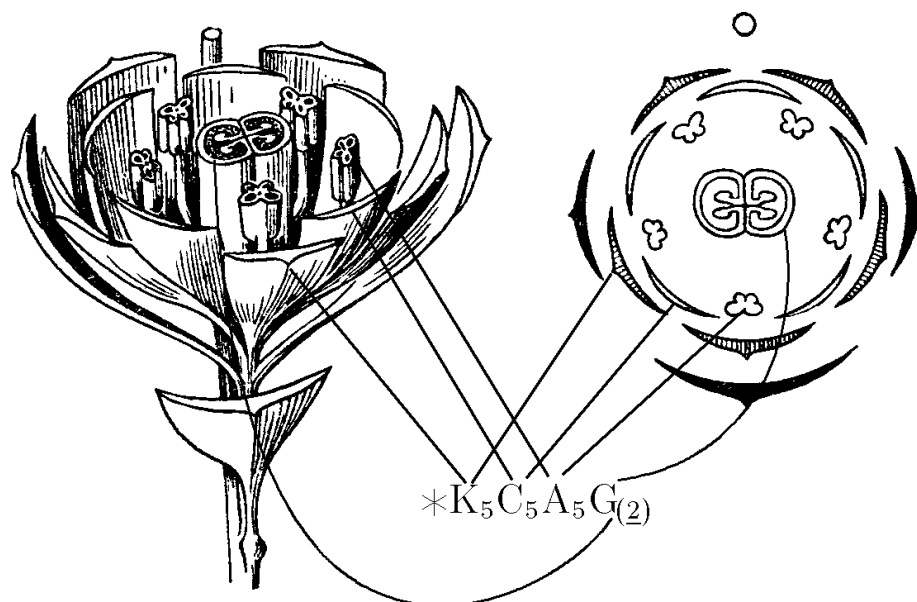


Figure 1.1. Relations between flower, its diagram and its formula

Most frequent symbols if flower formulas system used here:

- * actinomorphic (radial, star-shaped) flower
- ↑ zygomorphic (bilateral) flower
- ⚡ asymmetric flower. Sometimes, if flower is too small and/or perianth significantly reduced, symmetry was skipped in the formula.
- ♂ male flower (without fertile pistil)
- ♀ female flower (without developed stamens)
- ♂♀ bisexual flower
- K calyx, consists of sepals
- H calycle, or epicalyx (Malvaceae, Rosaceae)
- E external calyx (Caprifoliaceae)
- C corolla, consists of petals
- S staminodes (petal-like stamens)
- P simple perianth (i.e., perianth which is impossible to classify into calyx and corolla), consists of tepals
- A androeceum (all stamens together)
- G gynoecium (all pistils of carpels together)
- G₍₂₎ inferior ovary (here with two carpels)—perianth and stamens attached to the tip of the pistil

- $G_{(5)}$ superior ovary (here with five carpels)—perianth and stamens are attached to the basement of pistil
- $G_{-(3)-}$ half-inferior ovary (here from three carpels)—perianth and stamens attached to the middle of pistil
- \vee “or”, e.g. $K_{3\vee5}$ means three or five but not four sepals
- variation of part numbers, e.g. K_{3-5} means three, four or five sepals
- () fusion
- + separate flower circles
- \times splitting or sometimes (like $A_{\infty \times 5}$) fusion in several bundles
- ,
- ∞ indefinite (typically, more than 12 and also variable between flowers)
- [] separate groups of flower parts to which symbols “ \vee ” or “+” are applied

Examples of complicated flower formulae:

- $P_{0\vee2\vee(4)}A_{4-12}\vee P_{0\vee(\infty)}G_{(\overline{2})}$ (birch family, Betulaceae): unisexual flowers, male without perianth or with perianth of 2 free or 4 fused tepals, stamens from 4 to 12; female flowers without or with perianth of indefinite number of tepals, pistil with two carpels, ovary inferior.
- $\uparrow\vee *K_{(4\vee5)}C_{([2,3]\vee4\vee5)}A_{[2,2]\vee2\vee5}G_{(2)}$ (mint family, Labiatae s.l.): flowers bisexual, zygomorphic or actinomorphic, perianth double (with calyx and corolla): calyx with 4 or 5 fused sepals and corolla with 4 or 5 fused petals where 2 petals are different from other three (two lips); stamens 4, sometimes 5 or 2, in the first case one pair is different from another; pistil with 2 carpels, ovary superior.
- $*H_{(5\vee4\vee0)}K_{(5\vee4)}C_{5\vee4\vee0}A_{4-\infty}G_{1-\infty}$ (part of the rose family, Rosaceae): flowers bisexual, actinomorphic, there is a sub-calyx of 5 or 4 lobes, sometimes sub-calyx wanted; double perianth—calyx has 5 or 4 fused sepals whereas corolla has 5 or 4 free petals (sometimes corolla absent); stamens from 4 to indefinite; pistils from one to indefinite, ovary superior.
- $*\vee \uparrow K_{(5)}C_{(5)}A_5G_{(2 \times 2)}$ (forget-me-not family, Boraginaceae): flowers bisexual, actinomorphic or sometimes zygomorphic, double perianth—calyx with 5 fused sepals and corolla with 5 fused petals; 5 stamens; pistil has 2 carpels and each of them splits in two parts, ovary superior.

Appendix B. Alternative key to the most frequent families

More than a half of North Dakota flowering plants belong to the ten most frequent families. This key may help with their determination.

1. Inflorescence dense, flower-like head. Leaves without stipules, sometimes with milky sap. Calyx reduced to pappus or scales. Anthers united into the tube around the style. Fruit small, solid and dry achene, usually with long hairs on the top (pappus). **Compositae**, Aster family
 - Inflorescences with different structure 2.
2. Leaves narrow, linear, alternate in two ranks, with sheath and ligules; stems cylindrical in section, internodes usually hollow. Flowers each compressed between a bract (lemma) and bracteole (palea). Flowers arranged in 2 ranks in spikelets subtended by empty bracts (glumes); spikelets themselves grouped in more complex inflorescences, usually spikes, racemes, or panicles. Seed fused to pericarp to form a one-seed dry caryopsis. **Gramineae**, Grass family
 - Leaves narrow, linear, alternate in (usually) 3 ranks, with sheath and ligules (leaves could be reduced); stems triangular or cylindrical in section, internodes usually not hollow. Flowers reduced in many different ways, very often (sedges) the female flower is just a pistil surrounded with bag-like bract (perigynium). Flowers arranged in spikelets and/or spikes or more branched inflorescences. Seed is not fused to pericarp, the fruit is the one-seed dry nutlet. **Cyperaceae**, Sedge family
 - = Plants have different characters 3.
3. Flowers with upper and lower lips 4.
 - Flowers without lips 5.
4. Flowers with 4 stamens. Ovary split in four parts. Leaves opposite, stems quadrangular in section. **Labiatae**, Mint family (part)
 - Flowers with 10 stamens, corolla with banner (top petal) and keel (two front petals). Ovary solid. Leaves compound, with paired stipules. **Leguminosae**, Pea family
 - = Flowers labiate, but not as above Other families (e.g., Polygalaceae, Phrymaceae, Orchidaceae)
- 5 (3). Flowers showy, typically with the double perianth: calyx and corolla. Sometimes, flowers have more than 12 stamens. 6.
 - Flowers often inconspicuous, with the uniform perianth (greenish or colored). Flowers always with less than 12 stamens. 9.
6. Flowers normally with more than 12 stamens, and often also with more than 1 pistil. 7.
 - Flowers with less (usually 4, 5, 6 or 10) stamens, and always with one pistil. 8.
7. Flowers with multiple (or one) pistil(s) sitting inside a receptacle “cup” (*hypanthium*) or on the enlarged receptacle. Perianth double. Leaves with paired stipules. **Rosaceae**, Rose family
 - Flowers without hypanthium (but enlarged receptacle may present). Perianth double or uniform. Leaves without stipules **Ranunculaceae**, Buttercup family
 - = Flowers with multiple stamens, but not as above Other families (e.g., Nymphaeaceae, Alismataceae, Cistaceae)
- 8 (6). Flowers with one central pistil, receptacle is not enlarged. Stamens 6, two of them are smaller than others. Leaves without paired stipules. **Cruciferae**, Mustard family
 - = Plants with different characters Most of non-listed families
- 9 (5). Flowers often more than 3 mm in diameter, arranged in spikes, umbels, heads or more branched inflorescences. In most of representatives, every node has an *ocrea*: “sleeve” which continues upward with the stem. **Polygonaceae**, Buckwheat family
 - Flowers often very small, less than 3 mm in diameter, arranged in more compact inflorescences (often in glomerules). *ocrea* absent. **Amaranthaceae**, Amaranth family

= Plants with small, inconspicuous, often reduced flowers, but other characters are different from above
..... Other families (e.g., Potamogetonaceae, Urticaceae, Juncaceae)

Chapter 2

Manual to the commonly cultivated trees and shrubs

This dichotomous key is a highly modified version of the Herman D.E. & Chaput L.J. work of 2003. A “key” is similar to a road which forks repeatedly and which has signposts indicating what may be found along each branch. Key gives the reader one of two (sometimes three) choices. A number at the right of a description indicates the next step to take. The number in parenthesis after the number at the left indicates where you came from and allows you to back track (if there is no number, go to the previous step to backtrack).

There are three parts: conifers, woody vines and leafy trees and shrubs. The relatively rare species and the horticultural cultivars have been left out because their inclusion would necessarily have increased the complexity of the key and the volume of the publication.

If you use this key as a PDF file on electronic device, you may want to click on the colored names and this will open the Google image search for this species. All numbered references are also active links which work inside the PDF document. Names of native* North American species (including species with circumpolar distribution) are labeled with star.

A glossary appendix at the end of the capter explains terms that may be unfamiliar.

1. Trees or shrubs whose foliage is needle-like or scale like2.
 - Foliage not needle-like or scale-like but with normal leaves 18.
2. Usually more then five needles start from one point; deciduous *Larix sibirica* (Siberian Larch)
 - Not over five needles from one point; evergreen3.
- 3 (2). Needles in fascicles (bunches)4.
 - Needles not in fascicles8.
4. Needles per fascicle 5 *Pinus flexilis** (Limber Pine)
 - Needles per fascicle 2 or 35.
5. Needles over 10 cm long, in trios and pairs*Pinus ponderosa** (Ponderosa Pine)
 - Needles less than 8 cm long, only in pairs6.
6. Usually multi-stemmed shrub or shrub-like small tree; cone scales crowded at cone base; young bark dark*Pinus mugo* (Mugo Pine)
 - Trees; cone scales are not crowded at base; young bark bright (orange, yellow, bright-brown)7.
7. Cones symmetric, leaves typically about 5 cm, branches ascending *Pinus sylvestris* (Scotch Pine)
 - Cones asymmetric, leaves typically more 5 cm, branches mostly horizontally spreading
..... *Pinus contorta** (Lodgepole Pine)
- 8 (3). Leaves scale-like or awl-shaped, not over 1.5 cm long9.
 - Needles linear or needle-like, about 2.5 cm long 13.
9. Branchlets flattened; woody cones only about 1 cm long *Thuja occidentalis** (American Arborvitae)
 - Branchlets 3 or 4 angled; cones berrylike, about 0.5 cm in diameter 10.
10. Long trailing native groundcover rarely over 2 m high *Juniperus horizontalis** (Creeping Juniper)
 - Also cultivated is *Microbiota decussata* (Siberian Cypress) with woody cones, tips of its branches are nodding whereas in junipers, tips are mostly arcuate or straight.
 - Shrub at least 2 feet high when mature 11.

11. Needles about 1 cm long, strongly boat shaped or awl-shaped, all sharp *Juniperus communis** (Common Juniper)
 *Juniperus communis** (Common Juniper)
 – Some or all needles scale-like; trees 12.
 There are many other ornamental junipers in cultivation, both trees and shrubs.
12. Scale-like leaves not overlapping, or not more than by $\frac{1}{5}$ their length. Bark of larger branches in plates. Foliage turning purple-brown in winter *Juniperus virginiana** (Eastern Red-cedar)
 – Scale-like leaves overlapping by more than $\frac{1}{4}$ their length; bark of larger branches usually in strips. Foliage often bluer green, remaining the same in winter *Juniperus scopulorum** (Rocky Mt. Juniper)
- 13 (8). Needles fastened directly to twig, leave a circular leaf scar when removed; bark more or less smooth 14.
 – Needles attached to small pegs; bark scabrous 16.
14. Midrib visible also from above; cones berry-like; no resin *Taxus* spp. (Yews)
 Most often, *Taxus cuspidata* (Japanese Yew) and its hybrids are cultivated.
 – Midrib visible only from below; cones woody; have resin 15.
15. Needles sessile; cones disintegrating when mature; buds blunt and resinous *Abies balsamea** (Balsam Fir)
 – Needles petiolate; cones stable, with papery bracts extending beyond cone scale; buds sharp-pointed, dark purple and not resinous *Pseudotsuga menziesii** (Douglas fir)
- 16 (13). Needles somewhat flattened, 2 ranked; woody cones usually over 8 cm long *Picea abies* (Norway Spruce)
 – Needles 4 angled, not 2 ranked; cones 8 cm long or less 17.
17. Needles very sharp; cones over 5 cm long with ragged scales ... *Picea pungens** (Colorado, or Blue Spruce)
 – Needles only moderately sharp; cones less than 5 cm long with smooth, rounded edge on cone scales *Picea glauca** (Black Hills, or White Spruce)
- * * *
- 18 (1). Vines 19.
 – Trees, shrubs, or herbs 22.
19. Leaves compound 20.
 – Leaves simple 21.
20. Leaves alternate; 5 leaflets; fruit a berry *Parthenocissus quinquefolia** (Virginia Creeper)
 – Leaves opposite; 3 leaflets; fruit multiple nut *Clematis* spp. (Virgin's Bower)
- 21 (19). Margin coarsely serrate; leaves sometimes lobed, fruit a black berry *Vitis* spp. (Grape)
 Several species and hybrids are cultivated, e.g., hardy grapes *Vitis labrusca** "Valiant".
 – Margin fine serrate, leaves never lobed; fruit orange, splitting to show red interior *Celastrus scandens** (American Bittersweet)
- * * *
- 22 (18). Shrubs or herbs mainly less than 0.5 m high when mature 23.
 – Shrubs or trees over 0.5 m high when mature 25.
23. Leaves simple, elliptic, leathery, evergreen *Buxus sempervirens* (Boxwood)
 – Leaves not so 24.
24. Small shrub, herb-like; always 3 leaflets, not serrate but sometimes irregularly toothed *Toxicodendron radicans** (Poison Ivy)

- Perennial herb with woody underground rhizome; leaves 3-forked, each fork with 3 or 5 serrate leaflets
..... *Aralia nudicaulis** (Wild Sarsaparilla)
- 25 (22). Leaves compound: triple, palmate, pinnate or double pinnate 26.
 - Leaves simple: whole, lobed or dissected 42.
- 26. Compact branchy shrubs, leaflets usually less than 1 cm wide 27.
 - Coarser shrubs or trees, leaflets usually more than 1 cm wide 28.
- 27. Stipular prickles present; fruit a pod *Caragana* spp. (Peashrub)
Two small peashrubs are usually cultivated: *Caragana pygmaea* (Pigmy Peashrub) with lanceolate leaflets and *C. aurantiaca* (Orange Peashrub) with elliptic leaflets.
 - No stipular spines; fruit globose, multiple nut *Dasiphora fruticosa** (Shrubby Cinquefoil)
- 28 (26). Trees with long pinnate leaves, leaflets more than 5 pairs, elliptic, obtuse or mucronate, or leaves double pinnate with various leaflets 29.
 - Trees or shrubs with combination of characters different from the above 31.
- 29. Leaflets obtuse or mucronate, leaves pinnate or double pinnate 30.
 - Leaflets acute or acuminate, leaves double pinnate, large (sometimes up to 1 m)
..... *Gymnocladus dioicus** (Kentucky Coffetree)
- 30. Leaflets usually oblong, their size equal; leaves pinnate or double pinnate
..... *Gleditsia triacanthos** (Common Honeylocust)
 - Leaflets usually ovate, becoming gradually bigger to the upper part of the pinnate leaf
..... *Robinia pseudoacacia** (Black Locust)
- 31 (28). Branches with either stipular or corticular spines; shrubs 32.
 - Branches without spines; trees or shrubs 33.
- 32. Spines stipular; fruit a pod; bark greenish *Caragana arborescens* (Siberian Peashrub)
While *Caragana arborescens* has pinnate leaves, cultivated is *Caragana frutex* (Russian Peashrub) has triple leaves.
 - Spines corticular; fruit a fleshy hip; bark reddish or brownish *Rosa* spp. (Rose)
Multiple species and hybrids with tangled ancestry are cultivated, one of common species is shrubby *Rosa rugosa* (rugose rose) with wrinkled leaves.
- 33 (28). Leaves opposite 34.
 - Leaves alternate 39.
- 34. Palmate five-leaflet leaves; fruit a nutlike capsule *Aesculus glabra** (Ohio Buckeye)
 - Leaves not palmate; fruit not a nutlike capsule 35.
- 35. Leaves regularly serrate; twigs gray; buds brown 36.
 - Leaves irregularly toothed; twigs green or reddish brown with a bloom; buds silvery; fruit with two wings
..... *Acer negundo** (Boxelder Maple)
This tree became a noxious species in Europe.
- 36. Leaflets mostly 2–3 pairs, elliptic 37.
 - Leaflets mostly more than 3 pairs, lanceolate 38.
- 37. Base of petiole encasing bud (leaf scars concave and buds originate within it); leaflets whitened beneath
..... *Fraxinus americana** (White Ash)
 - Base of petiole below bud (leaf scars round and buds originate above it); leaflets not whitened beneath
..... *Fraxinus pennsylvanica* (Green Ash)
The most common species of ashes.
- 38 (36). Leaflets sessile *Fraxinus nigra** (Black Ash)
 - Leaflets stalked *Fraxinus mandshurica* (Manchurian Ash)
- 39 (33). Base of petiole encasing bud 40.

- Base of petiole below bud 41.
- 40. Twigs hairy *Rhus typhina* (Staghorn Sumac)
- Twigs glabrous *Rhus typhina* (Smooth Sumac)
- 41 (39). Pith chambered; leaflets obtusely serrate, about 8 cm long *Juglans nigra** (Black Walnut)
- Pith solid; leaflets distinctly serrate, about 4 cm long *Sorbus aucuparia* (European Mountain-ash)
- Also cultivated are: American *Sorbus decora** (Showy Mountain-ash), low tree or shrub with sticky, usually shiny buds, and *Sorbaria sorbifolia* (False Spirea), low shrub with long leaves and narrow, long pointed leaflets.
- 42 (25). Many or all leaves lobed or dissected (deeper than 1/4 of radius) 43.
- Leaves not lobed 52.
- 43. Leaves opposite 44.
- Leaves alternate 46.
- 44. Some terminal leaves not lobed, when lobed always 3, a coarse shrub; fruit a drupe *Viburnum opulus** (Cranberrybush)
- All terminal leaves lobed, 3 or 5, trees or shrubby trees; fruit schizocarpic with two wings 45.
- 45. Leaves silvery beneath; lobes of nearly equal length; a large tree *Acer saccharinum** (Silver Maple)
- Leaves not silvery beneath; terminal lobe longer than others; small tree or shrublike *Acer ginnala* (Amur Maple)
- Acer tataricum* (Tatarian Maple) is also cultivated, it has leaves with undeveloped, almost tooth-like lobes.
- 46 (43). Leaves triangular, 2-lobed, with dichotomous venation (see Glossary) *Ginkgo biloba* (Ginkgo)
- This famous Chinese “living fossil” is sometimes cultivated in North Dakota.
- Leaves not so 47.
- 47. Trees 48.
- Shrubs 51.
- 48. Leaves palmately or triple lobed, sometimes irregularly 49.
- Leaves pinnately lobed 50.
- 49. Leaves white hairy below *Populus alba* (White Poplar)
- Leaves not white hairy below, lobes irregular *Morus alba* (White Mulberry)
- 50 (48). Bark white and papery, many branches pendulous, leaves serrate, sometimes acutely lobed or even dissected *Betula* spp. (Birches)
- Betula pendula* ‘Dalecarlica’ (Cutleaf Weeping Birch) with dissected leaves and *Betula papyrifera** (Paper Birch) are frequently cultivated in North Dakota.
- Bark dark and ridged, leaf lobes obtuse *Quercus macrocarpa**, Bur Oak
- Also cultivated are: *Quercus mongolica* (Mongolian Oak), it has leaves with undeveloped, teeth-like lobes; and *Quercus ×bimundorum* (Prairie Stature Oak) which has leaves deeply lobed in the upper half.
- 51 (47). Leaves 1–2 cm long, rhombic ovate to rhombic obovate; fruit dry *Spiraea* spp. (Spirea)
- See also 92.
- Leaves bigger, variably orbicular, fruit fleshy (a berry) *Ribes* spp. (Currants and gooseberries)
- North Dakota native *Ribes odoratum** (Golden Currant) and European *Ribes alpinum* (Alpine Currant) are most frequently cultivated ornamental species.
- Also cultivated is *Physocarpus opulifolius* (Common Ninebark) with papery, detachable bark and dry fruits.
- 52 (42). Leaves silvery on both sides (this is visible better on younger leaves) 53.
- Leaves not silvery or at least upper leaf surface not silvery 55.
- 53. Leaves opposite; fruit red when ripe *Shepherdia argentea** (Silver Buffaloberry)
- Leaves alternate, fruit silvery when ripe 54.
- If leaves are alternate but fruit bright orange or red when ripe, this is likely the *Hippophaë rhamnoides* (Common Sea-Buckthorn), Eurasian plant often cultivated for its berries.

54. Petiole about 3 mm long; leaves ovate, wavy-curved; fruit globose; shrubby *Elaeagnus commutata** (Silverberry)
 – Petiole about 1 cm long; leaves lanceolate, flat; fruit ellipsoidal; treelike *Elaeagnus angustifolia* (Russian Olive)
- 55 (52). Leaves small (typically less than 5 cm), obovate, often reddish, gathered in fascicles; stems spiny *Berberis thunbergii* (Red Barberry)
 – Leaves not so 56.
56. Leaves opposite, sub-opposite (see Glossary), or whorled 57.
 – Leaves alternate 68.
57. Leaves sub-opposite; end of twig frequently modified into a thorn 58.
 – Leaves opposite or whorled; twigs not thorny 59.
58. Leaves nearly as broad as long *Rhamnus cathartica** (Common Buckthorn)
 – Leaves over twice as long as broad *Rhamnus davurica* (Dahurian Buckthorn)
- 59 (57). Leaves regularly toothed 60.
 – Leaf margins entire or irregularly toothed 61.
60. Leaf margins finely serrate, leaves glabrous, large shrubs or small trees *Viburnum lentago** (Nannyberry)
 – Leaf margins conspicuously serrate, leaves pubescent, small shrubs *Hydrangea arborescens** (Smooth Hydrangea)
 Two other Asian species of hydrangeas with glabrous leaves are also in cultivation, *Hydrangea paniculata* (leaves elongated), and *Hydrangea macrophylla* (leaves broadly ovate). Both are small shrubs.
- 61 (59). Trees with large heart-shaped whorled leaves *Catalpa speciosa** (Northern Catalpa)
 – Shrubs with elliptic opposite leaves 62.
62. Petioles less than 5 mm long; pith usually hollow 63.
 – Petioles 5 mm long or more; pith usually solid 65.
63. Small native shrubs; fruit white, twig usually reddish brown 64.
 – Large shrub; fruit orange or red; leaves acute; twigs tan, with hollow pith *Lonicera tatarica* (Tatarian Honeysuckle)
 Other similarly looking species of honeysuckles are cultivated, e.g. *Lonicera maackii* (Amur honeysuckle) with acuminate leaves and red poisonous fruits, and *Lonicera caerulea** with acute leaves and edible blue fruits. Most of non-native honeysuckles are dangerous invasive plants in U.S.
 In addition to honeysuckles, other shrubs of this family (Caprifoliaceae) such as native North Dakotan *Diervilla lonicera** (Northern Bush Honeysuckle) with yellow flowers, and Chinese *Weigela florida* (Flowering Weigela) with pink flowers, are cultivated. Both have leaves wider than *Lonicera* above, acuminate, elliptic or ovate, with serrate margins. While in *Lonicera* flowers (and fruits) are frequently in pairs, *Diervilla* and *Weigela* bear small multi-flowered clusters.
64. Leaves usually greater than 3 cm *Symphoricarpos occidentalis** (Western Snowberry)
 – Leaves smaller *Symphoricarpos albus** (Snowberry)
 These two species could be distinguished safely only when flower: stamens of *Symphoricarpos occidentalis* are exerted from the corolla whereas stamens of *S. albus* are included in the corolla.
- 65 (62). Twigs winged, with longitudinal emergences *Euonymus alatus* (Burning Bush)
 – Twigs smooth 66.
66. Twigs bright red; venation arcuate; fruit a white drupe *Cornus sericea** (Redosier Dogwood)
 – Twigs a greenish or brownish; venation netted; fruit a capsule 67.
67. Leaves green or light green, ovate, basal veins not in grooves *Syringa vulgaris* (Common Lilac)
 – Leaves dark green, circular or wide ovate, basal veins in grooves *Syringa meyeri* (Korean Dwarf Lilac)
 There are many other species and hybrids of lilacs in cultivation, e.g., *Syringa pubescens* which also has dark green leaves with veins in grooves, but they are more elongated, with the long tip.

- 68 (56). Trees 69.
 – Shrubs 85.
69. Leaves conspicuously heart-shaped; fruit a nut suspended from a wingy bract 70.
 – Leaves not so; fruit not so 71.
70. Leaves green below, midvein is 10 cm or more, fruit with the thick wall (not easy to crush with fingers) *Tilia americana** (American Linden, Basswood)
 – Leaves glaucous below, midvein is 6 cm or less, fruit with the thin wall (easy to crush with fingers) *Tilia cordata* (Littleleaf Linden)
 Hybrids between these two species, *Tilia × flavescens* are often cultivated in North Dakota. They are visually similar to *T. americana* but with have leaves with midvein 6-8 cm and coarse acuminate teeth.
 Asian *Tilia mongolica*, with prominent, long teeth or even sharp lobes, is also cultivated in the state.
 Older white mulberry (*Morus alba*) trees also have almost non-lobed heart-shaped leaves, but at least some leaves are with 3–5 obtuse lobes, and leaf base is almost always symmetric. See the 49.
- 71 (69). Bark white; peeling horizontally, marked by horizontal lenticels ... *Betula papyrifera** (Paper Birch)
 – Bark not so 72.
72. Petioles flattened, about as long as a leaf blade 73.
 – Petioles round, less than $\frac{3}{4}$ as long as leaf blade 74.
73. Leaves deltoid; bark dark and rough *Populus deltoides** (Cottonwood)
 – Leaves oval orbicular, bark light and smooth *Populus tremuloides** (Quaking Aspen)
- 74 (72). Leaves lanceolate or linear; buds with single caplike scale *Salix* spp. (Willows)
 Multiple willow species are cultivated. While their identification is beyond the scope of this manual, most important are *Salix pentandra** (Laurel Leaf Willow) and *Salix × 'Prairie Cascade'* and other “weeping willows” (hybrids with participation of true weeping willow, *Salix babylonica*).
 – Leaves broader; buds with several imbricate scales 75.
75. Twigs usually with definite thorns; leaves prominently doubly serrate *Crataegus* spp. (Hawthorn)
 Multiple species are cultivated, including North Dakota native *Crataegus chrysoarpa** (Fireberry Hawthorn), extremely spiny small tree, and more ornamental (and less spiny) *Crataegus × mordenensis* (Morden Hawthorn).
 – Twigs without definite thorns, serration varies but if tree somewhat thorny, then leaves singly serrate 76.
76. Leaf apex rounded; leaf shape oval; leaf base entire *Amelanchier** spp. (Juneberries, Serviceberries)
 Multiple species are in cultivation including North Dakota native *Amelanchier alnifolia** (Saskatoon Serviceberry).
 – Leaf apex pointed; leaf shape ovate, obovate, elliptical; serrate to base of leaf 77.
77. Leaves two-ranked (see Glossary) 78.
 – Leaves not two-ranked 81.
- 78 (76). Leaves symmetric at base, fruits with broad wings, in catkins ... *Ostrya virginiana** (Hophornbeam)
 – Leaves asymmetric at base, fruits different 79.
79. Pith chambered at nodes; leaves light green with three main veins; fruit a drupe *Celtis occidentalis** (Common Hackberry)
 – Pith not chambered; leaves deep or bright green with one main vein; fruit a spring ripening samara ... 80.
80. Leaves over 5 cm long, dull above; twigs coarse *Ulmus americana** (American Elm)
 – Leaves 5 cm long or less; shiny above; twigs fine *Ulmus pumila* (Siberian Elm)
 Closely related *Ulmus davidiana* (Japanese Elm) has slightly bigger leaves with maximal width above the middle.
- 81 (77). Buds large, odorate and gummy; leaves gray or rusty below ... *Populus balsamifera** (Balsam Poplar)
 – Buds not so; leaves not so 82.

82. Leaves often ovate or elliptic, not shiny, hairy beneath; lateral buds often on short deflected shoots covered with bark similar to rolled up long shirt sleeves; fruit a pome *Malus* spp. (Apples and Crabapples)
Multiple species in cultivation, from *Malus domestica* (Apple Tree) to numerous crabapples with small pomes (e.g., *Malus baccata*).
Similar to apples are pears (*Pyrus ussuriensis* and other species), they differ by having sharp lateral buds and leathery, shiny leaves.
– Leaves often oblong, shiny, glabrous beneath; lateral buds not so; fruit a drupe 83.
83. Serrations glandular tipped; twigs reddish; central stem noticeable . . . *Prunus pensylvanica** (Pin Cherry)
– Serrations without glands; bark gray; branchy crown 84.
84. Petiole hairy; veins prominent; some short twigs thornlike *Prunus americana** (American Plum)
– Petiole glabrous; veins not prominent; not thornlike *Prunus virginiana** (Chokecherry)
- 85 (68). Buds with several imbricate scales 86.
– Buds with single caplike scale *Salix* spp. (Willows)
86. Dark glossy green leaves without serrations; insignificant pinkish-white flowers; black pea-sized pomes *Cotoneaster lucidus* (Hedge Cotoneaster)
– Leaves at least partially serrate 87.
87. Leaves usually double serrate, broad 88.
– Leaves usually singly serrate, elliptic, oblong or similar 89.
88. Petiole hairy; fruit husk without beak *Corylus americana** (American Hazelnut)
– Petiole glabrous; fruit husk with a long beak *Corylus cornuta** (Beaked Hazelnut)
- 89 (87). Leaf apex rounded; leaf shape oval; leaf base entire
. *Amelanchier** spp. (Juneberries, Serviceberries)
– Leaf apex pointed; leaf shape ovate, obovate or elliptical; serrate to base of leaf 90.
90. Serrations glandular tipped; bark reddish; central stem usually noticeable
. *Prunus pensylvanica** (Pin Cherry)
– Serrations without glands; bark gray; central stem is absent 91.
91. Petiole hairy; veins prominent; some short twigs thornlike *Prunus americana** (American Plum)
– Petiole glabrous; veins not prominent; not thornlike 92.
Also cultivated is *Prunus tomentosa* (Nanking Cherry) with hairy leaves and petioles, prominent veins and no thorns.
92. Leaves usually with large teeth (up to 1/4 of the radius), rhombic; fruit dry *Spiraea* spp. (Spirea)
Most frequently cultivated spireas are *Spiraea ×vanhouttei* (leaves obovate, sometimes lobed), *Spiraea betulifolia** (leaves elliptic),
S. ×bumalda (leaves oblong), *Spiraea japonica* (leaves ovate, frequently with yellow tint), and *Spiraea nipponica* (leaves narrow,
lanceolate).
– Leaves with smooth margin or small appressed teeth, not rhombic; fruit fleshy 93.
93. Leaves narrowly elliptical; leaf base acute *Prunus pumila** (Sand Cherry)
– Leaves ovate or obovate; leaf base rounded or obtuse *Prunus virginiana** (Chokecherry)

Appendix A. Glossary

Acuminate	With long pointed tip.
Acute	With triangle-shaped tip.
Alternate	Bud or leaf arrangement (singly) along a stem at spiraled intervals.
Appressed	Flattened against.
Arcuate	Arc-like.
Ascending	Rising somewhat obliquely and curving upward.
Awl-shaped	Linear, with sharp pointed end.
Blade	The broad, flat, green part of the leaf.
Bract	A modified leaf from the axil of which a flower or flower cluster arises.
Capsule	Pod consisting of two or more chambers.
Catkin	A scaly-bracted spike of unisexual flowers.
Compound	A leaf that is made up of more than one leaf blade, termed leaflets.
Cultivar	A cultivated variety as distinguished from a botanical variety.
Dichotomous	(Venation): each vein divided in two.
Deciduous	Not persistent, leaves falling in autumn.
Drupe	Fleshy fruit with a pit or stone.
Entire	(Leaf margin): unbroken, without teeth or lobes.
Evergreen	Retains leaves year-round.
Fascicle	A small bundle.
Glabrous	Without hair, smooth.
Glandular	Small, usually shiny bumps on the surface.
Globose	Spherical.
Imbricate	Overlapping, like shingles on a roof.
Inconspicuous	Small, not readily noticed by the naked eye.
Lateral buds	Those buds below the terminal buds where side branches arise.
Leaflet	A single segment of a compound leaf.
Lenticel	A breathing pore in young bark, appearing as a light-colored, often lens-shaped, dot.
Needle	Elongate, linear, sharp-pointed leaves.
Nut	Dry 1-seeded indehiscent fruit.

Opposite	Growing in pairs but separated by a stem.
Palmate	With three or more lobes, veins or leaflets arising from one point.
Pendulous	Hanging down.
Petiole	The stalk of a leaf.
Pinnate	Compound leaf with leaflets on either side of central axis.
Pith	Spongy center of a twig; if it has crosswalls, it is called “chambered.”
Pome	Fleshy fruit with a core, such as a crabapple.
Resinous	Sticky with resin.
Samara	Dry fruit with a membranous wing.
Scale	Bud covering or tiny, blunt leaf.
Scar	Place where leaf base was attached to stem.
Serrate	With sharp teeth along the margin pointing forward.
Sessile	With no stalk or petiole.
Spines	Stipular spines came out of stipules, they are usually paired and attached to leaf bases; cortical spines came out of stem surface, they do not correspond with leaves.
Stipules	Small (usually) paired (usually) attachments to the base of leaf petiole, they are not similar to leaflets.
Sub-opposite	A bud/leaf arrangement in which they are close to being opposite from each other, but one is slightly lower than the other.
Thorns	Prominent, sharp leafless shoots.
Two-ranked	Appearing to come from only two sides of the twig; not equally distributed around the twig.
Venation	Pertaining to the vein pattern in the leaf blades.

Chapter 3

Manual to the Compositae

Keys are compiled from multiple sources, mainly from the “Flora of North America”, from Ackerfield’s (2015) “Flora of Colorado” and Lesica’s (2012) “Manual of Montana Vascular Plants”.

Group Key

- 1. Shrubs or subshrubs; woody above-ground stems present **Group A**
 - Plants herbaceous 2.
- 2. White-wooly herbs with discoid heads; upper portion of involuclral bracts papery **Group B**
 - Plants not as above 3.
- 3. Heads ligulate, with 5-teeth flowers; disk flowers absent; plants frequently with milky sap 4.
 - Heads with disk flowers 5.
- 4. Flowers yellow or orange **Group C**
 - Flowers white, pink, blue or purple **Group D**
- 5 (3). Heads discoid; ray flowers absent 6.
 - Heads radiate; both ray flowers (3-teeth) and disk flowers present 7.
- 6. Corollas conspicuously yellow or orange **Group E**
 - Corollas green, green-brown, green-yellow, white, pink, purple (rarely yellow at the base) **Group F**
- 7 (5). Ray flowers white, blue, purple, or pink **Group G**
 - Ray flowers yellow or orange 8.
- 8. Pappus of capillary or barbellate bristles, or of an outer series of short scales and inner series of capillary bristles; receptacle naked or fimbriate **Group H**
 - Pappus of awns, scales, a short crown, or absent; receptacle naked, chaffy, or bristly **Group J**

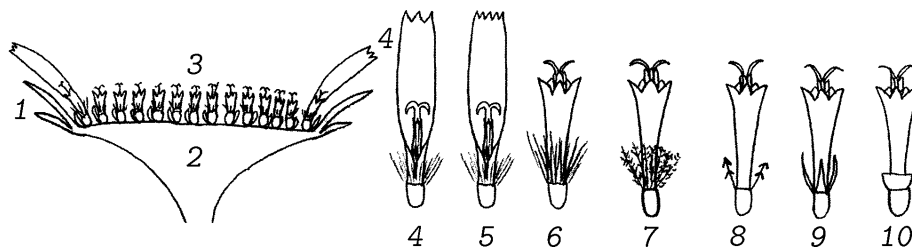


Figure 3.1. Compositae head and flowers. 1 Involuclral bracts; 2 Receptacle; 3 Disk flowers; 4 Ray flower (incomplete, pseudo-ligulate); 5 Ray flower (complete, ligulate); 6 Disk flower with pappus made of capillary bristles; 7 Plumose bristles; 8 Barbed awns; 9 Scales; 10 Crown. (Modified from Ackerfield, 2015).

Group A

Shrubs and subshrubs.

9. Pappus of disk flowers of erose scales or absent 10.
 – Pappus of capillary bristles 11.
10. Pappus of erose scales; ray flowers present *Gutierrezia*
 – Pappus absent; ray flowers absent. Involucral bracts in 4 to 7 unequal series; inflorescence usually a spike-like raceme *Artemisia*
 (Go to *Artemisia* section)
11. Stems usually white-tomentose, leaves not resinous *Ericameria*
 (*Ericameria nauseosa*, or (synonym) *Chrysothamnus nauseosus*)
 – Stems glabrate; leaves resinous, frequently twisted *Chrysothamnus*

Group B

White-wooly herbs with discoid heads; upper portion of involucral bracts papery: tribe *Glaphalieae*.

12. Plants annual 13.
 – Plants perennial 14.
13. Receptacle naked *Gnaphalium*
 – Receptacle with chaff between or surrounding the flowers (sometimes appearing to be an involucre).
 Stems often branched from the base; heads clustered on branch tips *Evax*
 (*Evax prolifera*)
 Mentioned for North Dakota only once, it is possible that this species does not occur in the state.
- 14 (12). Involucral bracts almost entirely papery, shiny white, glabrous *Anaphalis*
 (*Anaphalis margaritacea*)
 Mentioned for Morton county only.
 – At least part of involucral bracts colored or hairy 15.
15. Heads typically short pedunculate, with flowers of only one sex (male heads sometimes absent)
 *Antennaria*
 – Heads in glomerules, with female flowers on outside and males on inside of same head *Gnaphalium*

Group C

Heads ligulate; flowers yellow or orange: tribe *Cichorieae* (part).

16. Plants scapose: stems leafless (rarely 1 leaf) or absent 17.
 – Plants with leafy stems 21.
17. Heads solitary 18.
 – Heads ≥ 2 per stem 20.
18. Outer series of involucral bracts much shorter than the inner *Taraxacum*
 – Outer series of involucral bracts nearly as long the inner 19.
19. Some pappus bristles tapered to a broad base (narrow scales) *Nothocalais*
 (*Nothocalais cuspidata*)

- All pappus bristles capillary, not broadened at the base *Agoseris*
(*Agoseris glauca*)
- 20 (17). Plants with a mostly vertical taproot *Crepis*
 - Plants with a short, fibrous-rooted, nearly horizontal rhizome *Hieracium*
- 21 (16). Pappus plumose. Leaves entire; involucre bracts in 1 equal series *Tragopogon*
 - Pappus of capillary bristles 22.
 - = Pappus absent *Lapsana*
(*Lapsana communis*)
- 22. Achenes flattened; many species with prickles on leaves or stems 23.
 - Achenes more or less cylindrical; plants without prickles 24.
 - = Achenes dimorphic: outer white, curved, inner reddish, straight; leaves bristly hispid *Picris*
(*Picris echioides*)
- 23. Involucre cylindrical, ca. 2 times as long as wide *Lactuca*
 - Involucre campanulate ca. as long as wide *Sonchus*
- 24 (22). Plants fibrous-rooted sometimes with a horizontal caudex or stolons *Hieracium*
 - Plants taprooted *Crepis*

Group D

Heads ligulate; flowers white, pink, blue or purple: tribe *Cichorieae* (part).

- 25. Pappus bristles plumose 26.
 - Pappus bristles smooth or with short barbs or absent 27.
- 26. Involucre 20–30 mm high; involucre bracts in 1 series *Tragopogon*
 - Involucre 7–14 mm high; involucre bracts in 2 series, the outer reduced *Stephanomeria*
- 27 (25). Flowers white 28.
 - Flowers pink to blue 29.
- 28. Plants glabrous *Prenanthes*
 - Plants sparsely hirsute toward the base *Hieracium*
- 29 (27). Achenes flattened *Lactuca*
 - Achenes nearly terete, not compressed 30.
- 30. Pappus of tiny scales; involucre bracts 10–15; stem leaves not reduced *Cichorium*
(*Cichorium intybus*)
 - Pappus of free capillary bristles; involucre bracts about 5; stem leaves reduced *Lygodesmia*
(*Lygodesmia juncea*)
 - = Pappus of basally connated bristles; involucre bracts 8; distalmost stem leaves reduced
..... *Shinnersoseris*
(*Shinnersoseris rostrata*)

Group E

Heads discoid; flowers yellow.

- 31. Most of leaves opposite 32.
 - Most of leaves alternate 34.

47. Receptacle naked *Onopordum*
(*Onopordum acanthium*)
- Receptacle bristly 48.
48. Pappus bristles plumose *Cirsium*
– Pappus bristles barbed but not plumose *Carduus*
49. Receptacle densely bristly; involucre bracts fringed or spiny *Centaurea*
– Receptacle naked or with fine scales or pubescent 50.
50. Flowers white or whitish, sometimes corollas inconspicuous 51.
– Flowers not white or whitish (green, green-yellow, pink, blue, purple) 58.
51. Pappus absent 52.
– Pappus of scales or bristles 54.
52. Leaves opposite at least below, plants not scapose 53.
– Leaves alternate, plants scapose *Adenocaulon*
(*Adenocaulon bicolor*)
53. Heads in spikes, 1–2 per bract *Iva*
– Heads in ebracteate panicles *Cyclachaena*
(*Cyclachaena xanthifolia*)
- 54 (51). Pappus of scales *Chaenactis*
(*Chaenactis douglasii*)
- Pappus of simple to plumose bristles 55.
55. Involucre glandular. Leaves broadly lanceolate to deltoid *Ageratina*
– Involucre glabrate to pubescent but not glandular 56.
56. Leaves linear (inconspicuous rays usually present) *Symphyotrichum*
(*Symphyotrichum ciliatum*)
- Leaves lanceolate to deltoid 57.
57. Leaves glandular-punctate beneath, venation pinnate *Brickellia*
(*Brickellia eupatorioides*)
- Leaves white-tomentose beneath, venation palmate *Petasites*
(*Petasites frigidus*)
- = Leaves glabrous beneath, venation pinnate *Erechites*
(*Erechites hieraciifolius*)
- The presence of this species in North Dakota is questionable.
- 58 (50). Pappus an inconspicuous crown or absent 59.
– Pappus of capillary to plumose bristles 61.
= Pappus always absent, male heads cup-shaped *Ambrosia*
59. Outer involucre bracts leaf-like, longer than inner *Bidens*
– Outer involucre bracts not leaf-like 60.
60. Receptacle 8–45 mm high, conical; flowers purple above *Rudbeckia*
– Receptacle much smaller; flowers greenish *Artemisia*
(Go to *Artemisia* section)
61. Leaves in whorls *Eutrochium*
– Leaves opposite *Eupatorium*
(*Eupatorium perfoliatum*)
- = Leaves alternate 62.

62. Receptacle with fine, flat scales among the flowers *Acroptilon*
(*Acroptilon repens*)
- Receptacle naked or pubescent 63.
63. Leaves glandular or punctate beneath 64.
- Leaves not glandular or punctate, tomentose beneath, basal leaves sagittate or deltoid; cordate-based
..... *Petasites*
(*Petasites frigidus*)
64. Flowers not purple, usually pale yellow *Brickellia*
(*Brickellia eupatorioides*)
- Flowers purple 65.
65. Leaves elongate linear to lanceolate, margins entire; pappus uniform *Liatris*
- Leaves lanceolate to elliptic, margins toothed; pappus double *Vernonia*

Group G

Heads radiate; rays white, blue, purple, or pink.

66. Receptacle densely bristly 67.
- Receptacle chaffy or naked, but not densely bristly 69.
67. Marginal flowers with a falsely radiate corolla; involucre bracts usually with fringed, erose, or spinose margins and tips 68.
- Marginal flowers truly radiate; involucre bracts lacking fringed, erose, or spinose margins and tips
..... *Gaillardia*
68. Achenes barrel-shaped, with entire ends *Centaurea*
- Achenes oblong, compressed, with denticulate ends *Amberboa*
(*Amberboa moschata*)
- 69 (66). Pappus of the disk flowers of capillary or barbellate bristles, sometimes also double with a series of short hairs or that of the ray flowers sometimes reduced to a crown 70.
- Pappus of scales, awns, a short crown, or absent 83.
70. Rays short and inconspicuous, barely surpassing the diskflowers; annuals or short-lived perennials ... 71.
- Rays well-developed and surpassing the disk flowers; annuals or perennials 73.
71. Involucre 4–12 mm high, the bracts mostly herbaceous with a small chartaceous base 72.
- Involucre 3–5 mm high, the bracts brown or green and scarcely herbaceous. Leaves entire or some of the lower ones irregularly few-toothed, tapering to a short petiole, subglabrous to spreading-hirsute
..... *Conyza*
72. Achenes several-nerved; both basal and stem leaves linear *Symphyotrichum*
(*Symphyotrichum ciliatum*)
- Achenes 2-nerved; basal leaves oblanceolate to spatulate *Erigeron*
(*Erigeron acris*, *E. lonchophyllus*)
- 73 (70). Involucre bracts lacking a hard, yellowish or whitish chartaceous base, green and herbaceous throughout; usually equal or subequal 74.
- Involucre bracts with a hard, yellowish or whitish chartaceous base, or in distinct (clearly in 2 or more) series 76.
74. Involucre bracts, peduncles, and upper stems and leaves densely covered in glandular hairs; stem leaves linear to oblong; found usually in moist places 75.

- Plants unlike the above; stems and leaves glandular; basal leaves persistent or withering by flowering; pappus usually of outer setae or scales and inner bristles, sometimes absent *Erigeron*
- 75. Stems villous; leaves cauline, blades 1-nerved (venation reticulate), lanceolate to elliptic; involucre bracts often purplish; cold wet soils *Canadanthus*
(*Canadanthus modestus*)
- Stems glabrous; leaves basal and cauline, blades 3-nerved, linear; involucre bracts green; damp alkaline areas *Almutaster*
(*Almutaster pauciflorus*)
- 76 (73). Leaves mostly toothed to pinnatifid or pinnately dissected; involucre bracts (at least the lower) often reflexed or spreading and glandular-hairy 77.
- Leaf margins entire or sometimes just a few of the lower shallowly toothed; involucre bracts usually ascending or sometimes spreading to reflexed, sometimes glandular-hairy 78.
- 77. Leaf teeth lacking spinulose tips on the margins; involucre bracts with ascending tips
..... *Symphyotrichum*
(Go to *Symphyotrichum* section)
- Leaf teeth with spinulose tips, leaves deeply pinnatifid to bipinnatifid; heads solitary, large (the disk 6–20 mm in diam. when pressed); involucre bracts often reflexed; ray flowers blue to purple; plants densely glandular-stipitate throughout *Machaeranthera*
(*Machaeranthera canescens*)
- 78 (76). Involucre bracts with distinct scarious, ciliate-fringed margins; plants usually low, rarely exceeding 2 dm tall, often acaulescent; pappus of disk flowers of barbellate bristles or short bristle-like scales, that of ray flowers similar but usually shorter or sometimes reduced to a crown *Townsendia*
- Involucre bracts with less conspicuous scarious margins, these not ciliate-fringed; plants low to tall, caulescent or acaulescent; pappus of numerous capillary bristles or sometimes also with short outer setae or scales 79.
- 79. Upper stems, leaves, and/or involucre bracts glandular-hairy (sometimes minutely so)
..... *Symphyotrichum*
(Go to *Symphyotrichum* section)
- Stems, leaves, and involucre bracts glabrous or variously hairy but not glandular 80.
- 80. Pappus of several minute bristles and 2–3 well developed awns; plants colonial, stems and leaves without glands; basal leaves withering by flowering *Boltonia*
(*Boltonia asteroides*)
- Pappus different from above 81.
- 81. Inflorescence more or less flat-topped; at least some pappus bristles clavate 82.
- Inflorescence various but not flat-topped; pappus bristles not thickened toward the apex
..... *Symphyotrichum*
(Go to *Symphyotrichum* section)
- 82. Basal leaves withering, reduced; rays 2–10, white *Doellingeria*
(*Doellingeria umbellata*)
- Basal leaves persistent; rays more than 10, white *Oligoneuron*
(*Oligoneuron album*)
- = Basal leaves completely absent; rays more than 10, blue or violet *Eurybia*
(*Eurybia conspicua*)
- The presence of this species in North Dakota is dubious.
- 83 (69). Leaves simple with entire margins 84.
- At least some leaves compound, pinnatifid, dissected, or simple with toothed or lobed margins 86.

94. Involucral bracts in one row and essentially equal, sometimes with some smaller, calyculate bracteoles at the base of the involucre 95.
 – Involucral bracts imbricate or subequal in 2 or more rows 96.
95. Plants from taprooted or rhizomatous caudices with branching fibrous lateral roots; stem leaves progressively reduced distally; heads erect; involucral bracts rarely black-tipped, and if so then middle stem leaves not clasping *Packera*
 – Plants from button-like or lateral rhizomes with unbranched and fleshy fibrous roots; stem leaves basically equally distributed along the stem or if reduced distally then heads nodding and/or involucral bracts with black tips *Senecio*
- 96 (94). Heads numerous (dozens) and relatively small (few mm in diameter) in paniculate or corymbiform inflorescences; involucral bracts with a greenish or brownish tip 97.
 – Heads few and larger (the involucral bracts over 10 mm high) in various inflorescences; involucral bracts green 99.
97. Leaves variously hairy or glabrous, but not resinous or glandular-punctate, variously shaped, sometimes linear or narrowly lanceolate throughout the stem 98.
 – Leaves resinous or glandular-punctate, linear or narrowly lanceolate throughout the stem. Perennial herbs from rhizomes; leaves glandular-punctate with small, dark spots; achenes hairy *Euthamia*
98. Inflorescence more or less flat-topped *Oligoneuron*
 (Go to *goldenrods* section)
 – Inflorescence not flat-topped *Solidago*
 (Go to *goldenrods* section)
- 99 (96). Involucral bracts sticky and gummy, firm, the tips reflexed *Grindelia*
 – Involucral bracts not sticky and gummy, the tips reflexed or erect 100.
100. Leaves and/or stems strigose-puberulent to tomentose, narrow (1–10 mm wide), pinnatifid or toothed with the teeth bristle-tipped *Machaeranthera*
 (*Machaeranthera pinnatifida*)
 – Leaves simple with entire margins or if toothed then without bristle-tips 101.
101. Stem leaves well-developed and not greatly reduced in size from the lower leaves 102.
 – Leaves chiefly basal, stem leaves distinctly and greatly reduced in size from the lower leaves 103.
102. Leaves silvery sericeous, very narrow, grass-like *Pityopsis*
 (*Pityopsis graminifolia*)
 – Leaves hairy but not silvery sericious, ovate or oblanceolate *Heterotheca*
 (Go to *Heterotheca* section)
103. Stems curved or decumbent at the base, usually with 5 or more reduced stem leaves; pappus usually tawny or brown *Pyrrocoma*
 (*Pyrrocoma lanceolata*)
 – Stems erect, leafless or with fewer than 5 stem leaves; pappus white *Stenotus*
 (*Stenotus armerioides*)

Group J

(DYC-2): heads radiate; rays yellow or orange; pappus of awns, scales, a short crown, or absent.

104. Involucral bracts sticky and gummy, firm, the tips reflexed; pappus of 2-several separate, firm, deciduous awns *Grindelia*
 – Involucral bracts not sticky, gummy, and firm, the tips not reflexed or sometimes reflexed-spreading in age; pappus various 105.

105. Involucral bracts and leaves with conspicuous yellow-brownish oil glands; annuals. Ray flowers inconspicuous (1.5–2.5 mm long); plants usually ill-scented *Dyssodia*
(*Dyssodia papposa*)
– Involucral bracts and leaves without conspicuous yellow-brownish oil glands, although sometimes finely glandular-punctate; annuals or perennials, aromatic or not 106.
106. Leaves alternate, deeply pinnatifid to lacinate, the lowermost leaves up to 4 dm long; heads several in an elongated raceme; involucral bracts all more or less the same and herbaceous; plants 4–30 dm tall *Silphium*
– Plants unlike the above in all respects, variously distributed 107.
107. Involucral bracts in two distinct, dissimilar series (typically with an outer series of linear, foliaceous bracts and an inner series of oval, often membranous, striate bracts); achenes of disk flowers flattened parallel to the involucral bracts (at right angles to the radius of the head); leaves toothed to dissected or lacinate, not 3-nerved 108.
– Involucral bracts subequal or imbricate in two or more series and not conspicuously dimorphic, or if appearing dimorphic then the leaves 3-nerved (look on the abaxial side at the base) and entire to slightly toothed on the margins; achenes of disk flowers either not much flattened or flattened at right angles to the involucral bracts (parallel to the radius of the head) 110.
108. Inner involucral bracts basally connate for about 1/3 of their length *Thelesperma*
(*Thelesperma subnudum*)
– Inner involucral bracts distinct 109.
109. Pappus of 2–4 retrorsely barbed awns *Bidens*
– Pappus of short teeth or absent *Coreopsis*
(*Coreopsis tinctoria*)
In gardens, one may also find *Dahlia pinnata* from that group of genera (Coreoideae).
- 110 (107). Ray flowers small (surpassing the disk flowers but only 1–3 mm long) or inconspicuous (shorter than or barely surpassing the disk flowers) 111.
– Ray flowers longer than 3 mm, conspicuous and surpassing the disk flowers 112.
111. Leaves pinnately dissected; receptacle chaffy; heads arranged in a flat-topped or dome-shaped corymbiform cyme *Achillea*
– Leaves narrowly lanceolate with entire margins, 1-nerved, opposite below and alternate above; involucral bracts mostly 4, clasping the achenes such that the heads appear deeply furrowed; ray flowers 1–3 per head *Madia*
(*Madia glomerata*)
- 112 (110). Receptacle alveolate with numerous long, stiff bristles that do not individually subtend the flowers; pappus of scales, usually each with a long, prominent awn *Gaillardia*
– Receptacle naked, with a few scattered bristles, or chaffy; pappus various 113.
113. Receptacle naked, with a few scattered bristles, or with a single series of chaff between the ray and disk flowers near the edge of the head 114.
– Receptacle chaffy, at least in the center 118.
114. Leaves opposite, dissected into linear segments which are entire or dissected again or toothed, canescent, puberulent *Picradeniopsis*
(*Picradeniopsis oppositifolia*)
– Leaves alternate or mostly basal, and unlike the above 115.
115. Involucral bracts and ray flowers reflexed at maturity; stem leaves well-developed *Helenium*
(*Helenium autumnale*)
– Involucral bracts erect at maturity and ray flowers erect to spreading at maturity; leaves all basal or the stem leaves well-developed 116.

116. Achenes polymorphic: some beaked, some winged, some arcuate, some coiled *Calendula*
(*Calendula officinalis*)
– Achenes monomorphic 117.
117. Leaves simple, all basal or basal and cauline in one species, linear to narrowly oblanceolate or spatulate;
plants usually with a dense tuft of brownish or white hairs at the base of the leaves *Tetranneuris*
– Leaves pinnatifid or divided into 2–5 linear lobes or 3–7 segments, or if simple then oblanceolate and
10–30 cm long, basal and cauline; plants sometimes densely hairy in old leaf bases *Hymenoxys*
(*Hymenoxys richardsonii*)
- 118 (113). Plants scapose or subscapose—with the leaves essentially all basal. Leaves pinnatifid or simple but
triangular-hastate; ray flowers pistillate and fertile *Balsamorhiza*
(*Balsamorhiza sagittata*)
The presence of arrowleaf balsamroot in North Dakota is dubious.
– Plants leafy-stemmed, although the basal ones may be larger than the stem leaves 119.
119. Leaves pinnately dissected or trilobed 120.
– Leaves simple and not dissected, although the margins may be toothed 122.
120. Leaves fern-like and pinnatifid into narrow segments (mostly 1–3 mm wide), these segments again deeply
toothed or cleft; receptacle hemispheric; introduced plants *Anthemis*
– Leaves pinnatifid 121.
121. Leaves pinnatifid into linear, narrow segments; receptacle columnar (cone flower), 1.5–4.5 cm long and
2–4.5 times as long as wide; both the disk and ray flowers subtended by chaffy bracts *Ratibida*
– Leaves pinnatifid into lanceolate or elliptic, wider segments, or trilobed; receptacle hemispheric, up to 4
cm long in fruit but usually less than 2–4.5 times as long as wide (not columnar); only the disk flowers
subtended by chaffy bracts *Rudbeckia*
- 122 (119). Leaves softly strigose-canescens and whitish below, deltoid-ovate, the margins toothed or subentire;
achenes conspicuously wing-margined *Verbesina*
(*Verbesina encelioides*)
– Leaves not strigose-canescens and whitish below, variously shaped; achenes not wing-margined or only
thinly or slightly wing-margined 123.
123. Receptacle conic and elongating at maturity to about 2 cm long and 2.5 cm wide; ray flowers persistent
on the achenes; leaves opposite *Heliopsis*
(*Heliopsis helianthoides*)
– Receptacle flat, convex, or hemispheric, less than 2 cm long; ray flowers not persistent on the achenes;
leaves alternate or opposite below and alternate above 124.
124. Pappus of 2 awns or scales, occasionally with additional smaller scales between the awns, or a crown of
scales often prolonged into awns 126.
– Pappus absent 125.
125. Plants glaucous, leaves clasping *Dracopis*
(*Dracopis amplexicaulis*)
– Plants hispid and rough with spreading, stiff hairs; leaves not clasping *Rudbeckia*
(*Rudbeckia hirta*)
- 126 (124). Achenes thin-edged or slightly wing-margined; pappus of 2 persistent slender awns or scales ...
..... *Helianthella*
(*Helianthella quinquenervis*)
– Achenes not wing-margined or thin-edged; pappus of 2 early-deciduous awns with smaller scales between
them *Helianthus*
(Go to *Helianthus* section)

Solidago L. and Oligoneuron Small. (Goldenrods)

1. Plants long rhizomatous; basal leaves lacking; inflorescences not flat-topped 2.
 – Plants with a branched caudex or short (less than 10 cm) rhizome; basal leaves present or withered; inflorescences flat-topped or not flat-topped 6.
2. Leaves densely puberulent *Solidago mollis*
 – Leaves glabrate or sparsely strigose to minutely ciliate but not densely hairy 3.
3. Stem pubescent below the inflorescence 4.
 – Stem glabrous below the inflorescence 5.
4. Leaf blades narrowly lanceolate, largest usually on lower stem *Solidago canadensis*
 – Leaf blades oblanceolate, largest at mid-stem *Solidago velutina*
 Absent in North Dakota but might be found since occurs in neighboring states.
- 5 (3). Branches of inflorescence strongly puberulent, arched; rays ca. 13; plants > 40 cm tall
 *Solidago gigantea*
 – Inflorescence glabrate; branches often not arched; basal leaves sometimes present; rays ca. 8; plants often < 40 cm tall *Solidago missouriensis*
- 6 (1). Leaf blades glabrous or almost glabrous, green 7.
 – Leaf blades puberulent, green whitish grayish tint 14.
7. Stems flexuose (hence name “zig-zag goldenrod”), inflorescence leafy, grows in woods
 *Solidago flexicaulis*
 – Plants with combination of characters different from the above 8.
8. Basal leaf petioles long-ciliate *Solidago multiradiata*
 – Petioles not ciliate or minutely ciliate 9.
9. Rays white *Oligoneuron album*
 – Rays yellow 10.
10. Basal leaves spatulate to oblong, often rounded at the tip 11.
 – Basal leaves oblanceolate to linear-oblanceolate 12.
11. Inflorescence narrow, usually less than 3 cm in diameter *Solidago simplex*
 – Inflorescence wider, usually more than 3 cm in diameter *Solidago speciosa*
- 12 (10). Inflorescence more or less flat-topped *Oligoneuron riddellii*
 – Inflorescence not flat-topped 13.
13. Fascicles of small lateral branch leaves often present in axils; leaves not scented when crushed
 *Solidago missouriensis*
 – Fascicles of small lateral branch leaves are not usually present in axils; leaves usually anise-scented when crushed *Solidago odora*
 It is possible that this species is absent in the North Dakota.
- 14 (6). Involucre 5–8 mm high; involucre bracts striate *Oligoneuron rigidum*
 – Involucre 4–6 mm high; involucre bracts with a midvein but not striate 15.
15. Heads with as many or more rays than disk flowers *Solidago nemoralis*
 – Heads with more disk flowers than rays *Solidago nana*
 Absent in North Dakota but might be found since occurs in neighboring states.

***Artemisia* L. (Sagebrush, Sage, Wormwood)**

1. Well-developed shrubs; stems woody well above ground level 2.
 – Plants herbaceous or subshrubs (woody only at the base) 4.
2. Leaves deeply divided into filiform segments > 5 mm long. Leaves green, glabrous to sparsely villous *Artemisia abrotanum*
 European *Artemisia arctica* (herbaceous, with wider leaf segments) mentioned for North Dakota but its presence in the state is dubious.
 – Leaves entire to shallowly lobed into oblong to oblanceolate lobes, mostly <5 mm long 3.
3. Some or all of the leaves entire *Artemisia cana*
 – Leaves lobed. Plants > 40 cm high *Artemisia tridentata*
- 4 (1). Foliage green, glabrous to sparsely villous 5.
 – Leaves grayish canescent to tomentose at least on the lower surface 8.
5. Most or all leaves entire *Artemisia dracunculus*
 – Leaves lobed or divided 6.
6. Involucre 1–2 mm long; plants annual; leaves divided into filiform segments *Artemisia annua*
 Absent in North Dakota but might be found since occurs in neighboring states.
 – Annuals to biennials; involucre ≥2 mm long; leaf segments linear to lanceolate 7.
7. Ultimate leaf segments dentate, sharply acute *Artemisia biennis*
 – Ultimate leaf segments entire, rounded at the tip *Artemisia campestris*
Artemisia filifolia (shrub, stems wand-like) mentioned for North Dakota but its presence in the state is dubious.
- 8 (4). Leaves bicolor (white on the lower surface), serrate *Artemisia serrata*
 – Leaves more or less the same color on both sides, not serrate 9.
9. Heads with hairs on receptacle amongst the flowers 10.
 – Receptacle without hairs 12.
10. Ultimate leaf segments ≥2 mm wide *Artemisia absinthium*
 – Ultimate leaf segments ca. 1 mm wide 11.
11. Subshrub; involucre 2–3 mm high; inflorescence paniculate *Artemisia frigida*
 – Herbaceous; involucre 3–4 mm high; inflorescence spiciform to racemose *Artemisia scopulorum*
- 12 (9). Leaves sparsely or densely hairy but not tomentose *Artemisia campestris*
 – Leave tomentose at least below 13.
13. Plants sub-shrubs, not rhizomatous; leaves whiter beneath than above *Artemisia longifolia*
 – Rhizomatous; leaves about equally gray above and beneath *Artemisia ludoviciana*

***Symphyotrichum* Nees (American Aster)**

1. Annuals (ray or pistillate florets in 1–5 series). Leaf and phyllary margins ciliate; plants 7–70 or more cm; leaf apices acute to short-acuminate; achenes hirsute-strigose; moist, saline areas in prairies and steppes, irrigation ditches *Symphyotrichum ciliatum*
 – Perennials (ray florets usually in 1 series) 2.
2. Ray corollas usually white, sometimes purplish or pinkish-tinged 3.
 – Ray corollas violet, purple, blue, lavender, or pink (sometimes pale; white-rayed individuals occur in most species) 8.
3. Stems sparsely to densely hairy, sometimes glabrescent proximally 4.

- Stems glabrate to sparsely puberulent hairy in lines (at least distally) 6.
- 4. Involucral bract apices spine-tipped (spines white or clear) 5.
 - Involucral bract apices (flat or involute or folded and green) not spine-tipped. Stems erect; disc florets yellow, lobes sometimes more or less spreading, triangular, 0.4–1.2 mm (lengths to $\frac{1}{2}$ corollas)
..... *Symphyotrichum lanceolatum* (in part)
- 5. Involucres 2.5–4.5(–5) mm; ray florets (8–)10–18(–20), laminae 6–12(–20) mm; disc corollas 2.5–4 mm, lobes 0.5–0.6; achenes 1.2–2 mm; pappi 3–4 mm *Symphyotrichum ericoides*
 - Involucres (4.5–)5–8 mm; ray florets (15–)20–35, laminae (8–)18–30 mm; disc corollas 2–2.5 mm, lobes 0.7–1.2; achenes 2–2.5 mm; pappi 4.5–6 mm *Symphyotrichum falcatum* (in part)
- 6 (3). Basal and proximal leaf blades 15–50 mm wide, bases usually shallowly, sometimes deeply cordate to truncate or rounded (proximal sometimes attenuate), distal leaves more or less shortly winged-petiolate or sessile; array branches stiffly ascending to erect *Symphyotrichum urophyllum*
 - Basal and proximal leaf blades 2–20(–25) mm wide, bases attenuate or cuneate, not cordate or truncate, distal leaves sessile; array branches ascending to more or less divaricate. Involucral bract apices not involute or folded (sometimes spreading, outer involucral bracts sometimes foliaceous), obtuse to acute or acuminate 7.
- 7. Cauline leaf blades lanceolate, linear, linear-lanceolate, or oblanceolate, bases more or less clasping and/or more or less auriculate, margins usually more or less revolute (usually entire, sometime sparsely serrulate); heads 1–30 or more in lax arrays. Distal leaves (40–)50–150 × 2–6 mm; boreal fens
..... *Symphyotrichum boreale* (in part)
 - Cauline leaf blades ovate or elliptic to oblanceolate, lanceolate, or linear, bases attenuate or cuneate (if auriculate or clasping, blades not linear), margins usually flat, sometimes more or less revolute (then more or less serrate); heads (1–)10–100(–800 or more) in more or less dense arrays. Disc corolla lobes usually erect (lengths to $\frac{1}{2}$ corollas); stems erect. Leaf margins flat, sparsely serrate or entire; proximal leaves sessile or subsessile (more or less decurrent), only slightly reduced distally; array branches ascending, peduncle bracts 1–3(–5), linear-oblanceolate to linear-lanceolate, foliaceous (not grading into involucral bracts) *Symphyotrichum lanceolatum* (in part)
- 8 (2). Stems moderately to densely hairy 9.
 - Stems glabrous (usually distally hairy in lines, at least in arrays) or sparsely hairy 19.
- 9. Involucral bracts more or less stipitate-glandular (at least apically) 10.
 - Involucral bracts eglandular 13.
- 10. Proximal and distal leaf bases auriculate- or cordate-clasping, distal sometimes cuneate 11.
 - Proximal leaf bases rounded, cuneate, or more or less clasping, not auriculate, distal cuneate to more or less clasping 12.
- 11. Involucral bracts subequal, outer foliaceous, margins stipitate-glandular, faces glabrous, densely glandular; ray florets (40–)50–75(–100); disc florets 50–100 *Symphyotrichum novae-angliae*
 - Involucral bracts unequal, not foliaceous (green zones diamond-shaped or lance-spatulate in distal $\frac{1}{2}$), margins ciliate, sometimes also stipitate-glandular apically, faces more or less strigillose or cinereous-puberulent, more or less glandular; ray florets 9–24 or more; disc florets 15–50. Leaves thick, firm; involucral bracts strongly unequal, appressed to squarrose; disc corollas yellow to white, turning purplish, lobes 0.5–1 mm *Symphyotrichum patens* (in part)
- 12 (10). Stems, leaves, and peduncles eglandular, outer involucral bracts eglandular, inner distally stipitate-glandular; heads (5–)30–150 or more; achenes densely sericeous
..... *Symphyotrichum ×amethystinum* (in part)
 - Stems, leaves (usually at least distal), peduncles, and involucral bracts more or less stipitate-glandular; heads 1–30(–70); achenes usually sparsely to moderately strigose or strigillose, sometimes sparsely sericeous. Plants 10–80(–100) cm; leaves thin, apices obtuse; outer involucral bracts often broadly foliaceous, abaxial faces moderately hairy *Symphyotrichum oblongifolium*

- 13 (9). Basal and proximal leaves petiolate or winged-petiolate, blades ovate to lanceolate, bases usually more or less cordate or rounded, sometimes truncate or attenuate. Cauline leaves winged-petiolate, wings wider distally and leaves more or less sessile, the wings abruptly widening at the strongly auriculate-clasping petiolar bases *Symphyotrichum undulatum*
- Basal leaves petiolate or sessile, blades spatulate or oblanceolate to elliptic-lanceolate, bases (not cordate) cuneate or attenuate, proximal petiolate or sessile, blades ovate or obovate to oblong, lanceolate, or oblanceolate, bases cuneate or attenuate, sometimes auriculate- or cordate-clasping (and sessile) or subclasping. 14.
14. Leaf margins usually more or less serrate or crenate-serrate, sometimes entire. Plants caespitose (stems 1–5 or more), (7–)100–250 or more cm, with short, thick rhizomes or stout caudices; cauline leaves widely winged-petiolate or sessile (distal), bases more or less strongly auriculate-clasping; involucre bracts subequal, green zones linear-lanceolate to linear, outer sometimes more or less foliaceous; ray florets 20–50(–60), laminae (7–)12–18(–21) × (0.9–) 1.4–1.8 mm *Symphyotrichum puniceum* (in part)
- Leaf margins entire or more or less serrulate 15.
15. Proximal cauline leaf bases broadened proximal to constriction; distal leaf blades narrowly to broadly ovate, bases strongly cordate-clasping to auriculate-amplexicaul, apices usually acute, sometimes obtuse, mucronate to white-spinulose; involucre 5.5–12 mm; achenes sericeous or strigillose *Symphyotrichum patens*
- Proximal cauline leaf bases tapering, rounded or subclasping (not auriculate), distal cuneate 16.
16. Distal leaf apices not mucronate or spinulose; ray corollas violet. Plants colonial, 20–60 cm, long-rhizomatous; cauline leaves oblong to narrowly obovate, distal 30–70 × 4–10 mm, glabrous or strigose; ar-rays paniculiform *Symphyotrichum ascendens*
- Distal leaf apices white-spinulose or mucronate; ray corollas blue, pink, lavender, rose-purple, or violet 17.
17. Leaf faces more or less strigose; disc corollas yellow becoming brown 18.
- Leaf margins piloso-silky, faces glabrous proximally, densely silky distally, proximal apices mucronulate; distal leaf blades lanceolate, apices mucronate; peduncles densely sericeous-strigose; involucre bracts usually unequal, sometimes subequal, outer with expanded, more or less foliaceous distal $\frac{1}{2}$ – $\frac{2}{3}$, densely long-silky *Symphyotrichum sericeum*
18. Plants colonial or caespitose, 10–80 cm, rhizomatous or with woody, cormoid caudices; disc corollas 2–2.5 mm, lobes 0.7–1.2 mm; achenes 2–2.5 mm, densely strigose, pappi whitish *Symphyotrichum falcatum* (in part)
- Plants caespitose, 30–120 cm, caudices thick, woody; disc corollas 3–4 mm, lobes 0.5–0.7 mm; achenes 1.5–2 mm, densely sericeous, pappi tan to tawny, sometimes rose- or violet-tinged *Symphyotrichum ×amethystinum* (in part)
- 19 (8). Basal and proximal cauline leaves petiolate, blades more or less ovate, bases more or less deeply cordate or rounded, proximal sometimes truncate, cuneate, or attenuate 20.
- Basal and proximal cauline leaves petiolate or sessile, blades ovate to lanceolate or linear, bases usually cuneate or attenuate, sometimes rounded (if cordate-clasping, then usually sessile) 22.
20. Basal leaf bases shallowly cordate or rounded to attenuate, proximal cauline bases rounded to attenuate. Plants caespitose (glaucous); proximal and distal leaf margins entire (at most crenulate), distal bases auriculate and more or less clasping to rounded, margins flat; involucre bracts appressed (green zones diamond-shaped to lanceolate) *Symphyotrichum laeve* (in part)
- Basal leaf bases usually more or less deeply cordate, sometimes rounded or abruptly attenuate, proximal cauline bases more or less cordate, rounded, or truncate, sometimes cuneate 21.

21. Basal and proximal leaf bases usually more or less deeply cordate, sometimes rounded, distal blades ovate to lanceolate, bases cordate, rounded, attenuate, or cuneate, adaxial faces usually glabrous or sparsely to densely strigose, sometimes more or less scabrous, abaxial glabrous or more or less strigoso-pilose, often more or less pilose on veins; heads (5–)20–300 or more in densely paniculiform arrays, branches divaricate to ascending; involucre cylindro-campanulate to cylindric, (3–)4.5–5(–6) mm; phyllary green zones apical, lanceolate to diamond-shaped (often red-tipped); ray laminae (5–)6–8(–10) × 1.4–1.8 mm *Symphyotrichum cordifolium*
- Basal leaf bases shallowly cordate to rounded, proximal subcordate or cuneate; distal blades lance-ovate to linear, bases cuneate; adaxial leaf faces glabrous, glabrate, or scabrellous, abaxial glabrate to sparsely hirsute, midveins usually densely hirsute, sometimes glabrous; heads (6–)13–50(–100 or more) in open, paniculiform arrays, branches ascending; involucre campanulate, (4–)5–6.5 mm; phyllary green zones lanceolate to linear along midnerves; ray laminae (8.3–)10–15 × 1–2.3 mm; boreal forests *Symphyotrichum ciliolatum*
- 22 (19). Proximal cauline leaves petiolate to subpetiolate, petioles more or less narrowly winged, blades more or less ovate to lanceolate, bases rounded to attenuate (sometimes auriculate-clasping distally, then sessile). Plants cespitose (glaucous); proximal and distal leaf margins usually entire, sometimes crenulate, distal bases auriculate and more or less clasping to rounded, margins flat; involucre bracts appressed (green zones diamond-shaped to lanceolate) *Symphyotrichum laeve* (in part)
- Proximal cauline leaves sessile or subpetiolate, petioles widely winged, blades ovate, elliptic, oblanceolate, or lanceolate to linear, bases attenuate to cuneate, often auriculate-clasping 23.
23. Proximal and distal cauline leaves ovate, obovate, elliptic, oblanceolate, or lanceolate, distal sometimes lanceolate-linear or linear 24.
- Proximal and distal cauline leaves narrowly lanceolate or oblanceolate or elliptic, to linear or subulate 28.
24. Cauline leaf bases usually not or little clasping, sometimes slightly rounded or auriculate 25.
- Cauline leaf bases (at least some) usually cuneate, sometimes attenuate, usually more or less clasping, often more or less auriculate or rounded, margins serrate (proximal), crenate-serrate, or entire 26.
25. Leaves thin, margins flat; peduncle bracts 5–12 or more; involucre bracts linear-lanceolate (outer), subequal to unequal, outer often foliaceous *Symphyotrichum lanceolatum* (in part)
- Leaves firm, margins often recurved; peduncle bracts 1–3(–5); involucre bracts oblong-lanceolate (outer), more or less unequal, outer sometimes foliaceous. Cauline leaves progressively reduced distally, adaxial faces waxy, abaxial with well-marked, isodiametric areoles (axillary clusters often present); peduncle bracts foliaceous, distal closely subtending heads, not grading into involucre bracts; disc corollas cream to pale yellow turning pinkish; achenes 1.5–2 mm *Symphyotrichum praealtum* (in part)
- 26 (24). Stems usually flexuous; petiole and leaf bases strongly dilated (blades sometimes panduriform); leaf margins serrate; arrays corymbo-paniculiform *Symphyotrichum prenanthoides*
- Stems straight; petiole and leaf bases not dilated; leaf margins usually serrate or crenate-serrate, sometimes entire; arrays paniculiform 27.
27. Leaf faces scabrous or glabrate, sometimes abaxially pilose on midveins. Leaf margins serrate or entire, flat; array branches more or less divaricate to ascending, remotely small-leaved; ray corollas usually blue-violet or purple, rarely pink; stream shores *Symphyotrichum novi-belgii* (in part)
- Leaf faces glabrous or puberulen, sometimes abaxially villosulous on midveins. Plants cespitose, with short, thick rhizomes or caudices; leaf faces adaxially glabrate to scabrous, abaxially pilose on midveins; phyllary apices long-acuminate to caudate *Symphyotrichum puniceum* (in part)
- 28 (23). Involucre cylindro-campanulate or turbinate. Distal leaves (40–)50–150 × 2–6 mm; boreal fens *Symphyotrichum boreale* (in part)
- Involucre campanulate 29.

29. Cauline leaf bases cuneate, usually more or less clasping, often more or less auriculate or rounded, margins often serrate (proximal) or crenate-serrate, distal sometimes entire *Symphotrichum novi-belgii* (in part)
 – Cauline leaf bases usually not or little clasping, sometimes slightly rounded or auriculate, margins serrulate or entire 30.
- 30 (29). Adaxial leaf faces more or less waxy, abaxial with marked, isodiametric areoles; disc corollas cream to pale yellow *Symphotrichum praealtum* (in part)
 – Adaxial leaf faces not waxy, abaxial with indistinct, irregular areoles; disc corollas yellow. Arrays paniculiform (leafy), branches ascending; peduncle bracts 1–3(–5); involucre bracts usually more or less subequal, sometimes unequal, bases $\frac{1}{4}$ – $\frac{1}{2}$ indurate (outer often foliaceous); ray laminae 3–10(–14) × 0.5–1.3 mm; disc corollas 2.8–5.8 mm widespread *Symphotrichum lanceolatum* (in part)

***Helianthus* L. (Sunflower)**

1. Annuals or perennials (taprooted); leaves mostly alternate, petiolate (petiole lengths at least $\frac{1}{5}$ blades); paleae (at least central ones) either bearded (with apical tufts of whitish hairs) or prominently 3-toothed (middle teeth relatively narrow, lengths 4 or more times width); disc corolla lobes and style branches usually reddish (rarely yellow in *H. annuus* and *H. debilis*) 2.
 – Perennials (rhizomatous or with crown buds); leaves opposite or alternate, petiolate or sessile; paleae (at least central) glabrous or more or less hispid to puberulent (not bearded) and entire or relatively weakly 3-toothed (if 3-toothed, lengths of middle teeth usually less than 4 times widths); disc corolla lobes yellow or reddish (if reddish, style branches yellow) 3.
2. Plants 100–300 cm; leaf blades (at least larger) 10–40 cm wide, abaxial faces gland-dotted; involucre bracts ovate to lance-ovate (larger usually 5–8 mm wide), apices narrowed abruptly (acute to acuminate). Stems (leaves, involucre bracts) hispid; leaf margins usually serrate *Helianthus annuus* (in part)
 – Plants mostly 25–200 cm; leaf blades (larger) usually less than 12 cm wide (bases cuneate, truncate, or cordate), abaxial faces sometimes gland-dotted; involucre bracts usually lanceolate to lance-ovate (usually less than 4 mm, sometimes to 5 mm, wide), apices narrowed gradually. Stems (leaves, involucre bracts) densely canescent *Helianthus petiolaris*
- 3 (1). Leaves (at flowering) mostly or all basal (cauline leaves abruptly smaller, opposite). Leaf blades lance-linear, lance-ovate, oblong-lanceolate, or rhombic-ovate, bases cuneate (onto winged petioles); achenes 5–6 mm *Helianthus pauciflorus* (in part)
 – Leaves (at flowering) mostly cauline (not abruptly smaller distally) 4.
4. Disc corolla lobes reddish (at least at tips) 5.
 – Disc corolla lobes yellow 6.
5. Involucre bracts ovate, apices acute, abaxial faces glabrate to hispid *Helianthus pauciflorus* (in part)
 – Involucre bracts oblong-lanceolate, apices acuminate, abaxial faces usually hairy *Helianthus ×laetiflorus* (in part)
- 6 (4). Involucre bracts ovate to lanceolate, (3–)5–8 mm wide, apices abruptly attenuate (disc corolla throats notably bulbous at bases) *Helianthus annuus* (in part)
 – Involucre bracts linear to lanceolate or lance-ovate, usually 2–4 mm wide, apices gradually narrowed (disc corolla throats not notably bulbous at bases) 7.
7. Stems glabrous or glabrate (at least proximal to arrays of heads, sometimes glaucous) 8.
 – Stems hairy (more or less throughout, not glaucous) 12.
8. Involucres 5–7 or 8–9 mm diam; rays usually 5 or 8. Leaves: abaxial faces (greenish) usually tomentulose, sometimes glabrate, densely gland-dotted *Helianthus microcephalus*
 – Involucres (8–)9–28 mm diam.; rays (8–)10–21 (at least in larger heads) 9.

9. Anther appendages yellow 10.
 – Anther appendages dark or reddish brown 11.
If unsure, follow both ways!
10. Leaves: petioles (1–)2–5 cm, blades 10–32 × (1.2–)4–9 cm, margins coarsely serrate *Helianthus grosseserratus*
 – Leaves: petioles 0.5–1.5 cm, blades 4–20 × 0.8–4 cm, margins entire or shallowly serrate *Helianthus nuttallii* (in part)
- 11 (9). Leaves: petioles 1–3 cm, blades moderately serrate or entire, abaxial faces usually densely gland-dotted; involucre bracts (equaling or slightly surpassing discs): apices acute *Helianthus strumosus*
 – Leaves: petioles 2–5 cm, blades (at least larger leaves) moderately to notably serrate, abaxial faces usually sparsely gland-dotted; involucre bracts (at least longer, usually surpassing discs, by > ½ their lengths): apices acuminate *Helianthus decapetalus*
- 12 (7). Leaf blades usually 1-nerved, conduplicate, entire or slightly serrate; heads (1–)3–15, borne singly or in racemiform or spiciform arrays *Helianthus maximiliani*
 – Leaf blades 3-nerved, not conduplicate, entire or prominently serrate; heads (1–)3–16, borne singly or in more or less corymbiform, not racemiform or spiciform arrays 13.
13. Involucre bracts usually appressed, strongly unequal. Petioles 1–5 cm (lengths usually less than ½ blades); leaf blades lanceolate to lance-ovate; anther appendages dark brown or black; achenes (seldom formed) 4–5 mm *Helianthus ×laetiflorus* (in part)
 – Involucre bracts usually loose or spreading, more or less subequal 14.
14. Leaves petiolate, petioles 2–8 cm; blades lanceolate to ovate, 7–15 cm wide; achenes 5–7 mm (plants producing tubers, late in growing season) *Helianthus tuberosus*
 – Leaves sessile or petiolate, petioles 0–2 cm; blades elliptic, lance-linear, lanceolate, lance-ovate, linear, or ovate, 0.15–4(–8) cm wide; achenes 2–5 cm (plants sometimes producing tubers) 15.
15. Stems (usually reddish) erect; leaves subsessile or petiolate (petioles 0–1.2 cm, ciliate), abaxial faces scabrous or more or less hirsute; anther appendages dark brown or black *Helianthus giganteus*
 – Stems (usually yellow-brown or greenish) erect; leaves petiolate (petioles 0.5–1.5 cm, not ciliate), abaxial faces hispid to villous or tomentose; anther appendages yellow *Helianthus nuttallii* (in part)

***Heterotheca Cassini*, false goldenaster**

1. Distal leaves strongly ascending to spreading, blades narrowly to linearly oblanceolate (rarely broader), distal margins usually long-ciliate; proximal stems often brittle, brown to dark brown; axillary fascicles of leaves often present 2.
 – Distal leaves usually spreading, sometimes perpendicular, blades usually oblong, oblanceolate, or lanceolate, rarely obovate or ovate, not linear-oblanceolate, distal margins not long-ciliate; proximal stems not very brittle when fresh, green, white, or reddish to brown; axillary fascicles rare or absent 3.
2. Distal stems strigoso-canescens, usually with few, long-hispid hairs; distal leaves ascending, congested, distal margins not long-hispid-strigose, margins faces very densely strigoso-canescens (90–200 hairs/mm²; silvery whitish), eglandular; long, linear-oblanceolate bracts often subtending heads *Heterotheca canescens*
 – Distal stems sparsely to densely long-hispid; distal leaves usually ascending and surpassing heads, distal margins often long-hispid-strigose, faces either sparsely to moderately strigose (2–65 hairs/mm²; bright green to grayish green) and moderately stipitate-glandular or moderately strigose and eglandular *Heterotheca stenophylla*
3. Cauline leaf margins sparsely serrate *Heterotheca camporum*

- Mid and distal cauline leaf margins entire, proximal sometimes with 1–2 distal teeth. Plants (5–)16–40(–70) cm; distal leaves usually lanceolate or oblanceolate to oblong, rarely ovate (if lanceolate-triangular then not revolute), faces sparsely to densely hispid-strigose, sparsely to densely stipitate-glandular; inner pappus bristles equaling or longer than corollas *Heterotheca villosa*

Chapter 4

Manual to the genera of Gramineae

Keys are compiled from multiple sources, mainly from the “Flora of North America”, from Ackerfield’s (2015) “Flora of Colorado” and Lesica’s (2012) “Manual of Montana Vascular Plants”.

Group Key

1. “Non-typical” grasses: either spikelets with burs, or inflorescence is a spadix or dense cylinder, or spikelets in capitate clusters, or glumes absent, or bulbs replace flowers, or base of the plant bulbous, or spikelets stalked into caterpillar-like short branches, or plants form “tumbleweeds” 2.
If not sure, **skip** non-typical part and go to where you are directed below, all “skipped” grasses are covered two times in the key.
 - “Typical” grasses: no similarity with any statement from the above 15.
Diectomis fastigiata likely absent in North Dakota and therefore omitted in this key.
2. Spikelets enclosed in burs 3.
 - Spikelets not enclosed in burs 4.
3. Burs spiny; plants not strongly stoloniferous, monoecious *Cenchrus*
(*Cenchrus longispinus*)
 - Burs not spiny; plants strongly stoloniferous, dioecious *Buchloë*
- 4 (2). Inflorescence unisexual, the female spike with numerous spikelets in 8–24 rows (ears), with each spike surrounded by several leaf sheaths and husks, the male spikelets in panicles (tassels); blades flat, 2–12 cm wide, 3–9 dm long; corn *Zea*
(*Zea mays*)
 - Inflorescence unlike the above; not cultivated corn 5.
5. Spikelets in capitate clusters and subsessile in fascicles of leaves at each branch tip; plants stoloniferous. Lemmas acuminate at the tip, with a tuft of hairs along the margins near the middle, otherwise glabrous, the spikelets not white-woolly *Munroa*
(*Munroa squarrosa*)
 - Spikelets not in capitate clusters; plants stoloniferous or not 6.
6. Glumes absent, vestigial, or forming a small cup; riparian or emergent aquatic grasses 7.
 - Glumes (at least one) present; plants otherwise various 8.
7. Monoecious annuals; pistillate spikelets positioned above the staminate spikelets; lemmas of pistillate spikelets awned; staminate spikelets with 6 stamens; ligules mostly > 5 mm long *Zizania*
 - Perennials with bisexual florets; lemmas unawned; stamens 3; ligules < 1 mm long *Leersia*
- 8 (6). Florets mostly forming bulblets with shiny, dark purple bases and exerted, linear green tips *Poa*
(*Poa bulbosa*)
 - Florets not forming bulblets 9.
9. Plants with bulbous bases (resembling a small onion). Lemmas awnless; spikelets with 2 to several florets. Lower glumes 1–9-veined, 2–16 mm long; distal florets in the spikelets often forming a morphologically distinct rudiment *Melica*
Does not occur but might be found in North Dakota.

- Plants lacking bulbous bases and not similar to the above in other respects 10.
- 10. Glumes equal, strongly ciliate along the margin, much longer than the lemmas, with horn-like awns; spikelets 1-flowered, flattened, tightly packed in a dense cylindrical spike-like inflorescence *Phleum*
(*Phleum pratense*)
- Plants unlike the above in all respects 11.
Alopecurus species (below) are superficially similar to *Phleum* but glumes fused, awnless.
- 11. Glumes equal in size, broad and laterally compressed; spikelets suborbicular, one-flowered, tightly stacked together, crowded on short branches of a narrow, elongate panicle *Beckmannia*
(*Beckmannia syzigachne*)
- Glumes unlike the above; spikelets various 12.
- 12. Inflorescence a spike-like panicle composed of 3–13 widely spaced, widely spreading to often curved, spike-like unilateral branches; spikelets sessile, 3–5.5 mm long, 1-flowered, embedded and appressed to the slender rachis branches, awnless or with a short awn-tip; at maturity the spike-like panicle breaking off at the base and forming a “tumbleweed” like plants *Schedonnardus*
(*Schedonnardus paniculatus*)
- Plants unlike the above in all respects; if spikelets embedded and appressed to the rachis then the spikelets with 2–5 florets and the terminal spikelets with awns 2–8 cm long 13.
- 13. Spikelets arranged in a dense, cylindrical spike-like panicle, subtended by long bristles 14.
- Spikelets unlike the above in all respects 15.
- 14. Bristles subtending the spikelets in 3 series—outer, inner, and with a central primary bristle 25–35 mm long; cultivated grasses occasionally persisting outside of gardens *Pennisetum*
(*Pennisetum glaucum*)
- Bristles subtending the spikelets in a single series; weedy or native grasses but not cultivated ... *Setaria*

* * *

- 15 (1). Inflorescence usually with long hairs on the rachis and pedicel; spikelets in pairs with one sessile fertile spikelet and one pediceled staminate or rudimentary spikelet, or sometimes the pediceled spikelet absent with just the pedicel remaining, or spikelets present in thrios at the tips of branches ... **Group A**
- Spikelets unlike the above; rachis and pedicel hairy or not 16.
- 16. Inflorescence branches bearing spikelets all on one side of the rachis **Group B**
- Spikelet arrangement not as above 17.
- 17. Spikelets truly sessile, arranged in 2-sided spikes or spike-like racemes **Group C**
- Spikelets pedicellate, arranged in panicles or racemes (sometimes the spikelets arranged in very dense spike-like, cylindrical panicles or racemes, but with short pedicels present upon dissection or when bending) 18.
- 18. Spikelets with one well-developed floret (four, sometimes five or six, visible scales) **Group D**
- Spikelets with two to several well-developed florets (more than six scales visible) **Groups E, F, G**

Group A

Spikelets in pairs.

- 19. Spikelets arranged in one to several spike-like branches 20.
- Spikelets not arranged in spike-like branches 21.
- 20. Spike-like branches solitary at the tips of long, slender peduncles *Schizachyrium*
(*Schizachyrium scoparium*)

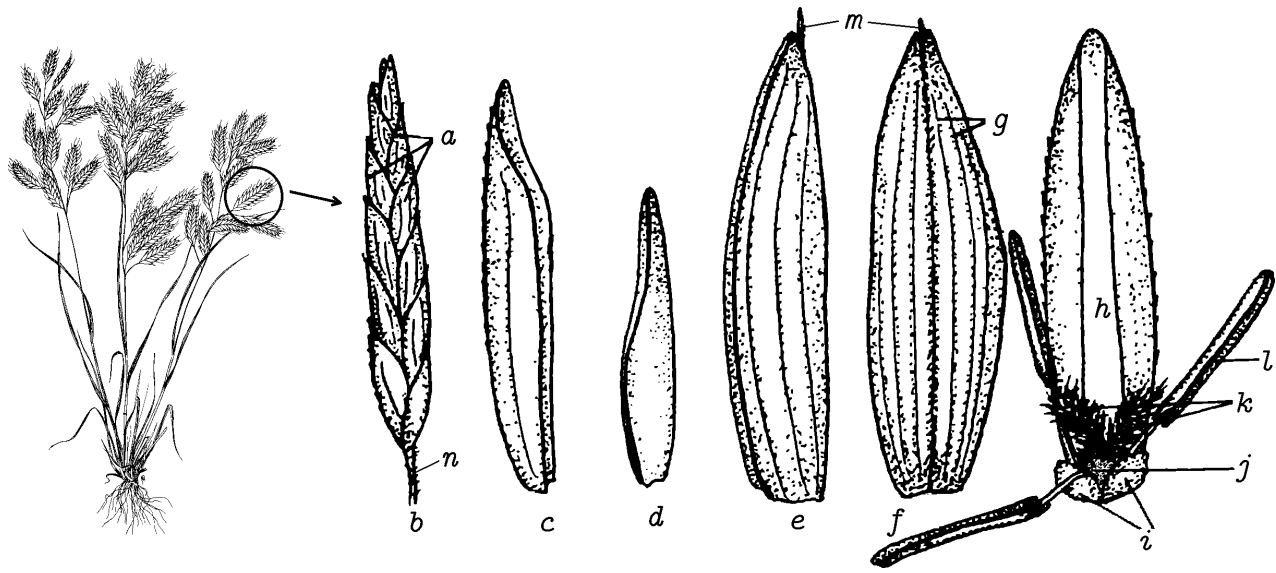


Figure 4.1. Reproductive organs of grasses. *a, e, f* lemmas (note the small awn); *b* spikelet; *c* upper palea; *d* lower palea; *g* veins; *h* glume; *i* lodicules; *j* ovary; *k* stigmas; *l* stamen; *m* awn; *n* pedicel. (From various sources.)

- Spike-like branches not solitary at the ends of long, slender peduncles; pedicelled spikelets mostly over 5.5 mm long; spike-like branches more or less digitately arranged *Andropogon*
- 21 (19). Inflorescence densely hairy with tawny, long hairs; pedicelled spikelet absent, with just the pedicel remaining; leaf blades 1–4 mm wide *Sorghastrum*
(*Sorghastrum nutans*)
- Inflorescence not densely hairy with tawny, long hairs; pedicelled spikelet present; leaf blades 5–100 mm wide *Sorghum*

Group B

Inflorescence branches bearing spikelets all on one side of the rachis.

- 22. Inflorescence more or less digitate (in digitate whorls, or of a single terminal whorl of branches) ... 23.
 - Inflorescence not digitate 25.
- 23. Lemmas or glumes awned. Glumes unawned; lemma awns 3–10 mm long, straight; lemma keels sparsely to densely hairy; leaf margins glabrous to shortly scabrous at the base *Chloris*
(*Chloris virgata*)
 - Lemmas or glumes not awned 24.
- 24. Spikelets 4–8 mm long, with 3-several florets *Eleusine*
(*Eleusine indica*)
 - Spikelets 2–3.5 mm long, with one fertile floret. Ligules membranous; plants not mat-forming, lacking stolons and rhizomes, annuals *Digitaria*
- 25 (22). Spikelets or spikes pendulous and hanging to one side of the rachis. Spikelets with 1 fertile floret and sometimes with 1 reduced floret above; fertile lemma with 3 awn tips *Bouteloua*
(*Bouteloua curtipendula*)
 - Spikelets not as above 26.

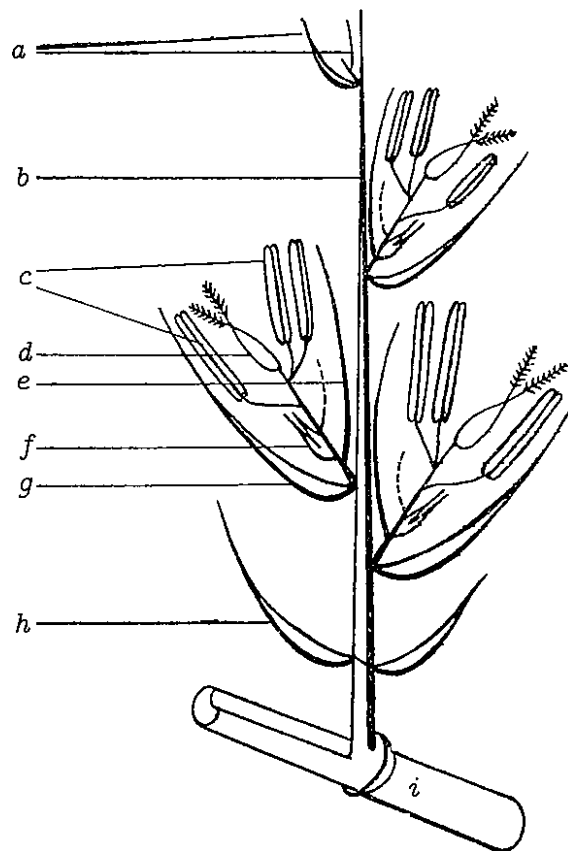


Figure 4.2. Spikelet. *a* sterile flower; *b* rachilla (axis of the spikelet); *c* stamens; *d* pistil; *e* palea; *f* lodicules; *g* lemma; *h* glume; *i* rachis (axis of the spike). (From various sources.)

26. Inflorescence a spike-like panicle composed of 3–13 widely spaced, spreading to curved, spike-like unilateral branches; spikelets sessile, 3–5.5 mm long, embedded and appressed to the slender branches, awnless or with a short awn-tip; at maturity the panicle breaking off at the base and forming a “tumbleweed” like plants *Schedonnardus* (*Schedonnardus paniculatus*)
- Plants unlike the above 27.
27. Plants dioecious, stoloniferous; staminate spikelets 2-flowered, 4–6 mm long, in 2 rows on each branch, disarticulating at the branch and falling as a single unit *Buchloë*
- Plants monoecious, stoloniferous or not; spikelets unlike the above 28.
28. Spikelets arranged in a dense brush-like or eyebrow-like spike or spikes 29.
- Spikelets not arranged as above 30.
29. Spikelets 1–4 per stem, spreading to ascending, with 1 or more reduced florets above the perfect one (these sometimes reduced to awns); rhizomes absent *Bouteloua*
- Spikelets 4–30 per stem, strongly ascending, without reduced florets above the perfect one; plants strongly rhizomatous *Spartina*
- 30 (28). Spikelets with two or more well-developed florets; lemmas not firm and cartilaginous, awned or not; ligule membranous 31.
- Spikelets with one well-developed floret; lemmas awnless, firm and cartilaginous; ligule hairy, membranous, or absent 33.

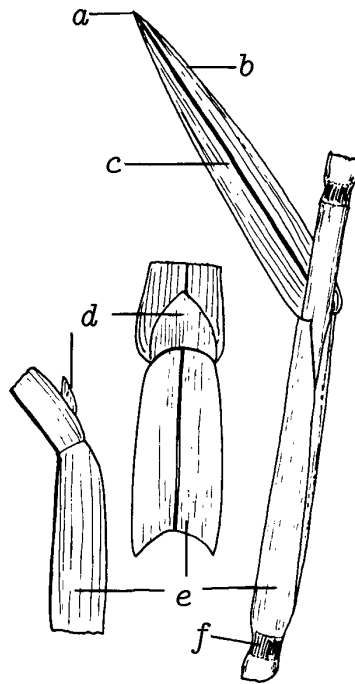


Figure 4.3. Grass leaves. *a* apex; *b* blade; *c* midrib (midvein); *d* ligule; *e* sheath; *f* node. (From Pohl, 1954.)

31. Spikelets crowded in semi-orbicular to triangular clusters at the ends of stiff, wiry branches; glumes and lemmas coarsely ciliate on the keel, usually with a short awn-tip about 1 mm or less in length . . . *Dactylis*
(*Dactylis glomerata*)
– Spikelets in linear or oblong panicle branches, not crowded in dense clusters; glumes and lemmas unlike the above 32.
32. Lemmas with 5–9 prominent nerves, glabrous, blunt-tipped; plants small, 0.2–1.5 dm tall, usually prostrate or spreading *Sclerochloa*
Sclerochloa dura might be found in North Dakota.
– Lemmas 3-nerved, the nerves usually hairy at least below, blunt or acute at the tips; plants usually larger, 0.5–15 dm tall, erect. Ligules 2–8 mm long, attenuate and becoming lacerate at maturity; lemmas usually awned or sometimes acute, silvery-hairy on the nerves in the lower half *Leptochloa*
(*Leptochloa fusca*)
- 33 (30). Ligules absent; spikelets with stiff hairs, awned or with a sharp mucronate tip *Echinochloa*
– Ligules present, hairy or membranous; spikelets glabrous or with soft hairs, awnless. Lower glume absent or inconspicuous; rachis often flattened and broadly winged; plants caespitose to rhizomatous
. *Paspalum*
Paspalum setaceum might be found in North Dakota.

Group C

Spikelets sessile, arranged in 2-sided spikes or spike-like racemes.

34. Spikelets embedded and appressed into the rachis flush with the nodes (resembling a cylinder); spikelets 9–12 mm long, with 2–5 florets, the terminal spikelet with awns 20–80 mm long, the other spikelets with shorter awns 2–9 mm long *Aegilops*
(*Aegilops cylindrica*)
– Spikelets not embedded and appressed into the rachis; plants otherwise unlike the above 35.

35. Spikelets arranged edgewise at the nodes of the rachis; first glume absent except in the terminal spikelet *Lolium*
 – Spikelets not arranged edgewise to the rachis; first glume usually present 36.
36. Spikelets widely divergent from the rachis at a wide angle (mostly about 35°–90°) 37.
 – Spikelets ascending, not widely divergent from the rachis at a wide angle 38.
37. Spikes ovate, 0.8–2.5 cm long; annuals *Eremopyrum*
Eremopyrum triticeum was not observed in North Dakota but could be found here.
 – Spikes rectangular to lanceolate, 3–10 cm long; perennials *Agropyron*
 (*Agropyron cristatum*)
- 38 (36). Spikelets 3 per node, one-flowered, the central spikelet fertile and the two lateral spikelets reduced (often to awns) and on short pedicels *Hordeum*
 – Spikelets 1–7 per node, if with 3 spikelets per node then the spikelets all fertile and the lateral spikelets not reduced and pedicellate, or the spikelets with 2–several flowers 39.
39. Annuals; spikelets tightly packed into long, dense spikes 5–20 cm long, usually with long, ascending awns over 6 mm; cultivated crop occasionally escaping along roadsides 40.
 – Perennials; spikelets unlike the above in all respects; not a cultivated crop 42.
40. Spikelets 3 per node, one-flowered; lemmas with long awns mostly over 3 cm long, these tightly appressed and ascending, the lowest awns equal to or longer than the upper awns *Hordeum*
 (*Hordeum vulgare*)
 – Spikelets solitary at each node, with 2 to several flowers; lemmas various, if long-awned then unlike the above 41.
41. Glumes linear-subulate, 1-nerved; lemmas strongly ciliate along the upper keel *Secale*
 (*Secale cereale*)
 – Glumes ovate to lanceolate, 5–7-nerved, hard; lemmas sometimes slightly ciliate along the keel
 *Triticum*
- 42 (39). Glumes and lemmas with conspicuous, long awns mostly over 6 mm long *Elymus*
 – Glumes and lemmas lacking awns or the awns shorter than 6 mm 43.
43. Spikelets 2–7 at most or all nodes 44.
 – Spikelets solitary at all or most nodes 48.
44. Glumes very narrow (about 1 mm wide or less) and gradually tapering to a sharp point, 1-nerved ... 45.
 – Glumes linear-lanceolate (about 2–4 mm wide), usually at least 3-nerved near the middle 46.
45. Spikelets 2 per node (or if 3 or more per node then the leaf blades 8–20 mm wide), 9–25 mm long, 2–7-flowered; base of the plants lacking numerous, old shredded leaf bases *Leymus*
 – Spikelets mostly 3 per node (look at multiple nodes, sometimes a few have 2 per node), 7–9 mm long, 1–2-flowered; leaf blades mostly 1.5–7 mm wide; base of the plants with numerous old, shredded leaf bases that become fibrous *Psathyrostachys*
 (*Psathyrostachys juncea*)
46. Spikelets 3–8 per node, arranged in a dense spike 15–35 cm long; glumes 12–25 mm long; lemmas softly hairy, at least toward the base *Leymus*
 This species (*Leymus racemosus*) could be found in North Dakota.
 – Spikelets 2 per node, arranged in a spike 4–20 cm long; lemmas glabrous to scabrous 47.
47. Rhizomes present; glumes asymmetrical, slightly curving to one side toward the tip, tending to taper from below midlength to a pointed tip; spikelets solitary or sometimes 2 per node; leaf blades usually glaucous, bluish-green *Pascopyrum*
 (*Pascopyrum smithii*)

- Rhizomes absent, plants caespitose or tufted; glumes symmetrical and straight, not curving to one side, tapering from midlength or higher to a pointed tip; spikelets 2 per node; leaf blades usually green
 *Elymus*
- 48 (43). Glumes truncate or rounded at the tips, or blunt with a small mucronate tip; one margin of the leaf sheath usual ciliate (at least on the middle or lower sheaths) *Thinopyrum*
- Glumes gradually tapering to an acute or awned tip; one margin of the leaf sheath usually not ciliate 49.
- 49. Spikelets not imbricate, the tips of the lower spikelet barely reaching the base of the spikelet above or overlappim it by a small amount; lemma awns strongly divergent to arcuate at maturity 50.
- Spikelets mostly all imbricate and closely overlapping except sometimes low on the spike, the tips of the lower spikelet reaching the middle of the spikelet above; lemmas awnless or awns various 51.
- 50. Glumes about $\frac{1}{2}$ the length of the spikelet, acute to obtuse at the tips *Pseudoroegneria*
 (*Pseudoroegneria spicata*)
- Glumes about $\frac{1}{4}$ – $\frac{1}{3}$ the length of the spikelet, the tips acute or with a short awn 0.5–4 mm long *Elymus*
 (*Elymus albicans*)
- 51 (49). Rachis intemodes short, 2.5–3.5 mm long or shorter; glumes lanceolate and 3-nerved, 3–5 mm long, somewhat twisted, with a short awn 1–3 mm long *Agropyron*
- Rachis intemodes more than 5 mm long; glumes various 52.
- 52. Glumes almost linear, 1-nerved (subulate); spikelets occasionally paired at some nodes *Leymus*
- Glumes linear-lanceolate, 3–7-nerved near the middle; spikelets all solitary or sometimes 2 per node 53.
- 53. Glumes asymmetrical, slightly curving to one side toward the tip; leaf blades usually glaucous, bluish-green *Pascopyrum*
 (*Pascopyrum smithii*)
- Glumes symmetrical and straight, not curving to one side; leaf blades usually green *Elymus*

* * *

×*Elyhordeum* is the name given to hybrids between *Elymus* and *Hordeum*. These hybrids are fairly common. All appear to be sterile, and their characters are intermediate between parental species.

Group D

Spikelets with one well-developed floret.

- 54. Glumes equal, strongly ciliate along the margin, much longer than the lemmas, with horn-like awns; spikelets flattened, tightly packed in a dense cylindric spike-like inflorescence *Phleum*
 (*Phleum pratense*)
- Plants unlike the above in all respects 55.
- 55. Glumes equal in size, broad and laterally compressed; spikelets suborbicular, tightly stacked together, crowded on short branches of a narrow, elongate panicle *Beckmannia*
 (*Beckmannia syzigachne*)
- Glumes unlike the above; spikelets various 56.
- 56. Spikelets arranged in a dense, cylindrical spike-like panicle, subtended by long bristles 57.
- Spikelets unlike the above in all respects 58.

57. Bristles subtending the spikelets in 3 series - with an outer, inner, and central primary bristle 25–35 mm long; cultivated grasses occasionally persisting outside of gardens *Pennisetum*
(*Pennisetum glaucum*)
– Bristles subtending the spikelets in a single series; weedy or native grasses but not cultivated ... *Setaria*
- 58 (56). Lemmas 3-awned at the apex. Plants not stoloniferous, monoecious *Aristida*
– Lemmas awnless or with a single awn 59.
59. Spikelets with one upper fertile terminal floret and one lower sterile floret consisting only of a single lemma (resembling a glume and usually equal to or slightly longer than the upper glume), usually with prominent nerves; lemma of fertile floret smooth and shiny, hard and indurate, with inrolled margins over the palea; disarticulation below the glumes 60.
– Spikelets unlike the above 62.
60. Ligules absent; spikelets oval, with hispid to bristly hairs (these often pustulate at the base); inflorescence an open panicle with densely flowered branches *Echinochloa*
– Ligules present (either a membrane or tuft of hairs, sometimes as short as 0.1 mm); spikelets and inflorescence various 61.
61. Spikelets usually hairy, with mostly rounded tips; panicle 3–10 cm long, with relatively few spikelets ...
..... *Dichantherium*
– Spikelets glabrous or merely scabrous on the nerves, with acute, acuminate, or awned tips; panicle 5–50 cm long, with numerous spikelets *Panicum*
- 62 (59). Spikelets with one fertile, central floret with 1–2 bristle-like or narrowly lanceolate sterile florets below (these can be very difficult to see), awnless; glumes equal or nearly so, laterally flattened and keeled, the keel often with a thin, pale wing; leaves flat *Phalaris*
– Spikelets lacking bristle-like or narrowly lanceolate sterile florets below, awned or not; glumes various, but never winged; leaves flat or involute 63.
63. Lemmas hard and indurate (much more so than the glumes), closely enclosing the palea and grain (usually with overlapping margins), without evident nerves, usually terminally awned (the awn sometimes over 2 cm long) 64.
– Lemmas not hard and indurate or closely enclosing the palea, usually at least 1-nerved, awned or not (but the awn never over 2 cm long) 69.
64. Awns 9–25 cm long; glumes 15–60 mm long *Hesperostipa*
– Awns less than 7 cm long (or occasionally fallen or absent); glumes 2.5–25 mm long 65.
65. Lemma bases with a dense ring of hairs at the top of the callus; flowering stems widely spreading or sometimes prostrate, with only 2–3 leaf sheaths and reduced leaf blades *Oryzopsis*
(*Oryzopsis asperifolia*)
– Lemmas lacking a dense ring of hairs at the base; flowering stems usually unlike the above 66.
66. Lemmas densely covered with hairs 1.5–6 mm long *Achnatherum*
– Lemmas glabrous or shortly hairy with hairs less than 1 mm long 67.
67. Glumes 2.5–5 mm long, with acute to rounded tips; lemma oblong to elliptic, often awnless or the awn early-deciduous, 1.8–6 mm long; callus rounded, not sharp; cauline leaf blades 0.5–10 mm wide; florets 1.5–6 mm long *Piptatheropsis*
– Glumes 6–8 mm long, with acuminate tips; lemma with the awn 10–25 mm, deciduous, slightly twisted, flexuous; callus blunt; cauline leaf blades 8–16 mm wide; florets 4.5–7.5 mm long *Patis*
(*Patis racemosa*)
= Glumes 5.5–15 mm long, the tips acuminate or shortly awned; lemma lanceolate, or rarely oblong-elliptic, awned 2–11 mm long; callus pointed, blunt or often sharp 68.

68. Lemmas tightly closed (unable to pry apart, the margins strongly overlapping their entire length at maturity), glabrous to uniformly hairy, minutely papillate, the tips not lobed, tapering to a crown; palea not evident, $\frac{1}{4}$ – $\frac{1}{2}$ the length of the lemma, glabrous *Nassella*
(*Nassella viridula*)
- Lemma margins not strongly overlapping their entire length (able to pry the lemma apart, look for a line on the lemma), sparsely to densely uniformly hairy, not minutely papillate, the tips often 1–2-lobed; palea $\frac{1}{2}$ to subequal to the lemma, usually hairy *Achnatherum*
×*Achnella caduca* is a sterile hybrid between *Achnatherum hymenoides* and *Nassella viridula*. It differs from *Achnatherum hymenoides* in its longer glumes and florets; from *Nassella viridula* in its more saccate glumes, longer lemma hairs, and well-developed palea.
- 69 (63). Florets subtended by a tuft of long callus hairs, the hairs at least $\frac{1}{3}$ as long as the lemmas 70.
- Florets not subtended by a tuft of long callus hairs, or with a tuft of short callus hairs to 0.5 mm 72.
70. Lemmas or glumes awned from the tips *Muhlenbergia*
(*Muhlenbergia racemosa*)
- Lemmas awnless or awned from the middle or below; glumes awnless 71.
71. Lemmas awned, usually from the back or near the middle (this sometimes included in the spikelet and difficult to distinguish from callus hairs), or rarely the awn absent; glumes scabrous on the keel; plants rhizomatous or tufted, but the rhizomes lacking leaf-like scales, 1.5–15 dm; ligule membranous *Calamagrostis*
- Lemmas awnless; glumes not scabrous on the keel; plants rhizomatous, the rhizomes covered with leaf-like scales, to 25 dm; ligule of hairs *Calamovilfa*
(*Calamovilfa longifolia*)
72. Lemmas and/or glumes awned, the awn 1 mm or longer 73.
- Lemmas and glumes awnless, or the awn less than 1 mm long 80.
73. Glumes nearly equal, tipped with awns of nearly equal length 74.
- Glume unlike the above 75.
74. Lemmas 0.5–1.5 mm long, glabrous; disarticulation below the glumes; plants tufted, lacking rhizomes *Polypogon*
(*Polypogon monspeliensis*)
- Lemmas 1.9–4 mm long, long-hairy on the callus and sometimes also on the midnerve and margins; disarticulation above the glumes; plants rhizomatous with long, creeping scaly rhizomes ... *Muhlenbergia*
- 75 (73). Lemmas awned from the back, near the middle or below 76.
- Lemmas awned from the tip or above the middle 78.
76. Spikelets arranged in an open to contracted panicle, not dense, cylindric and spike-like; glumes scabrous on the keels but otherwise glabrous *Agrostis*
- Spikelets arranged in a dense, cylindric spike-like panicle; glumes hairy on the keels and along the nerves, or uniformly hairy over the entire surface 77.
77. Lemmas glabrous; glumes equal; hairy on the keels and along the nerves, or occasionally hairy over the entire surface; spikelets with one fertile floret and no reduced florets *Alopecurus*
- Lemmas with yellowish hairs; glumes conspicuously unequal, hairy throughout; spikelets with the middle floret perfect and two reduced florets on either side (reduced to sterile lemmas) *Anthoxanthum*
(*Anthoxanthum monticola*)
78. Awns arising from the tip of the lemma 79.
- Awns arising from below the tip of the lemma. Paleas absent or minute and to 0.5 mm long; rachilla not extended *Agrostis*
79. Glumes equal to or longer than the lemma; disarticulation below the glumes; spikelets 2.5–4 mm long, strongly compressed; leaves flat, 4–15 mm wide *Cinna*

- Glumes shorter than the lemma; disarticulation above the glumes; spikelets terete, not strongly compressed; leaves various *Muhlenbergia*
- 80 (72). Glumes of two distinctly different shapes, the lower glume narrow and 1-nerved with an acute tip, the upper glume broad and obovate, 3–5-nerved, with a rounded or broadly acute tip *Sphenopholis*
- Glumes more or less similar in shape (equal or not in length) 81.
- 81. Low, mat-forming, prostrate annuals; spikelets 1.5–2.5 mm long, in a dense, cylindric, spike-like panicle 1.5–5 cm long, often purplish-black-tinged *Crypsis*
Was not found in North Dakota but possibly occurs here.
- Plants unlike the above in all respects 82.
- 82. Ligules composed entirely or mostly of hairs, or shortly membranous and topped with long, ciliate hairs; apex of leaf sheaths with or without a tuft of white hairs *Sporobolus*
- Ligules a membranous sheath, the top not long-hairy but often lacerate; apex of leaf sheath lacking a tuft of white hairs 83.
- 83. Glumes shorter than the lemma; lemma glabrous or often hairy, at least along the nerves ... *Muhlenbergia*
- Glumes equal to or longer than the lemma; lemma glabrous or scabrous on the nerves, or just the callus sparsely hairy with hairs to 0.5 mm long 84.
- 84. Leaves mostly basal, involute or flat and narrow, mostly 0.5–2 mm wide; plants tufted, lacking rhizomes or stolons; ligule 0.5–3 mm long. Paleas absent or minute and to 0.2 mm long; rachilla not extended *Agrostis*
(*Agrostis scabra*)
- Stem leaves well-developed, flat, 2–10 mm wide; plants usually with rhizomes or stolons, occasionally tufted, sometimes decumbent at the base and rooting at the lower nodes; ligule 1–8 mm long 85.
- 85. Disarticulation above the glumes; palea absent or to about $\frac{1}{2}$ the length of the lemma; spikelets not strongly compressed *Agrostis*
- Disarticulation below the glumes; palea slightly shorter than the lemma; spikelets strongly compressed to subterete. Spikelets 2.5–4 mm long; plants rhizomatous, 5–20 dm tall *Cinna*

Groups E, F, G

Spikelets with 2-several well-developed florets.

- 86. Rachillas (axes of spikelets) long-hairy (hairs 6–10 mm long); leaves flat, 15–40 cm long and 2–4 cm wide; inflorescence large, 15–35 cm long; plants 2–6 m tall, “reedlike” with hollow internodes, found along ditches and rivers *Phragmites*
(*Phragmites australis*)
- Rachillas various but not long-hairy; plants otherwise unlike the above in all respects 87.
- 87. Stems, leaves, and sheaths velvety-hairy; spikelets 2-flowered, the lower floret perfect and the upper floret staminate; glumes longer than the florets *Holcus*
(*Holcus lanatus*)
- Plants unlike the above in all respects 88.
- 88. Spikelets flattened, 9–20 mm long, with 5–20 florets, usually imperfect with staminate and pistillate flowers in separate inflorescences and often on separate plants; leaves with a tuft of long ciliate hairs on each side of the collar; ligule a short-ciliate membrane; leaf blades distichous; plants strongly rhizomatous, often found in alkaline swales *Distichlis*
(*Distichlis spicata*)
- Plants unlike the above in all respects 89.
- 89. Ligules composed mostly or entirely of a fringe of ciliate hairs 90.
- Ligules membranous 94.

99. Spikelets arranged in a dense, spike-like panicle, the middle perfect and lateral 2 reduced to sterile lemmas, broadly ovate; glumes nearly equal in length, as long as the florets; plants sweet-smelling when dried *Anthoxanthum*
(*Anthoxanthum monticola*)
– Spikelets in an open or narrow panicle, but not dense and spike-like 100.
100. Awns (of lower florets) 10–20 mm long; spikelets 7–15 mm long 101.
– Awns 0.5–8 mm long; spikelets 2–7 mm long. Callus hairs short (about $\frac{1}{5}$ – $\frac{1}{4}$ the length of the lemma) or absent; lemmas awned from near the base; leaves flat to involute, 0.3–4 mm wide *Deschampsia*
101. Spikelets mostly 3–6-flowered; lemmas 10–12 mm long; leaves flat, 2–4 mm wide *Avenula*
(*Avenula hookeri*)
- 102 (98). Leaf sheath closed to the top or nearly so 103.
– Leaf sheath open more than $\frac{1}{2}$ the length 104.
103. Callus long-hairy with hairs 1–2 mm long; leaf sheath glabrous *Schizachne*
(*Schizachne purpurascens*)
– Callus unlike the above; leaf sheath usually hairy or sometimes glabrous *Bromus*
- 104 (102). Lemmas awned from a bifid apex (look closely, this can be minute). Awns bent or twisted, 3–15 mm long; spikelets with 2–4 florets; lemmas 5-nerved, not silvery-hairy along the margins; uppermost floret with the rachilla hairy and prolonged *Trisetum*
– Lemmas awned from an entire apex 105.
105. Annuals; inflorescence a narrow panicle, the spikelets often more or less situated on one side of the rachis *Vulpia*
(*Vulpia octoflora*)
– Perennials; inflorescence various but the spikelets usually not situated on one side of the rachis ... 106.
106. Lemmas 5–7-nerved; spikelets 2–10-flowered *Festuca*
– Lemmas 3-nerved; spikelets 2-flowered *Muhlenbergia*

Group G

Spikelets with 2 or more florets; lemmas awnless.

107. Glumes very dissimilar, the upper glume broad and much wider than the lower, obovate and 3–5-nerved, the lower glume narrow, acute, and 1-nerved; spikelets 2–3-flowered; paleas colorless *Sphenopholis*
– Glumes unlike the above; spikelets and paleas various 108.
108. Inflorescence a dense, spike-like panicle, the rachis densely short-hairy; paleas colorless, often as long as the lemmas; lemmas glabrous or scabrous just along the keel; leaves mostly basal, 1–3 mm wide
..... *Koeleria*
(*Koeleria macrantha*)
– Inflorescence not a dense, spike-like panicle, the rachis various; paleas with at least a green central nerve, shorter than to as long as the lemmas; lemmas various; leaves various 109.
109. Uppermost floret with the rachilla hairy and prolonged; upper glume about equal to the lowermost floret; spikelets with 2–3 florets *Trisetum*
– Uppermost floret without a prolonged rachilla, or the rachilla extended but glabrous; upper glume usually shorter than the lowermost floret; spikelets various 110.
110. Spikelets broadly ovate, golden-brown; glumes nearly equal in length, as long as the florets; plants sweet-smelling when dried *Hierochloë*
– Spikelets unlike the above 111.
111. Lemmas with 3 conspicuous nerves (with two lateral nerves and one central midnerve) 112.

- Lemmas with 5 or more nerves, or sometimes the lateral nerves inconspicuous and just the central mid-nerve evident 113.
- 112. Leaf sheaths closed to the top or nearly so; inflorescence an open panicle with whorled branches; lemmas glabrous; glumes truncate; plants frequently rooting at the lower nodes *Catabrosa*
(*Catabrosa aquatica*)
 - Leaf sheaths open to the base or nearly so; inflorescence branches not whorled; lemmas glabrous or hairy on the nerves; glumes acute; plants not rooting at the lower nodes. Lemma tips acute; spikelets 1.2–4 mm long, 2–3-flowered; inflorescence unlike the above *Muhlenbergia*
- 113. Leaf sheaths closed to the top or nearly so 114.
 - Leaf sheaths open more than $\frac{1}{2}$ the length 117.
- 114. Plants with bulbous, swollen bases or the spikelets hanging on one side of the rachis; spikelets less than 2.6 mm wide and not strongly inflated *Melica*
Does not occur but might be found in North Dakota.
 - Plants lacking bulbous, swollen bases; if the spikelets hanging on one side of the rachis, then these over 2.6 mm wide in side view and strongly inflated 115.
- 115. Lemmas 6–35 mm long, the tips usually not scarious, often awned *Bromus*
 - Lemmas 2–7 mm long, the tips usually scarious, awnless 116.
- 116. Lemmas glabrous, 7-nerved *Glyceria*
 - Lemmas cobwebby at the base or the keel and veins hairy below, 5-nerved *Poa*
- 117. Lower glume 3–5-nerved and upper glume 5–9-nerved; inflorescence a short panicle 1–4 cm long, the spikelets generally arranged on one side of the rachis, blunt-tipped; plants small, 0.2–1.5 dm tall, often prostrate or spreading *Sclerochloa*
Sclerochloa dura might be found in North Dakota.
 - Lower glume 1–5-nerved and upper glume 3–7-nerved; inflorescences terminal, open panicles; plants 7–20 dm, grow on wetlands *Scolochloa*
(*Scolochloa festucea*)
 - = Lower glume 1–3-nerved and upper glume 3-nerved; plants otherwise unlike the above 118.
- 118. Lemmas with nerves parallel and not converging at the tip; lower glumes 0.4–2.1 mm long and upper glumes 0.8–2.7 mm long 119.
 - Lemmas with nerves converging at the tip; lower glumes 2.5–10 mm long and upper glumes 3–9 mm 120.
- 119. Lemma nerves faint, not prominently raised; plants caespitose, lacking rhizomes *Puccinellia*
 - Lemma nerves conspicuous and prominently raised; plants rhizomatous *Torreyochloa*
Does not occur in North Dakota but might be found here.
- 120. Lemmas tips scarious, obtuse to broadly acute; lemma nerves usually conspicuously hairy at least below, or with a tuft of cobwebby hairs at the base *Poa*
 - Lemma tips usually not scarious, acute to acuminate; lemma nerves glabrous to scabrous but never hairy, lacking a tuft of cobwebby hairs at the base. Axis of the spikelet scabrous. Plants monoecious, lacking rhizomes or with short rhizomes; inflorescence unlike the above; leaves involute or flat *Festuca*

Chapter 5

Manual to Cyperaceae

Keys are compiled mainly from the Larson's (1993) "Aquatic and wetland vascular plants of the northern Great Plains" and Lesica's (2012) "Manual of Montana Vascular Plants".

Key to Genera

1. Achene enclosed in a saclike perigynium which in turn is subtended by a scale *Carex*
 – achene naked, merely subtended by a scale and the perianth (if any)
2. Leaves appear to be lacking, all reduced to bladeless sheaths3.
 – At least 1 leaf with a distinct blade (sometimes short) present4.
3. Spikelets solitary *Eleocharis*
 – Spikelets numerous *Schoenoplectus*
 In many manuals, they are listed under *Scirpus* so to continue identification with, for example, "Flora of Great Plains", go to *Scirpus* page.
- 4 (2). Perianth of numerous, long, whitish or rufous bristles, greatly surpassing the scales and giving the spikelets a cotton tuft appearance *Eriophorum*
 – Perianth of few small bristles or scales, or the perianth lacking5.
5. Achene subtended by 1 or more bristles in addition to a scale6.
 – Bristles absent; achene subtended only by scales7.
6. Inflorescence subtended by an erect bract that appears to be a continuation of the stem ... *Schoenoplectus*
 In many manuals, they are listed under *Scirpus* so to continue identification with, for example, "Flora of Great Plains", go to *Scirpus* page. In "Flora of North America", species with big spikelets listed under *Bolboschoenus*.
 – Inflorescence subtended by ≥ 2 leaf-like bracts. Spikelets mostly ≤ 8 mm long, in small groups in an open inflorescence *Scirpus*
- 7 (5). Spikelets mostly flattened; the scales arranged opposite each other *Cyperus*
 – Spikelets (spikes) ovoid; scales arranged spirally. Main bract erect and stem-like; inflorescence appearing lateral *Lipocarpha*

Chapter 6

Manual to the Labiatae s.l.

This family is understood here in the extremely broad sense: it includes representatives of Bignoniaceae, Lentibulariaceae, Linderniaceae, Orobanchaceae, Pedaliaceae, Phrymaceae, Plantaginaceae, Scrophulariaceae, Verbenaceae and some other groups.

Key to Genera

1. Trees or woody vines2.
 - True water plants which do not only grow in water, but also use water for their body support4.
 - = Principally terrestrial, herbaceous or shrubby plants6.
2. Trees3.
 - Woody vines *Campsis*
(*Campsis radicans*)
3. Leaves simple, whorled *Catalpa*
 - Leaves pinnate, opposite *Tecoma*
(*Tecoma stans*)
- 4 (1). Plants with dissected leaves bearing animal-trapping bubbles, flowers showy, yellow, labiate, in lax inflorescences *Utricularia*
In fact, leaves of bladderwort are modified shoots.
 - Leaves are not dissected5.
5. Flowers small, white with yellow centers *Bacopa*
(*Bacopa rotundifolia*)
 - Flowers small, inconspicuous, perianth reduced *Callitriche*
- 6 (1). Perianth non-showy, green, brown or completely absent7.
 - Perianth showy, white, yellow, blue, red or purple9.
7. Flowers with reduced perianth but stamens purple *Besseyia*
(*Besseyia wyomingensis*)
Does not occur in North Dakota but might be found here.
 - Stamens are also non-showy8.
8. Water plants with upright, robust stem and whorled linear leaves; flowers without perianth *Hippuris*
 - Plants do not usually occur in water, scapose (stems leafless), perianth not reduced, petals filmy, stamens exerted *Plantago*
 - = Terrestrial plants, leaves opposite, flowers with brown-green perianth, petals not filmy, stamens inserted *Scrophularia*
(*Scrophularia lanceolata*)
- 9 (6). Plants with reduced, non-green leaves, achlorophyllous full parasites *Orobanche*
 - Plants with green leaves 10.

39. At least some upper leaves pinnately lobed or toothed *Pedicularis*
(*Pedicularis canadensis*)
– At least some upper leaves triply dissected *Castilleja*
(*Castilleja sessiliflora*)
- 40 (38). Flower with two visible lips, corolla more or less open 41.
– No visible lips, corolla closed *Orthocarpus*
(*Orthocarpus luteus*)
41. Corolla with a long spur *Linaria*
– Corolla with a broad pouch at the base *Antirrhinum*
(*Antirrhinum majus*)
- 42 (32). Flowers with 4 petals and 2 stamens; fruits are heart-shaped or globose capsules 43.
– Flowers different from the above 45.
43. Calyx lobes almost equal, 5. Flowers white, with conspicuous tube, in dense terminal spikes
..... *Veronicastrum*
(*Veronicastrum virginicum*)
– Calyx lobes 4 or 4 bigger and 1 smaller. Flowers usually blue 44.
44. Corolla tube conspicuous, fruit almost globose, spikes terminal, dense *Pseudolysimachion*
(*Pseudolysimachion longifolium*)
– Corolla tube inconspicuous, fruit flattened, spikes terminal or axillary, lax *Veronica*
- 45 (42). Flowers actinomorphic or only slightly zygomorphic, without lips 46.
– Flowers distinctly zygomorphic, usually with lip(s) 50.
46. Leaves whole with entire margins 47.
– Leaves with toothed margins and/or dissected or lobed 48.
47. Leaves elliptic *Bacopa*
(*Bacopa rotundifolia*)
– Leaves linear or spatulate *Limosella*
- 48 (46). At least some lower leaves double dissected, inflorescences head-like *Glandularia*
(*Glandularia bipinnatifida*)
– Leaves toothed, whole, once lobed or dissected, inflorescences long or short spikes 49.
= Leaves whole, serrate, flowers axillary *Gratiola*
49. Corolla slightly zygomorphic (two upper petals are slightly different), stems with only few pairs of developed leaves *Stylodon*
(*Stylodon carneus*)
Likely absent in North Dakota.
– Corolla almost actinomorphic, stems with many pairs of developed leaves *Verbena*
- 50 (45). Most of upper leaves opposite 51.
– Most of upper leaves alternate 57.
51. Flowers mostly axillary or in lax inflorescences 52.
– Flowers in distinct terminal inflorescences 56.
52. Leaves linear, 1–2 mm wide; flowers on long pedicels, usually pink or purple *Agalinis*
– Leaves broader 53.
53. Creeping plant with heart-shaped, pubescent, viscid leaves; fruits with two prominent horns
..... *Proboscidea*
(*Proboscidea louisianica*)
– Plant are different from the above 54.

Chapter 7

Manual to the Polygonaceae

Keys are compiled from multiple sources, mainly from the “Flora of North America” and Lesica’s (2012) “Manual of Montana Vascular Plants”.

Key to Genera

1. Ocreae absent; nodes not swollen; flowers usually enclosed in involucre or subtended by involucre bracts *Eriogonum*
 - Ocreae present, persistent or deciduous; nodes usually swollen; flowers not enclosed in involucre or associated with involucre bracts 2.
2. Tepals 6 3.
 - Tepals 3, 4, or 5 4.
3. Inner tepals of fruiting perianths non-acrescent; achenes winged; stamens (6–)9 *Rheum*
(*Rheum rhabarbarum*)
 - Inner tepals of fruiting perianths usually accrescent, large and hide the achene; achenes without prominent wings; stamens 6 *Rumex*
- 4 (2). Outer tepals winged or keeled 5.
 - Outer tepals unwinged and unkeeled 6.
5. Outer tepals winged (usually just keeled in *Fallopia convolvulus*); ocreae chartaceous, tan to brownish, glabrous or scabrous to variously pubescent, never 2-lobed distally *Fallopia*
 - Outer tepals keeled; ocreae often hyaline, silvery, glabrous, 2-lobed distally *Polygonum* (in part)
- 6 (4). Leaves mostly basal, some cauline; inflorescences terminal, spikelike (sometimes bearing pyriform, pink to brown or purple bulblets); stems simple *Bistorta*
(*Bistorta vivipara*)
 - Leaves cauline; inflorescences terminal and axillary or axillary; stems usually branched, rarely simple 7.
7. Achenes strongly exserted; perianths non-acrescent; tepals distinct *Fagopyrum*
 - Achenes included or exserted; perianths accrescent or nonaccrescent; tepals connate to 2/3 their lengths 8.
- 8 (7). Ocreae often hyaline, silvery, glabrous, 2-lobed distally, often disintegrating into fibers or completely. Flowers frequently axillary *Polygonum* (in part)
 - Ocreae chartaceous, usually tan, brown, or reddish, rarely silvery, glabrous or scabrous to variously pubescent, never 2-lobed distally, often tearing with age. Inflorescences spikelike, paniclelike, or capitate ... *Persicaria*

Eriogonum Michaux, wild buckwheat

1. Plants annual or biennial, without a branched caudex 2.

- Plants perennial with a woody, branched caudex 6.
- 2. Flowering stems scapose 3.
- Flowering stems leafy 5.
- 3. Leaf blades variously glabrous or hirsute on one or both surfaces 4.
- Leaf blades densely tomentose to floccose-tomentose or floccose on one or both surfaces
..... *Eriogonum cernuum*
- 4. Perianths glabrous *Eriogonum gordonii*
- Perianths pubescent *Eriogonum trichopes*
- 5 (2). Leaves glabrous to sparsely villous *Eriogonum visheri*
- Leaves tomentose *Eriogonum annuum*
- 6 (1). Perianth with a tubular base not less than 1 mm long that appears to be a continuation of the pedicel.
Some leaves usually more than 5 mm wide; flowers bright yellow *Eriogonum flavum*
- Perianth with a mostly rounded base 7.
- 7. Inflorescence open *Eriogonum brevicaule* (USDA: *Eriogonum lagopus*)
- Inflorescence capitate, perianth white or pink *Eriogonum pauciflorum*

***Fagopyrum* Mill., buckweat**

Both species are cultivated and occasionally “escaped”.

- 1. Achene faces smooth, angles smooth; tepals 3–5 mm; perianths, creamy white to pale pink; inflorescences
paniclelike, 1–4 cm, terminal and axillary *Fagopyrum esculentum*
- Achene faces irregularly rugose, angles often sinuate-dentate; tepals 1.5–3 mm; perianths, green with
whitish margins; inflorescences racemelike, 2–10 cm, axillary *Fagopyrum tataricum*

***Fallopia* Adans., false buckweat**

This genus is still frequently treated as a part of *Polygonum*.

- 1. Achenes minutely granular-tuberculate, dull; fruiting perianths glabrous or with blunt, hyaline hairs,
wings absent or, rarely, 0.4–0.9 mm wide; plants annual
..... *Fallopia convolvulus* (USDA: *Polygonum convolvulus*)
 - Achenes smooth, shiny; fruiting perianths glabrous, wings 1.5–2.1 mm wide; plants perennial or annual
..... 2.
 - 2 (1). Plants perennial or annual; fruiting perianth wings decurrent on stipelike base, undulate or crinkled,
rarely flat, margins wavy-crenulate to incised or lacerate, rarely entire
..... *Fallopia scandens* (USDA: *Polygonum scandens*)
 - Plants annual; fruiting perianth wings usually truncate to attenuate-decurrent on stipelike base, flat or,
less often, undulate or crinkled, margins entire or rarely undulate-crenate
..... *Fallopia dumetorum* (USDA: *Polygonum dumetorum*)
- Might be found in North Dakota.

***Persicaria* (L.) Mill., smartweed**

This genus is still frequently treated as a part of *Polygonum*.

1. Stems with recurved prickles, scandent or, rarely, ascending to erect. Peduncles usually glabrous, sometimes with retrorse prickles proximally; leaves petiolate; bases of leaf blades sagittate to cordate; stamens 8 *Persicaria sagittata* (USDA: *Polygonum sagittatum*)
 – Stems unarmed, usually erect or ascending, rarely prostrate or decumbent 2.
2. Some or all ocreae foliaceous and green distally. Plants perennial; rhizomes or stolons usually present; leaf blades ovate-lanceolate to elliptic or oblong-lanceolate, 1–6(–8) cm wide
 *Persicaria amphibia* (in part) (USDA: *Polygonum amphibium*)
 – All ocreae chartaceous and hyaline, tan, brown, or reddish brown throughout, never foliaceous and green distally 3.
- 3 (2). Perianths glandular-punctate 4.
 – Perianths not glandular-punctate 7.
4. Achenes minutely roughened, dull; axillary inflorescences sometimes enclosed in ocreae
 *Persicaria hydropiper* (USDA: *Polygonum hydropiper*)
 – Achenes smooth, shiny; inflorescences never enclosed in ocreae 5.
5. Outer tepals with anchor-shaped veins; achenes discoid
 *Persicaria lapathifolia* (in part) (USDA: *Polygonum lapathifolium*)
 – Outer tepals without anchor-shaped veins; achenes 3-gonous or biconvex 6.
6. Punctae confined to bases of perianths and sometimes on inner tepals
 *Persicaria hydropiperoides* (in part) (USDA: *Polygonum hydropiperoides*)
 – Punctae more or less uniformly distributed over perianths. Inflorescences interrupted; ocreolae (ocreae on inflorescences) mostly not overlapping, margins mostly ciliate with hairs to 2 mm; leaf blades 0.6–2.4 cm wide *Persicaria punctata* (USDA: *Polygonum punctatum*)
- 7 (3). Peduncles stipitate-glandular 8.
 – Peduncles not stipitate-glandular 10.
8. Plants perennial; rhizomes or stolons usually present; inflorescences terminal
 *Persicaria amphibia* (in part) (USDA: *Polygonum amphibium*)
 – Plants annual; rhizomes and stolons absent; inflorescences terminal and axillary 9.
9. Outer tepals with anchor-shaped veins; tepals 4(–5); inflorescences mostly arching or nodding
 *Persicaria lapathifolia* (in part) (USDA: *Polygonum lapathifolium*)
 – Outer tepals without anchor-shaped veins; tepals 5; inflorescences erect or, rarely, nodding
 *Persicaria pensylvanica* (in part) (USDA: *Polygonum pensylvanicum*)
- 10 (7). Plants perennial; rhizomes or stolons usually present 11.
 – Plants annual; rhizomes and stolons absent 12.
11. Achenes biconvex; styles 2. Perianth roseate to red; surfaces of ocreae glabrous or appressed-pubescent to hirsute, not glandular-punctate *Persicaria amphibia* (in part) (USDA: *Polygonum amphibium*)
 – Achenes 3-gonous; styles 3 *Persicaria hydropiperoides* (in part) (USDA: *Polygonum hydropiperoides*)
- 12 (10). Margins of ocreae without bristles or with bristles to 1 mm; ocreolae (ocreae on inflorescences) mostly overlapping; achenes discoid, rarely trigonous 13.
 – Margins of ocreae ciliate with bristles 0.2–1.3(–2) mm, if bristles less than 1 mm then ocreolae not overlapping; achenes discoid, biconvex, or 3-gonous; styles 2–3
 *Persicaria maculosa* (USDA: *Polygonum persicaria*)
13. Outer tepals with anchor-shaped veins; tepals 4(–5); inflorescences mostly arching or nodding
 *Persicaria lapathifolia* (in part) (USDA: *Polygonum lapathifolium*)
 – Outer tepals without anchor-shaped veins; tepals 5; inflorescences mostly erect, rarely nodding
 *Persicaria pensylvanica* (in part) (USDA: *Polygonum pensylvanicum*)

***Polygonum* L., knotweed**

Summer fruits are often distinct from the fall fruits.

1. Stems distinctly and more or less regularly 8–16-ribbed; leaf blade venation pinnate, secondary veins conspicuous; anthers whitish yellow; nearly worldwide 2.
(*Polygonum aviculare* s.l.)

One may not proceed further, it is enough to accept all species under this these as *Polygonum aviculare* s.l. (in broad sense).

 - Stems tetragonous, ribs obscure or absent; leaf blade venation parallel, secondary veins not conspicuous; anthers pink to purple 11.
2. Leaves in distal part of inflorescence reduced, not overtopping flowers (shorter than or equaling flowers); inflorescences axillary and terminal, spikelike 3.
 - Leaves in distal part of inflorescence overtopping flowers; inflorescences entirely axillary 4.
3. Achenes striate-tubercled *Polygonum patulum*
 Might be found in North Dakota.
 - Achenes smooth or roughened. Margins of tepals greenish yellow or yellow, rarely pink or white; achenes 2.5–3.5 mm
Polygonum ramosissimum (USDA: *Polygonum bellardii*, *Polygonum leptocarpum*) (in part)
- 4 (2). Achenes striate-tubercled, uniformly tubercled, or obscurely tubercled 5.
 - Achenes smooth to roughened 10.
5. Plants green to bluish green; margins of tepals white, pink, or red 6.
 - Plants light green or yellowish; margins of tepals green to yellow 8.
6. Achenes coarsely striate-tubercled *Polygonum aviculare* (USDA: *Polygonum arenastrum*, *Polygonum buxiforme*) (in part)
 - Achenes obscurely tubercled 7.
7. Plants dark brown to black after drying; distal part of ocreae dis-integrating into persistent fibers, brown
Polygonum ramosissimum (USDA: *Polygonum bellardii*, *Polygonum leptocarpum*) (in part)
 - Plants green after drying (sometimes whitish from powdery mildew); distal part of ocreae persistent, silvery
Polygonum aviculare (USDA: *Polygonum arenastrum*, *Polygonum buxiforme*) (in part)
- 8 (5). Perianth tube 40–55% of perianth length; tepals more or less keeled; pedicels 1.3–1.8 mm, enclosed in ocreae
Polygonum achoreum
 - Perianth tube 20–38% of perianth length; tepals not keeled; pedicels 2–7 mm, exerted from ocreae 9.
9. Leaf blades elliptic to obovate; distal parts of ocreae more or less persistent, silvery; achenes striate-tubercled
Polygonum erectum
 - Leaf blades narrowly elliptic to lanceolate, rarely ovate; distal parts of ocreae soon disintegrating into persistent brown fibers; achenes uniformly tubercled
Polygonum ramosissimum (USDA: *Polygonum bellardii*, *Polygonum leptocarpum*) (in part)
- 10 (4). Perianth tube 40–57% of perianth length
Polygonum aviculare (USDA: *Polygonum arenastrum*, *Polygonum buxiforme*) (in part)
 - Perianth tube 18–38% of perianth length; plants heterophyllous; cymes crowded toward tips of branches
Polygonum ramosissimum (USDA: *Polygonum bellardii*, *Polygonum leptocarpum*) (in part)
- 11 (1). Ocreae 5–12 mm; perianths and achenes 3–5 mm; flowers closed; pedicels 2–6 mm; perianth tubes 20–28% of perianth lengths
Polygonum douglasii
 - Ocreae 3–5 mm; perianths and achenes 1.2–2.6 mm; leaf blades with 1 pleat on each side of midrib
Polygonum tenue

***Rumex* L., dock**

1. Flowers mostly unisexual; pedicels articulated near base of tepals; outer tepals normally angled towards inner tepals; inner tepals not enlarged or slightly enlarged, normally 1–3 mm, equaling to slightly wider than achenes; tubercles absent; leaf blades obovate-oblong, ovate-lanceolate, lanceolate-elliptic, or lanceolate (rarely linear-lanceolate), base hastate or at least broadly cuneate (almost truncate)
Rumex acetosella
 - Flowers normally bisexual, sometimes bisexual and unisexual within same inflorescence; leaf blades never hastate or sagittate; pedicels with or without evident articulation 2.

- 2 (1). Plants not developing basal rosette of leaves (this is hard to observe in the end of season); stems erect, ascending, procumbent, or decumbent, normally with regular, leafy axillary shoots tending to develop second-order axillary inflorescences (often overtopping first-order ones); leaf blades mostly lanceolate, elliptic, ovate, ovate-lanceolate, or ovate-elliptic, base cuneate or almost rounded, or in some species broadly cuneate; inner tepal margins entire (rarely in some species minutely erose-denticulate) 3.
- Plants developing basal rosette of leaves (sometimes, especially in annual species, not persistent at maturity); stems mostly erect, sometimes ascending, spreading, or almost prostrate, simple or several from base, not branching below terminal paniculate inflorescence, without axillary shoots; leaf blades variable in shape, base cordate to cuneate; inner tepal margins entire or variously dentate 6.
3. Inner tepals 20–30 mm wide *Rumex venosus*
- Inner tepals normally less than 15 mm wide 4.
4. Pedicels approximately 3–5 times as long as inner tepals, articulated in proximal part. Leaf blades mostly linear-lanceolate, 5–10 times as long as wide, thin; inflorescences normally interrupted (at least in basal 2); inner tepals longer than wide, or rarely as long as wide *Rumex verticillatus*
- Pedicels usually not more than 2–2.5 times as long as inner tepals, articulated near middle or in proximal 2 5.
5. Leaf blades ovate-lanceolate or elliptic-lanceolate, distinctly widest in proximal $\frac{1}{2}$; inner tepals usually 4.5–6 mm, broadly triangular; tubercles (2–)3; stems normally erect, rarely ascending *Rumex altissimus*
- Leaf blades in most cases lanceolate or linear-lanceolate, usually widest near middle; inner tepals 2–3 mm; tubercle 1; stems erect or ascending *Rumex salicifolius*
- 6 (2). Inner tepals with tubercles absent (or one inner tepal with indistinct tubercle or slightly thickened midvein), margins entire, indistinctly erose or, rarely, minutely denticulate 7.
- Inner tepals with at least 1 distinct tubercle, margins entire, denticulate, or variously dentate 9.
7. Pedicels with distinctly swollen articulation point 8.
- Pedicels without swollen articulation point. Leaf blades ovate-triangular, ovate-lanceolate, or oblong-lanceolate, base distinctly to weakly cordate, occasionally rounded or truncate; inflorescences normally with comparatively long branches more than 7–8 cm *Rumex occidentalis* (USDA: *Rumex aquaticus*)
8. Leaf blades 15–30 × 1–4 cm, base narrowly cuneate; inner tepals 3–5 mm wide; achenes usually reddish brown, less than 1–1.5 mm wide *Rumex pseudonatronatus* (in part)
Might be found in North Dakota.
- Leaf blades 25–60 × 7–15 cm, base broadly cuneate, rounded-truncate, or slightly cordate; inner tepals 4.5–7.5 mm wide; achenes dark brown or brown, normally 1.5–2 mm wide . . . *Rumex longifolius* (in part)
- 9 (6). Inner tepals with margins entire or minutely and indistinctly erose-denticulate (teeth less than 0.2 mm); however, in *Rumex stenophyllus* often more distinctly dentate, then inner tepals reniform, orbiculate, broadly ovate, or broadly ovate-triangular (approximately as long as wide, or wider than long), base often cordate 10.
- Inner tepal margins variously dentate (at least some teeth 0.3 mm or longer, almost always evidently longer than wide (excluding teeth), base variable but normally not cordate 16.
10. Inner tepal margins denticulate or dentate, at least proximally, normally less than 6 mm, with three equal or subequal tubercles *Rumex stenophyllus*
- Inner tepals normally more than 6 mm, with 1 distinct tubercle, other inner tepals without tubercles or tubercles small 11.
11. Inner tepals with 1 indistinct tubercle less than 1(–1.3) mm, or some with tubercles absent (usually both types occur within same inflorescence) 12.
- Inner tepals normally with 3 tubercles, or at least with 1 distinct tubercle more than (1–)1.5 mm wide 13.

12. Leaf blades 15–30 × 1–4 cm, base narrowly cuneate; inner tepals usually 3–5 mm wide; achenes reddish brown, usually 1–1.5 mm wide *Rumex pseudonatronatus* (in part)
 Might be found in North Dakota.
- Leaf blades 25–60 × 7–15 cm, base broadly cuneate; inner tepals 4.5–7.5 mm wide; achenes brown to dark brown, normally 1.5–2 mm wide *Rumex longifolius* (in part)
- 13 (11). Inner tepals with 3 distinctly equal or subequal tubercles; leaf blades 20–70 cm, lanceolate or oblong-lanceolate, base cuneate, occasionally or rounded or truncate
 *Rumex britannica* (USDA: *Rumex orbiculatus*)
- Inner tepals with 1 tubercle, or with 3 unequal tubercles, at least 1 tubercle distinctly larger; leaf blades variable (rarely tubercles subequal, then largest leaves smaller than 55 cm) 14.
14. Leaf blades broadly ovate, ovate-triangular, or ovate-elliptic, base deeply and broadly cordate, apex obtuse to subacute; tubercle usually 1 *Rumex confertus*
- Leaf blades ovate-lanceolate, oblong-lanceolate, or lanceolate, base cuneate, truncate, or subcordate, apex acute or subacute; tubercles 1–3 15.
15. Leaf blades ovate-lanceolate or oblong-lanceolate, margins flat or weakly undulate; inner tepals 5–10 mm, broadly ovate to orbiculate, base usually distinctly cordate; tubercles normally 1 (occasionally 2–3); stems usually 80–150 cm *Rumex patientia*
- Leaf blades usually lanceolate, margins strongly undulate and crisped; inner tepals 3.5–6 mm, orbiculate-ovate or ovate-deltoid, base truncate, or subcordate; tubercles normally 3 (rarely 1–2); stems usually 40–100 cm *Rumex crispus*
- 16 (9). Leaf blades 7–25 cm, lanceolate-linear or lanceolate (rarely oblong-lanceolate), at least four times as long as wide; inner tepal margins with long bristlelike or subulate-filiform teeth longer than or equaling width of inner tepals (very rarely teeth shorter, or even absent); inner tepals (excluding teeth) narrowly triangular or narrowly rhombic-triangular, normally approximately 2 times as long as wide; plants annual (less commonly biennial or short-lived perennial) *Rumex maritimus*
- Leaf blades 20–40 cm, ovate, obovate to elongate, occasionally broadly oblong-lanceolate, less than 4 times as long as wide; inner tepal margins with short-subulate or triangular-subulate (not bristlelike) teeth equaling or shorter than width of inner tepals; inner tepals (excluding teeth) usually deltoid or broadly triangular (occasionally ligulate) normally approximately 1.5–2 times as long as wide; plants annual, biennial, or perennial *Rumex obtusifolius*

Chapter 8

Manual to Amaranthaceae

Keys are compiled mainly from the “Flora of North America” and Lesica’s (2012) “Manual of Montana Vascular Plants”.

Key to Genera

- 1. Stems woody at least at the base 2.
 - Plants herbaceous annuals or perennials 6.
- 2. Foliage white-tomentose and stellate-pubescent *Krascheninnikovia*
(*Krascheninnikovia lanata*)
 - Foliage not both stellate-pubescent and tomentose 3.
- 3. Leaves linear, fleshy 4.
 - Leaves narrowly oblanceolate to deltoid 5.
- 4. Flowers and fruits tomentose at least above *Bassia*
(*Bassia scoparia*)
 - Flowers and fruits glabrate *Suaeda*
- 5 (3). Fruit coin-like-circular, smooth and winged all around *Grayia*
(*Grayia spinosa*)
 - Fruit often appendaged, lanceolate to obovate, usually not winged all around *Atriplex*
- 6 (1). Stems jointed with opposite, scale-like leaves *Salicornia*
(*Salicornia rubra*)
 - Stems not jointed; leaves mostly alternate 7.
- 7. Leaves linear, somewhat fleshy, terete or subterete 8.
 - Leaves broader or not fleshy or both 11.
- 8. Leaf tips not armed *Suaeda*
 - Leaves tipped with a bristle or spine 9.
- 9. Flower bracts spine-tipped *Salsola*
 - Flower bracts not spine-tipped *Halogeton*
(*Halogeton glomeratus*)
- 11 (7). Fruit at least partly enclosed by 2, at least partly united bracts 12.
 - Fruit enclosed by the perianth or not enclosed 15.
- 12. Plants stellate-pubescent *Axyris*
(*Axyris amaranthoides*)
 - Plants glabrous to scurfy but hairs not stellate 13.
- 13. Fruit compressed; bracts crenulate-wing-margined; perianth 4-parted *Suckleya*
(*Suckleya suckleyana*)
 - Fruit not strongly compressed, often not winged; perianth 5-parted or absent 14.

14. Perianth of staminate flowers cup-shaped, lobes fleshy-crested on back, pink; perianth segments subtend the fruit are within the small (0.5–2 mm) bracteoles *Endolepis*
(*Endolepis dioica*)
- Perianth and bracteoles not so *Atriplex*
- 15 (11). Sepals scarious-margined, bracts usually spine-tipped *Amaranthus*
– Sepals not scarious-margined; bracts not spine-tipped (rarely sharp-pointed) 16.
16. Perianth lacking or 1- to 3-parted, not enclosing the fruit 17.
– Perianth 3- to 5-parted (sometimes lacking in female flowers), at least partly enclosing the fruit ... 18.
17. Leaves lanceolate, some usually hastate *Monolepis*
(*Monolepis nuttalliana*)
- Leaves linear *Corispermum*
- 18 (16). Fruiting perianth with horizontal wings *Cycloloma*
(*Cycloloma atriplicifolium*)
- Fruiting perianth without wings 19.
19. Plants (at least some parts) with glandular or glandular-vesicular hairs *Dysphania*
(*Dysphania botrys*)
- Plants farinose or glabrous *Chenopodium*

***Amaranthus* L., amaranth**

1. Flowers in axillary glomerules; terminal spikes or panicles absent. Female flowers with 3 to 5 sepals >1 mm 2.
– Flowers in terminal and axillary spikes or panicles as well as axillary glomerules 3.
2. Female bracts 2 to 3 times longer than sepals; seeds ≤1 mm long *Amaranthus albus*
– Female bracts approximately as long as the sepals; seeds ≥1.3 mm long *Amaranthus blitoides*
- 3 (2). Plants dioecious 4.
– Plants monoecious 5.
4. Some female bracts much longer than sepals, greenish *Amaranthus arenicola*
– Female bracts ca. as long as sepals, reddish *Amaranthus tuberculatus*
- 5 (3). Sepals rounded or blunt at the tip, often with an excurrent midvein *Amaranthus retroflexus*
– Sepals acute or tapering to an aristate tip. Female bracts 3–4 mm long *Amaranthus hybridus*

***Atriplex* L., saltbush**

1. Shrubs or subshrubs 2.
– Herbaceous, taprooted annuals 4.
2. Stems spiny; leaves nearly as broad as long *Atriplex confertifolia*
– Stems without spines; leaves linear to oblong 3.
3. Shrubs, often >50 cm high with woody stems *Atriplex canescens*
– Subshrubs to 50 cm high, woody only at the base *Atriplex gardneri*
- 4 (1). Mature pistillate bracts suborbicular, entire-margined, lacking appendages 5.
– Mature pistillate bracts lanceolate, ovate or deltoid, usually with tooth-like margins or appendages ... 7.

5. Mature pistillate bracts >5 mm long, cordate-based. Pistillate flowers of 2 kinds: some with calyx 3-5-lobed and seed horizontal, others lacking perianth, enclosed in pair of bracteoles. Lower leaves various *Atriplex hortensis*
 – Pistillate flowers all alike. Lower leaves generally triangular.
6. Bracteoles thick spongy, margin united to middle. Inflorescence with leafy bracts to the tip, glomerules loose, irregularly spaced. Lower leaves triangular, thin-textured *Atriplex glabriuscula*
 – Bracteoles not thickened, ≤5 mm long, orbicular, cuneate-based. Inflorescence less leafy and more compact. Leaves broadly triangular-hastate, green on both sides, thick-textured *Atriplex micrantha*
 (A. heterosperma in "Flora of North America")
- 7 (4). Fully expanded leaves green, although sometimes weakly farinose. Mature pistillate bracts >2 mm long 8.
 – Most mature leaves gray, the surface heavily farinose 9.
8. Mature pistillate bracts inflated around the seed with a thick, spongy, often tuberculate layer of cells ...
 *Atriplex subspicata*
 – Mature pistillate bracts without an inflated spongy layer *Atriplex patula*
- 9 (7). Leaves sinuate-dentate, sometimes hastate at the base; pistillate bracts with appendages on the face *Atriplex rosea*
 – Leaves with entire or gently wavy margins; bracts sometimes with appendages on the margin but not on the face 10.
10. Mature pistillate bracts elliptic with deeply lobed margins throughout *Atriplex argentea*
 – Upper portion of mature pistillate bracts with shallowly lobed margins or an apical tooth. Lower portion of mature pistillate bract tuberculate on the face *Atriplex powellii*

***Chenopodium* L., goosefoot**

1. Seeds vertical or both horizontal and vertical; leaf blades glabrous or occasionally farinose (*Ch. glaucum*). Perianth segments usually 3; plants annual 2.
 – Seeds all horizontal; leaf blades usually farinose 6.
2. Leaf blades lanceolate or oblong, glaucous abaxially *Chenopodium glaucum*
 – Leaf blades triangular or rhombic, rarely lanceolate, green and glabrous abaxially 3.
3. Glomerules 3–10 mm diam., sessile on unbranched terminal and occasionally axillary spikes; perianth segments mostly fleshy, red at maturity 4.
 – Glomerules 2–5 mm diam., sessile on lateral branched spikes; perianth segments membranaceous, green at maturity 5.
4. Glomerules not subtended by leaflike bracts in distal ½ of spike; flowers maturing uniformly from apex of plant to base *Chenopodium capitatum*
 – Glomerules subtended by leaflike bracts throughout inflorescence; flowers maturing from base of plant to apex *Chenopodium foliosum*
5. Perianth segments connate nearly to tip *Chenopodium chenopodioides*
 Absent in North Dakota but might be found since occurs in neighboring states.
 – Perianth segments mostly connate only at very base *Chenopodium rubrum*
- 6 (1). Flowers individually disposed in panicles; leaf blades glabrous 7.
 – Flowers in loose or dense glomerules; leaf blades usually farinose 8.
7. Leaves sinuate-dentate; seeds 1.3–1.9 mm diam. *Chenopodium simplex*
 – Leaves entire; seeds 0.8–1.3 mm diam. *Chenopodium polyspermum*
 Absent in North Dakota but might be found since occurs in neighboring states.

- 8 (6). Primary leaves linear, linear-lanceolate, or occasionally narrowly oblong-ovate, 2–3 times longer than broad or longer; usually without teeth or lobes or occasionally with a pair of basal lobes 9.
 – Leaves ovate, rhombic, triangular, or lanceolate, to 2 times longer than broad; usually with basal lobes and often with additional teeth on margin 12.
9. Leaves with 1 vein, blades linear, usually somewhat fleshy, margins entire. Fruit an utricle, pericarp separable; plant mostly not farinose *Chenopodium subglabrum*
 – Leaves with 3 veins from base, blades linear, lanceolate, or occasionally narrowly oblong-ovate or triangular-rhombic, usually without teeth or lobes or occasionally with a pair of basal lobes 10.
10. Leaves 3 times longer than broad or longer 11.
 – Fruit an utricle, pericarp separable; seeds rounded on top 12.
11. Perianth spreading from fruit at maturity; plants strictly erect *Chenopodium pratericola*
 – Perianth enclosing fruit at maturity. Plants usually spreading; perianth segments obtuse; leaf blades usually unlobed *Chenopodium desiccatum*
- 12 (10). Seeds honeycomb-pitted. Lower leaves serrate and usually lobed, with central lobe only slightly longer than lateral lobes or leaves unlobed and merely toothed *Chenopodium berlandieri*
 – Seeds smooth or areolate 13.
13. Leaves triangular 14.
 – Leaves ovate to broadly ovate, rhombic, or lanceolate, variously lobed or toothed 17.
14. Leaf blades toothed and sometimes with basal lobes, usually glabrous 15.
 – Leaf blades with basal lobes but no additional teeth, usually farinose 16.
15. Seeds 0.8–1.2 mm diam, seed margin round; leaf blades often with basal lobes ... *Chenopodium urbicum*
 Absent in North Dakota but might be found since occurs in neighboring states.
 – Seeds 1–1.5 mm diam., seed margin acute; leaf blades without basal lobes *Chenopodium murale*
 Absent in North Dakota but might be found since occurs in neighboring states.
- 16 (14). Plants simple below, branching above; seeds 1–1.3 mm diam. *Chenopodium fremontii*
 – Plants profusely branching from base; seeds 0.9–1.1(–1.2) mm diam. *Chenopodium incanum*
- 17 (13). Leaf blades without teeth except for often present basal lobes or teeth. Flowers in markedly different stages of development in the same glomerules *Chenopodium standleyanum*
 – Leaf blades with lateral teeth and often basal lobes. Leaves ovate, rhombic, or lanceolate, longer than broad; lateral lobes when present smaller than the terminal lobe. Leaf margins tapering to an acute apex. Inflorescence branched spicate or cymose *Chenopodium album*
 (Incl. *Ch. strictum*)

Chapter 9

Manual to Salicaceae

Keys are compiled mainly from the “Flora of North America” and “Flora of Great Plains”.

Key to Genera

1. Buds 3-10-scaled, usually resinous; leaf blades usually less than 2 times as long as wide, venation \pm palmate; stipules caducous; catkins pendulous, sessile; floral bracts: apex deeply or shallowly cut, pistillate floral bracts deciduous after flowering; flowers without nectaries (with a non-glandular, cup- or saucer-like disc); stamens 6–60(–70); stigmas 2–4; capsules 2–4-valved, narrowly ovoid to spherical . . . *Populus*
- Buds 1-scaled; leaf blades often more than 2 times as long as wide, venation usually pinnate; stipules persistent or absent; catkins erect, spreading, or \pm pendulous, sessile or terminating flowering branchlets; floral bracts: apex entire, erose, 2-fid, or irregularly toothed, pistillate floral bracts persistent or deciduous after flowering; flowers: perianth reduced mostly to adaxial nectary; stamens 1, 2, or 3–10; stigmas 2; capsules 2-valved, obclavate to ovoid or ellipsoid *Salix*

Populus L., poplar, cottonwood

1. Leaf blades usually 5–8(–10) cm, abaxial surface densely tomentose abaxial surface tomentum bright white; late leaf blades (3 or) 5-lobed *Populus alba*
- Leaf blades (1–)3–20(–27.5) cm, abaxial surface glabrous, glabrate, densely hairy, silky, or pubescent (not densely tomentose when young, not tomentose on intervein regions) 2.
2. Petioles round, cylindrical, or slightly flattened distally to plane of blades 3.
- Petioles flattened at right angle to plane of blades distally 5.
3. Petioles densely pubescent, at least distally *Populus ×jackii*
- Petioles glabrous or sparsely pubescent 4.
4. Leaf blades usually triangular-ovate or narrowly ovate to cordate, base rounded to cordate; petioles often markedly swollen distally *Populus trichocarpa*
- Leaf blades usually narrowly ovate to ovate (rarely broadly ovate), base rounded to broadly cuneate or subcordate; petioles not conspicuously swollen distally *Populus balsamifera*
Populus balsamifera hybridizes and intergrades with native species of sect. *Tacamahaca*, *P. angustifolia*, to form *P. ×brayshawii* B. Boivin. *Populus ×brayshawii* is most similar to *P. angustifolia* (petioles 0.2–0.8(–1.7) cm; leaf blades: abaxial surface whitish green, not obviously stained with reddish resin, usually lanceolate to narrowly ovate); it differs in longer petioles and darker twigs, characteristics in which it approaches *P. balsamifera*. Some trees of *P. balsamifera* from North Dakota (Bottineau and Divide counties) also seem to show an influence of *P. angustifolia*, although they are far from the present range of the latter species.
- 5 (2). Leaf blade: margins not translucent, not ciliate, margins subentire to finely crenate-serrate, teeth (12-)18-30 (-42) on each side, sinuses 0.1-1 mm deep *Populus tremuloides*
- Leaf blade: margins translucent, ciliate 6.
6. Leaves: basilar glands (0 or) 1–6 7.
- Leaves: basilar glands 0 8.

7. Basal glands 0 or 1; blade bases broadly cuneate, apices gradually acuminate *Populus ×canadensis*
 – Basal glands 0–6; blade bases truncate to subcordate, apices abruptly acuminate *Populus deltoides*
Populus ×acuminata Rydberg is the intersectional hybrid of *P. angustifolia* with *P. deltoides* (sect. *Aigeiros*) that occurs on floodplains of major streams. As with other cloning hybrids, it can often occur without one or both parents. It differs from *P. angustifolia* in larger, ovate leaves with coarser teeth, less color differentiation between abaxial and adaxial surfaces, and longer petioles that are slightly flattened side to side near the junction with the blade. Because of its frequency and morphological consistency, *P. ×acuminata* was first described as a species and is often treated as such in local and regional floras.
- 8 (6). Largest early leaf blade: margins with sinuses less than 1.2 mm deep *Populus nigra*
 – Largest early leaf blade: margins with sinuses 2(–7) mm deep. Late leaf blade: margins with (10–)25–40(–55) teeth on each side *Populus deltoides*

Salix L., willow

1. Petioles bearing lobate glands at or near the attachment to the blade; leaves finely glandular-serrate ... 2.
 – Petioles lacking glands or sometimes with minute vestiges of glands, or the petioles only glandular-viscid, in which case the leaves are narrowly lanceolate to lanceolate; leaves serrate or entire, occasionally glandular-serrate 4.
2. Leaves ovate-lanceolate, green on both surfaces, paler beneath but not white-glaucous 3.
 – Leaves elliptic-lanceolate, white-glaucous beneath *Salix serissima*
3. Leaves acute to short-acuminate, glossy above, thick and rather leathery *Salix pentandra*
 – Leaves mostly long-acuminate, semiglossy above, not especially thick *Salix lucida*
- 4 (1). Leaves linear-lanceolate, mostly 8–20 times longer than wide, entire to remotely serrulate; colonial shrub often forming dense thickets 5.
 – Leaves mostly broader in proportion to their length (often up to 10–12 times longer than wide in *S. nigra* which is a large tree) 6.
5. Largest medial blades: abaxial surface usually densely silky or pilose, adaxial sparsely silky to glabrescent, margins usually entire, slightly revolute; petioles pubescent adaxially; staminate adaxial nectaries 0.3–0.8 mm; capsules 3–10 mm *Salix exigua*
 – Largest medial blades: abaxial surface usually glabrescent, sometimes densely villous or long-silky, adaxial usually glabrescent, sometimes densely villous to pilose, margins remotely spinulose-serrulate, flat; petioles glabrous or villous adaxially; staminate adaxial nectaries 0.6–1.4 mm; capsules (4–)5–8(–10) mm *Salix interior*
- 6 (4). Leaves acuminate, gradually or abruptly tapered to a long, slender tip 7.
 – Leaves acute, obtuse, rounded or only short-acuminate at the tip 14.
7. Leaves the same shade of green on both surfaces, linear-lanceolate to lanceolate, often up to 10–12 times longer than wide *Salix nigra*
 Does not occur in North Dakota but might be found here.
 – Leaves pale to white-glaucous beneath, narrowly lanceolate, lanceolate, ovate-lanceolate or somewhat oblanceolate, less than 10 times longer than wide 8.
8. Leaves dark green and shiny above; twigs brittle and easily snapping off at the base 9.
 – Leaves yellowish-green to dark green and dull above; twigs flexible, not easily snapping off at the base 11.
9. Leaves coarsely serrate, with 4–6 glandular teeth per cm of leaf margin; petioles glandular-viscid at the summit; twigs olive to brown *Salix fragilis*

- Leaves more finely serrate, with 7–10 or more teeth per cm of leaf margin; petioles not glandular-viscid at the summit, or only with minute vestiges of glands 10.
- 10. Twigs golden-yellow to orange, glabrous; large tree to 20 m tall *Salix alba*
In Great Plains, we have only *Salix alba* var. *vitellina*.
- Twigs reddish-brown to grayish-brown, glabrous or often gray-pubescent; small or medium-sized tree to 10 m tall *Salix caroliniana*
Does not occur in North Dakota.
- 11 (8). Leaves ovate-lanceolate to lanceolate, mostly long-acuminate with tail-like tips; petioles commonly recurved; branchlets flexuous, somewhat drooping *Salix amygdaloides*
- Leaves lanceolate or somewhat oblanceolate, acuminate; petioles straight; branch-lets erect to spreading, not drooping 12.
- 12. Twigs gray-brown to dark brown, closely gray-pubescent the first year and often into the second ... 13.
- Twigs yellow or yellowish-gray to yellowish-brown, glabrous *Salix lutea*
- 13. Juvenile blades densely villous on abaxial surface or midrib long-silky; largest medial blades usually villous on abaxial surface, hairs white; petioles tomentose adaxially; pistillate adaxial nectaries 0.4–1.3 mm; floral bracts 1–2.6 mm *Salix cordata*
- Juvenile blades glabrous on abaxial surface or midrib sparsely pubescent to short-silky; largest medial blades glabrous or pilose on abaxial surface, hairs white and, sometimes, ferruginous; petioles glabrous, pubescent, or villous adaxially; pistillate adaxial nectaries 0.2–0.4 mm; floral bracts 0.4–1.1 m. Largest medial blades thinly or moderately glaucous abaxially, surface hairs usually white; stigmas 0.2–0.3 mm; pistillate catkins densely or moderately densely flowered *Salix eriocephala*
- 14 (6). Leaves persistently pubescent, especially on the lower surface (rarely glabrate in age in *S. humilis*) 15.
- Leaves glabrous or glabrate with age 18.
- 15. Leaves elliptic, narrowly ovate or narrowly obovate, sparsely to densely pubescent beneath; leaf margins flat 16.
- Leaves linear-oblong to narrowly lanceolate or oblanceolate to narrowly obovate, densely pubescent (rarely glabrate in *S. humilis*) or white-tomentose beneath; leaf margins usually revolute 17.
- 16. Pubescence including some reddish-brown hairs intermixed with silvery ones on one or both of the leaf surfaces; leaves obtuse to rounded at the tip, commonly arranged so that they appear fan-like on the branchlets *Salix scouleriana*
- Pubescence all gray; leaves acute to short-acuminate at the tip, more or less regularly alternate on the branchlets *Salix bebbiana*
- 17 (15). Shrubs of cold springs or fens; leaves linear-oblong to oblong or narrowly lanceolate, white-tomentose beneath; leaf margins revolute *Salix candida*
- Shrubs of upland habitats; leaves oblanceolate to narrowly obovate, densely pubescent (rarely glabrate) and greenish beneath; leaf margins flat to slightly revolute *Salix humilis*
- 18 (14). Leaves entire or nearly so, or with a few scattered inconspicuous teeth, sometimes to crenate-serrate with the teeth distributed unevenly around the margins 19.
- Leaves mostly serrate or finely serrate, the teeth evenly distributed around the margins 22.
- 19. Small bog shrub 40–100 cm tall; leaves elliptic-lanceolate to oblanceolate, acute to rounded and often apiculate at the tip, 2–4.5 cm long *Salix pedicellaris*
- Larger shrubs and small trees of various habitats, mostly 2–7 m tall; leaves of various shapes, never apiculate at the tip, mostly 3–10 cm long 20.
- 20. Mature leaves with some minute reddish-brown hairs persistent on one or both surfaces; leaves arranged in a fan-like manner on the branchlets, mostly obtuse to rounded at the tip *Salix scouleriana*

-
- Mature leaves glabrous or glabrate, lacking reddish-brown hairs; leaves rather regularly alternate on the branchlets, acute to short-acuminate 21.
 - 21. Leaves dull grayish-green above, the lower surface usually rugose, with the veins raised prominently on the lower surface (except in var. *perrostrata*, with the lower leaf surface smooth, without raised veins) *Salix bebbiana*
 - Leaves (at least larger ones) bright to dark green above, smooth beneath, only the primary veins, if any, raised on the lower surface, crenate-serrate, 4–10 cm long; twigs yellowish-brown to dark brown, dull *Salix discolor*
 - 22 (18). Leaves paler below than above, but not glaucous, elliptic-lanceolate to oblanceolate, mostly 2–3.5 times longer than wide *Salix maccalliana*
 - Leaves white-glaucous beneath, narrowly lanceolate or narrowly oblanceolate, mostly 3–6 times longer than wide *Salix petiolaris*

Chapter 10

Manual to Pteridophyta

Keys are original and/or compiled mainly from the “Flora of North America”, “Flora of Great Plains” and V. Skvortsov’s (2004) “Taxonomical characters of *Equisetum* species from Russian flora”.

Key to Classes

1. Leafless plants, aboveground body are mostly green segmented stems (in the spring, there might be also non-green stems), leaves are reduced to barely visible scales Classis Equisetopsida
– Leafy plants 2.
2. Microphyllous, somewhat moss-like plants with multiple small (millimeters in length) leaves, typically with no more than one vein Classis Lycopodiopsida
– Megaphyllous, with leaves usually larger (centimeters, decimeters), dissected, with multiple branching veins 3.
3. Leaves usually divided in green, flattened, photosynthetic part, and non-green, spore-bearing part (rarely this second one does not develop well) Classis Ophioglossopsida
– Leaves are with or without sporangia, monomorphic (all similar) or dimorphic (leaves with sporangia different) but are not divided in parts explained above Classis Pteridopsida

Key to Lycopodiopsida, clubmosses and spikemosses

1. Shoots flattened, plants with vertical branched stems 10–40 cm height *Lycopodium complanatum*
– Shoots radially symmetric, plants mostly with low, spreading stems up to 5 cm height 2.
2. Upper and under leaves on the same portion of stem essentially equal in length; stems forming open, spreading mats. Leaves with lax or slightly ascending cilia *Selaginella rupestris*
– Upper and under leaves on the same portion of stem unequal; stems compactly branched, forming dense mats *Selaginella densa*

Key to Equisetopsida, (*Equisetum*, horsetails)

1. Stems with apical spike 2.
– Stems vegetative, without apical spike 6.
If there are both types of stems, go either way. Lateral spikes might be ignored.
2. Aboveground stem achlorophyllous, brown, yellowish or pinkish. Sometimes, in the end of development, it makes green lateral branches 3.
– Aboveground stem green, chlorophyllous 6.
3. Leaf teeth of aboveground stems reddish-brown, filmy, completely fused by 2–4 so leaf whorls consist of 3–6 broadly lanceolate, entire teeth; tips of smaller teeth are not visible. After spore ripening, stems become greener and make lateral green branches *Equisetum sylvaticum*

- Leaf teeth free or fused by 2–5 but not to the top so tips of smaller teeth are visible, they separate by rupturing, therefore margins of bigger teeth teared. Colors of teeth are different4.
 - 4. Stems very thick, 5–12 mm in diameter. Leaf whorls large, 20–40 mm in length, with (15) 20–40 teeth, their tips long acuminate, with acumen longer than base part. Spike length 40–80 mm, with central cavity *Equisetum telmateia*
Does not occur in North Dakota.
 - Stems 2–6 mm in diameter. Teeth 6–15 (20), different shape but always without acumen. Spike length 10–35 mm, without central cavity5.
 - 5. Sheath tube bluish-green. Teeth in (8) 10–20 and always have wide light-colored, transparent margin which is broader than the darker central part of tooth (magnification required). After spore ripening, stems always become green and make lateral branches *Equisetum pratense*
 - Whorls as a whole brown or with whitish (not greenish or bluish) sheath tube. Leaf teeth by 6–12 (16), without wide transparent margins, they have only white, non-transparent, narrow (more narrow than central parts) margins. Generative shoots degrade after ripening (however, sometimes they survive and become green and branching) *Equisetum arvense*
- * * *
- 6 (1, 2). Leaf teeth on all aboveground shoots have broad base part and separated long acumen which (at least on some teeth) soon falls off and leaves horizontal scar on the top of teeth. Sometimes, whole teeth fall off, and in that case, only sheath margin remains. Stomata in regular rows and submerged into cuticle7.
 - Leaf teeth of aboveground shoots do not drop. On the main stem, teeth do not have long acumen; on branches, teeth could be acuminate but nothing falls off, all tips always sharp. Stomata not in regular rows, their subsidiary cells are on the level of epidermis 12.
 - 7. Length of basal part of tooth 1.5–3 (4) times less than length of sheath tube on the same node. Leaf teeth stay in place, at least on some nodes. Acumens of leaf teeth are shorter, equal or to 1.5 times longer than their basal parts. Aboveground stems 0.5–3.5 in diameter, central cavity not more than 1/2 of stem diameter8.
 - Length of the basal part of tooth 4–10 times less than length of sheath tube on the same node, or teeth fully fall off, and only the sheath margins are left on all nodes. Acumens of leaf teeth 2–5 times longer than their basal parts. Normal stems 4–10 mm thick (but sometimes sprout stems are about 1 mm in diameter), central cavity usually more than 3/4 of stem diameter9.
 - 8. Acumens of teeth always stay, at least on some stem nodes, and 1.2–1.5 times longer than the basal parts. Shoots typically flexuous, with curved internodes. Teeth in whorls by 3 (sometimes 4) *Equisetum scirpoides*
 - Acumens of leaf teeth shorter than their base parts, or sometimes equal or to 1.2 times longer, or they fall off from all teeth. Shoots usually not flexuous, sometimes arc-shaped. Teeth in whorls by 4–6 (rarely more, up to 12; some stems within group might have 3 teeth in the whorl) *Equisetum variegatum*
 - 9(7). Ratio between length and width (upper rim) of sheath tube is less than 1.8 on middle nodes 10.
 - Ratio between length and width (upper rim) of sheath tube is 2–4 on middle nodes *Equisetum ramosissimum*
Does not occur in North Dakota.
 - 10. All of the sheaths on the main stem bearing a black band, sheaths about as long as broad; spores normal *Equisetum hyemale*
 - None or only part of the sheaths on the main stem bearing a black band, sheaths mostly longer than broad; spores normal or abortive 11.

11. Spores normal, well formed; sheaths of the main stem all green or the basal 1 or 2 irregularly banded or dark colored; stems smooth. Cone apex usually rounded, sometimes apiculate with blunt tip *Equisetum laevigatum*
 – Spores abortive; sheaths on at least the lower half of the main stem black banded; stems mostly rough with silica tubercles on the ridges. Cone apex pointed *Equisetum ×ferrissii*
- 12 (6). Aboveground stems clearly separated in central axis and multiple lateral branches 13.
 – Aboveground stems do not branch or with sporadic branches, or branch only near the basis and make groups of where it is hard to say which stem is central and which are lateral 16.
 If there are shoots of both types, go either way.
13. Internode ribs with deep longitudinal groove which starts from backs of leaf teeth. Branches on all length with on all length with cross wrinkles. Margins of branches with acute emergences directed downwards *Equisetum telmateia*
 Does not occur in North Dakota.
 – Internode ribs flat or convex, without longitudinal grooves. Teeth without groove on their backs or with groove but then it does not go into internodes 14.
14. Stem on all length is covered by small spines, their length is bigger than width. These spines often cover all internodes but sometimes, they are not numerous and concentrated under nodes. Basal segment of branches thin filmy, easy to crumple 15.
 – Stem smooth or covered with small blunt papillae which length is less than their width. Basal segment of branch dense, not easy to crumple 16.
15. Teeth of basal branch segment narrowly triangle, long acuminate, with length:width ratio 3–5. Teeth of the first branch segment (next to basal) also long, acute, with ratio 1.5–5 or more (do not count the acumen). Branches always branch again. Teeth on main stem, at least in the beginning of the development fused by 2–4 so the leaf whorl consists of 3–6 lanceolate, brown or reddish brown “big” teeth, their tips are often bent outwards *Equisetum sylvaticum*
 – Teeth of basal branch segment wide triangle, not acuminate, with length:width ratio approximately 1. Teeth of the first branch segment (next to basal) also short and broad, without acumen (sometimes with acumen) with ratio 1 (do not count acumen). Branches usually do not branch again (secondary branching exists only as anomaly). Teeth on the main stem simple, free or sometimes some of them fused by 2–3 but their tips are not bent outwards *Equisetum pratense*
- 16 (12, 14). Commissure between teeth on the sheath tube without narrow groove (requires living sample or soaked herbarium sample). Branches (if they exist) with central cavity. Central cavity of the main stem large, $\frac{5}{6}$ of the diameter or more *Equisetum fluviatile*
 – Commissure between teeth on the sheath tube with sharp narrow groove. Central cavity of the main stem is less than $\frac{2}{3}$ of the diameter 17.
17. First (next to basal) segment of all branches is significantly (1.5–4 times) shorter than leaf whorl of the same node on main stem, and 1.5–3 times longer than basal segment of the same branch. Length of the first segment is more or less constant on the same shoot. Internode depressions without grooves. Branches on all length with cross wrinkles made of small ribs. Non-branching shoots consist of stems like normal main stems, with central cavity and surface like on branches, teeth there in the middle part all similar, triangle, without acumen *Equisetum palustre*
 – First (next to basal) segment of (at least upper) branches longer than leaf whorl on the same node on main stem, and (3) 4–10 times longer than basal segment of the same branch. Sometimes, weak and poorly branched plants have first segment equal or slightly shorter than leaf whorl on the same node on main stem, but in this case, length of the first segment is increasing from the base of main stem towards its tip. Internode depressions with central narrow, sharp groove. Branch surface smooth or with cross thin wrinkles which are visible only under high magnification; the surface similar to *E. palustre* could occur only on the lowest internodes. Non-branching shoots branch-like, without central cavity and wrinkled surface; their teeth long acuminate, with tip often bent outwards *Equisetum arvense*

Key to *Ophioglossopsida* (*Botrychium*, moonworts)

1. Leaf blades deltate, mostly 5–25 cm, commonly sterile, sporophores absent or misshapen; plants mostly over 12 cm; leaf sheaths open or closed2.
 - Leaf blades mainly oblong to linear, mostly 2–4 cm, all fertile, sporophores always present; plants to 15 cm, mostly less than 10 cm; leaf sheaths closed3.
- 2 (1). Trophophore blade thin, herbaceous; leaf sheaths open; sporophores, when present, arising from base of trophophore blade high on common stalk; leaves absent during winter *Botrychium virginianum*
 - Trophophore blades leathery; leaf sheaths closed; sporophores, when present, arising near ground from basal portion of common stalk; leaves present during winter. Segments of blades rounded, nearly entire, plane *Botrychium multifidum*
- 3 (1). Trophophores linear to linear-oblong, simple to lobed, lobes rounded to square and angular, stalks usually $1/3$ – $2/3$ length of trophophore; plants in deep shade under shrubs and trees. Segments rounded; plants herbaceous *Botrychium simplex*
 - Trophophores linear to deltate (narrowly oblong in *Botrychium minganense*), pinnate, rarely simple, lobes, if present, of various shapes, stalk usually less than $1/4$ length of trophophore; plants usually in exposed sites4.
4. Distance between 1st and 2d pinna pairs greater than that between 2d and 3d pairs; segments asymmetric, enlarged on acroscopic side. Apex of blade undivided or coarsely divided; pinnae from ovate to fan-shaped, margins shallowly sinuate; small leaves frequently simple or nearly so; large mature blades subternate to ternate; sporophores 1-pinnate *Botrychium simplex*
 - Distance between 1st and 2d pinna pairs same or slightly more than between 2d and 3d pairs; segments asymmetric to symmetric5.
5. Trophophores present; basal pinnae or segments with venation like ribs of fan, midrib absent; basal pinnae fan-shaped to spatulate6.
 - Trophophores present or replaced by sporophore; if present, basal pinnae or segment venation pinnate, midrib present, ovate to lanceolate, blunt, shallowly to deeply lobed *Botrychium matricariifolium*
6. Trophophore blades ovate to deltate. Sporophores 3–5 times length of trophophores, arising at or just above leaf sheath; blades bright green, pinnae remote or approximate, fan-shaped, papery *Botrychium simplex*
 - Trophophore blades oblong to oblong-lanceolate7.
7. Basal pinnae broadly fan-shaped. Plants fleshy; trophophores on most plants more than 5×2 cm; pinnae 4–9 pairs, approximate to overlapping; margins usually entire to undulate, rarely dentate; sporophores 0.8–2 times length of trophophore; dry sites *Botrychium lunaria*
 - Basal pinnae narrowly fan-shaped, or cuneate to lanceolate or linear8.
8. Trophophores \pm folded longitudinally when alive, usually to 4×1 cm; pinnae to 5 pairs, most proximal pinnae 2-lobed. Blades very fleshy; sporophores usually less than 1.5 times length of trophophores; pinnae mostly linear; basal pinna lobes usually \pm equal; appearing in spring *Botrychium campestre*
 - Trophophores flat or folded only at base when alive, usually to 10×2.5 cm; pinnae to 10 pairs, basal pinnae unlobed or if lobed, not usually 2-cleft. Blades narrowly oblong, firm to herbaceous; pinnae nearly spheric to fan-shaped; margins shallowly crenate; proximal sporophore branches 1-pinnate *Botrychium minganense*

Key to Pteridopsida, true ferns

All true fern genera below are frequently given under one family name, “Polypodiaceae”. However, contemporary classifications of ferns recognize multiple families:

Aspleniaceae *Athyrium*, *Cystopteris*, *Gymnocarpium*, *Onoclea*, *Thelypteris*, *Woodsia*

Dennstaedtiaceae *Pteridium*

Marsileaceae *Marsilea*

Osmundaceae *Osmunda*

Polypodiaceae *Dryopteris*

Pteridaceae *Cheilanthes*, *Pellaea*

1. Sterile and fertile leaves distinctly dimorphic; sporgonia borne in berrylike or cylindrical modified pinnae 2.
 - Leaves uniform or nearly so 4.
2. Petiole winged (stipulate) at the base *Osmunda cinnamomea*
 - Petiole not winged (stipulate) 3.
3. Rhizomes widely creeping; sterile blade pinnatifid *Onoclea sensibilis*
 - Rhizomes nearly erect (stolons may be present); sterile blade pinnatepinnatifid ... *Onoclea struthiopteris*
- 4 (1). Blade simple or pinnatifid. Veins anastomosing *Onoclea sensibilis*
 - Blade 4-palmate *Marsilea vestita*
 - = Blade at least 1-pinnate 5.
5. Blade broadly triangular 6.
 - Blade linear, lanceolate, or otherwise but never broadly triangular 8.
6. Sori continuous along the margins of the ultimate segments (or sori does not develop but margins still rolled) *Pteridium aquilinum*
 - Sori discrete, round, median to submarginal 7.
7. Rachis distinctly winged, pilose *Thelypteris palustris*
 - Rachis never winged, glabrous *Gymnocarpium dryopteris*
- 8 (5). Blade 1-pinnate 9.
 - Blade pinnate-pinnatifid or 2-pinnate 10.
9. Sori continuous along the reflexed or revolute margin of the pinnae *Pellaea glabella*
 - Sori discrete, median on the pinnae, curved or hooked distally *Athyrium filix-femina*
- 10 (8). Blade widest above its middle *Onoclea struthiopteris*
 - Blade widest at or below its middle 11.
18. Sori continuous along the margins of the segments 12.
 - Sori discrete 13.
12. Pinnules jointed at the base *Pellaea glabella*
 - Pinnules and segments not jointed at the base *Cheilanthes feei*
13. Blade densely hairy or scaly, or both, on one or both surfaces 14.
 - Blade lacking indument or ramentum of any kind or if present only sparsely so and mostly limited to the veins 15.
14. Petiole jointed *Woodsia oregana*
 - Petiole continuous *Cheilanthes feei*
15. Indusium reniform, attached at the sinus 16.
 - Indusium various 18.
16. Rhizome compact or only short creeping; rachis glabrous 17.
 - Rhizome slender and extensively creeping; rachis usually at least sparsely pilose ... *Thelypteris palustris*
17. Indusium attached on the basiscopic side only, elsewhere free, ovate-lanceolate to broadly cup-shaped *Cystopteris fragilis*

- Indusium attached beneath the sorus, early opening and splitting into spreading segments *Woodsia oregana*
 - 18 (15). Blade at least 2-pinnate *Dryopteris carthusiana*
 - Blade pinnate-pinnatifid *Dryopteris cristata*
- Hybrid between these two species, *D. ×uliginosa*, is a large plant with leaf characters intermediate between parents.

Some useful literature

Blakeslee A.F., Jarvis C.D. 1926. Trees in winter. Their study planting, care and identification. New York: Macmillan.

Core E.L., Ammons N.P. 1958. Woody plants in winter. Pittsburgh, Pennsylvania: Boxwood Press.

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