Sub-Guide to Freely Branched Mosses -- MidWest

Revised through 30 April 2010

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***Reminder**: A dagger (†) indicates that not all of the species within a given genus, or the genus containing a species listed, have the character(s) defining that Group. Abbreviations for the **distribution** of taxa are found at the end of the Concordance.*

Group P1 - Shoots strongly flattened (complanate) or angular

Group P1

Shoots **angular** with leaves folded (**conduplicate**); plants **aquatic**, submerged part of year.
- Leaves with a **narrow**, **single** costa; SE — *Brachelyma subulatum*
- Leaves **ecostate** (costa lacking); leaves keeled or flat; WS — *Fontinalis*†

Shoots **complanate**.
- Leaves with a **narrow**, **single** costa.
  - Plants **without both** large and small leaves.
    - Leaf tip **rounded-obtuse**, leaves **asymmetric**, upper leaf cells >5:1; WS* — *Homalia trichomanoides*
    - Leaf tips **acuminate to acute**.
      - Leaf margins **distinctly serrulate**, leaf tip **twisted** at apex; E, WA — *Steerecleus serrulatus*
      - Leaf margins **entire**, leaf tip **not** twisted, in wet swampy places; WS — *Leptodictyum riparium*†
- Leaves with a **long**, **double** costa ending above leaf middle.
  - Leaf cells **smooth,** costa about 3/4 of leaf length.
- Leaves with a **short** & **double** costa, or none.
  - Leaf cells **large, lax, hexagonal**, often rhizoids and papillose gemmae on leaf tips; E, N, CA — *Hookeria*
  - Leaf cells firm- to thick-walled, **rounded to linear**.
    - Leaves slenderly **long** decurrent; leaf margins **entire**, or serrulate at tip; WS — *Plagiothecium*†
    - Leaves **shortly** decurrent, undulate or not; on vertical substrates; WS* — *Neckera*
    - Leaves **not** decurrent.
      - Leaves **obtuse**, **asymmetric** and with a **basal** lobe; MS, TN, NC, VA — *Homaliadelphus sharpii*
      - Leaves **secund**; very **shiny** plants; margins sharply **serrulate** above; WS — *Brotherella recurvans*
      - Leaves **straight** or slightly secund at tips.
        - Rhizoids **axillary** and **papillose**; stem **hyalodermis** well or moderately developed.
          - Leaves ±**serrate** throughout; alar cells **quadrate**; WS* — *Herzogiella turfacea*†
          - Leaves ±**entire**; alar cells ±**undifferentiated**; WS* — *Isopterygiopsis muelleriana*†
        - Rhizoids **below** leaf insertions and **smooth**; stem hyalodermis **lacking**.
          - Leaf apical cells **long**.
            - Alar cells **enlarged**, **subquadrate** and **thick-walled**; WS — *Callicladium haldanianum*
            - Alar cells **quadrate**, but **neither** particularly enlarged **nor** thick-walled.
              - Leaves **acuminate**; pseudoparaphyllia **filamentous**; E — *Isopterygium tenerum*
              - Leaves **broadly acute**; pseudoparaphyllia **lacking**; WS — *Entodon*†
            - Alar cells ±**undifferentiated**; pseudoparaphyllia **lacking**; WS — *Pseudotaxiphyllum*
          - Leaf apical cells **short**; pseudoparaphyllia **foliose**; E, SW — *Taxiphyllum*†

Group P2 – Shoots julaceous (especially when dry) – shoots smoothly cylindric with crowded, overlapping and appressed leaves

Group P2

Leaves with a **narrow**, **single** costa.
- Leaf margins with **cilia**, plant stem and branches with **paraphyllia**; E — *Thelia*
- Leaf margins **serrulate**; leaves **concave**-**cucullate**; leaf tips **twisted** and apiculate; E — *Bryoandersonia illecebra*
- Leaf margins **entire** or slightly serrulate apically; paraphyllia **lacking**.
  - Median leaf cells **long**.
    - Branching ±**pinnate** and in one **plane**; lawns and disturbed areas; WC, NY — *Pseudoscleropodium purum*
  - Median leaf cells **short**; stems growing **singly** at **right angles** to bark; SE — *Cryphaea*

Leaves with a **short**, **double** costa or none.
- Leaves **serrulate** to **dentate**; alar cells **indistinctly** subquadrate; WS(N) — *Myurella*†
- Leaves spinulose-**serrate** to serrulate at the **apex**.
  - Leaves spinulose-**serrate** & **hyaline** above; shoots **julaceous**; cells **papillose**; WS — *Hedwigia*
  - Leaves with a slightly **serrulate tip**; cells **smooth**.
    - Shoots curved-**ascending** (dry); alar cells ±**undifferentiated**; E — *Leucodon*†
    - Shoots **straight** (dry); alar cells **numerous** & **quadrate**; E — *Entodon*†
- Leaves **entire**; plants in very wet places, e.g., shallow water; alar cells **short** and **wide**; WS* — *Scorpidium*

Group P3 – Leaves spreading at right angles (squarrose) or squarrose-recurved; leaf tips often channeled

Group P3

Stems **red**; plants ±**robust** and loosely **ascending**; costa **double** (long or short) or lacking; WS* — *Rhytidiadelphus*

Stems **green**; plants ±**slender** and **creeping**; costa long and **single**, short and **double**, or lacking; WS* — *Campylium*

Group P4– Plants with erect branches from a creeping stem

Group P4

Costa **long** and **single**.
- Alar cells **quadrate** to **oblate**.
  - Branching **irregular**; costa **not** toothed; alar cells **extending** up leaf margin; E — *Forsstroemia producta*
- Alar cells ±**undifferentiated**.
  - Leaves **channeled** at the costa; margins erect or **incurved** at the apex; E — *Drummondia prorepens*

Costa **variable** (single, short and double or lacking within the same plant); on trunks of trees.
- Secondary stems **sub-pinnately** branched; brood bodies **lacking**; E — *Forsstroemia trichomitria*

Group P5– Plants with leaves distinctly sickle-shaped and turned to one side (falcate-secund)

Group P5

Costa **long**, **single** and **narrow**.
- Paraphyllia **abundant** and **filamentous**; stem leaves deeply plicate, not complanate; WS — *Palustriella*
- Paraphyllia **lacking**.
  - Leaf cells **prorulose**; leaves plicate and **rugose**; WS* — *Rhytidium rugosum*
  - Leaf cells **smooth**.
    - Leaves **neither** complanate **nor** undulate.
      - Stems with a **hyalodermis** (thin-walled, hyaline cells on stem surface).
        - Leaves **plicate** and **denticulate** in upper portion; WS* — *Sanionia*
        - Leaves **striolate** (finely ridged) to **plane,** and **entire** to slightly denticulate.
          - Alar cells **inflated**; plants occurring in **streams** on rocks or wet places; WS — *Hygrohypnum*†
          - Alar cells **little** differentiated; plants in rich **fens**; N — *Limprichtia*
      - Stems **lacking** a hyalodermis (thick-walled cells on stem surface).
        - Plants of **upland** habitats, leaves **plicate**; WS — *Brachythecium*†
        - Plants of **wet** habitats, leaves **not** plicate.
          - Leaves **keeled**, **3-ranked**; WS* — *Dichelyma*
          - Leaves **neither** keeled **nor** 3-ranked.
            - Costa **excurrent**; alar cells abruptly inflated or undifferentiated; WS* — *Drepanocladus*†
            - Costa **subpercurrent**; plants in **fens** and **seeps**.
              - Leaf margins finely **denticulate**; WS* — *Warnstorfia*
              - Leaf margins **entire**.
                - Central **strand** (small cells) in stem; WS* — *Drepanocladus*†
                - Central strand **lacking**; N — *Hamatocaulis*

Costa **short** and **double**, or none.
- Arms of double costa **meeting** at the base, or **none**.
  - Shoots in **flat**, evenly **pinnate**, **feather**-like, **fronds**; plants **large**; WS* — *Ptilium crista-castrensis*
  - Shoots **loosely complanate**; plants **very shiny**; leaves **very serrulate** above; E, NW — *Brotherella recurvans*
  - Shoots **julaceous**; found in wet places (often submerged); WS* — *Scorpidium scorpioides*
  - Shoots **falcate-secund** when **dry**, erect when moist; on trees; WS* — *Pylaisiella*
  - Shoots **lacking** the above unique characters.
    - Leaves **plane**.
      - Leaf cells **prorulose**.
        - Leaves crowded, **spreading** and **secund**; alar cells **subquadrate**; E, AK, BC — *Ctenidium*
      - Leaf cells **smooth**.
        - Alar cells in **several** rows and **thick**-walled; leaves **serrate** above; SE — *Heterophyllum affine*
        - Alar cells in **1-2** rows with **2-3** cells inflated; leaves ±**serrulate**; E — *Pylaisiadelpha tenuirostris*
        - Alar cells in **triangular** patches; leaves ±**entire**.
          - Plants on **wet rocks** in mountain streams; branching ±**irregular**; WS — *Hygrohypnum*†
          - Plants of **mesic** to wet habitats; branching regularly **pinnate**; WS — *Hypnum*

Group P6 – Plants with paraphyllia or tomentum on stem.

Group P6

Stems with **tomentum,** calciphile in fens, swamps; WS* *Tomentypnum*
Stems with **paraphyllia**.
- Leaves with a **short**, **double** costa or none; plants irregularly pinnate.
- Leaves with a **long**, **double** costa.
  - Plants **2-3**-pinnate with **stepwise** flat fronds; upper leaf cells **prorulose**; WS* *Hylocomium splendens*
  - Plants **irregularly** to **1-2**-pinnate; cells smooth or prorulose.
    - Leaves **spinulose**-serrate all around; NE, N *Hylocomiastrum umbratum*
    - Leaves **serrate** in upper half; stem leaves **rugose** at acumen base; E *Loeskeobryum brevirostre*
- Leaves with a **long**, **narrow** costa.
  - Plants **dendroid**; upper leaf cells **short** (2-5:1).
    - Plants **little** altered dry; leaf margins strongly serrate in **upper half**; on rich soil; E *Climacium*
  - Plants **irregular pinnate**; cells **linear** (> 8:1); margins **spinulose**; NE, N *Hylocomiastrum pyrenaicum*
  - Plants **lacking** the above unique characters.
    - Alar cells **inflated** in well marked groups.
      - Stem leaves deeply **plicate**; paraphyllia **filamentous** and abundant; soil and rocks; WS *Palustriella*
      - Stem leaves **plane**; paraphyllia **foliose** and few to many; wet areas; WS* *Cratoneuron*
    - Alar cells mostly **not** differentiated, if so, **not** inflated.

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Paraphyllia **papillose**.
- Plants **small**; stem leaves **<0.6mm**; leaf cells minutely **pleuripapillose**.
  - Leaf cells pleuripapillose **both sides** of leaf; E *Cyrto-hypnum*
  - Leaf cells pleuripapillose **back side** of leaf only; E, AZ *Rauiella*
- Plants **larger**; stem leaves **1-1.9mm**; branch leaf cells mostly **unipapillose**.
  - Plants **1-pinnate**, suberect and wiry; WS *Abietinella abietina*
  - Plants **2-3-pinnate**, mostly spreading and softer; E, NW *Thuidium*

Paraphyllia **smooth**.
- Leaf cells with either **forked**, or **elongate** and **curved** papillae; leaves **ovate**; E *Thelia*
- Leaf cells either **prorulose** or with **short** and **simple** papillae; leaves ±**lanceolate**.
  - Stem and branch leaves somewhat **differentiated**; 1-pinnate; E, AZ *Bryohaplocladium*
  - Stem and branch leaves **uniform**.
    - Leaf cells **elongate**, **oblong-rhombic** to oblong-linear.
      - Paraphyllia linear**-lanceolate** and numerous.
        - Capsules **inclined**, **asymmetric**; W *Pseudoleskea*
      - Paraphyllia **filiform** and abundant; capsules inclined to horizontal and curved; WS* *Helodium*
    - Leaf cells **short** (isodiametric or nearly so, hexagonal to short-rhombic); W *Pseudoleskea*

Group P7 – Plants with red stems

Group P7

Costa **long** and **double**.
- Stems with **paraphyllia**.
  - Plants **dendroid** (tree-like) on soil in wet, shady places; E — *Climacium*
  - Plants **2-3**-pinnate with **stepwise** flat fronds; upper leaf cells **prorulose**; WS* — *Hylocomium splendens*
  - Plants **irregularly** branched; stem leaves **rugose** at acumen base; E — *Loeskeobryum brevirostre*
- Stems **without** paraphyllia and irregularly branched; WS* — *Rhytidiadelphus*

Costa **long** and **single**.

Costa **short** & **double**, or none.
- Leaves distinctly **falcate-secund**; WS — *Hypnum*†
- Leaves squarrose to **squarrose-recurved**; WS* — *Rhytidiadelphus*
- Leaves **straight**.
  - Leaves with a **hyaline** tip; shoots **whitish** and ±**julaceous** when dry; cells **papillose**; WS — *Hedwigia ciliata*
  - Leaves with a **green** tip; leaf cells **smooth**.
    - Alar cells **inflated**, **hyaline** and **thin**-walled in distinct **auricles**; WS (N) — *Calliergonella cuspidata*
    - Alar cells **short**-oblong with **thick orange** walls; WS — *Pleurozium schreberi*

Group P8 – Plants with shoots flat on top and appearing "braided"

Group P8

Costa **single** and **narrow**; pseudoparaphyllia present.
- Cells **prorulose** on leaf back; regularly 1-pinnate; leaves serrulate **all around**; E, AK, BC — *Ctenidium*
- Cells **smooth**; closely 1-pinnate in **feather-like** fronds; leaf **tips** serrulate; WS* — *Ptilium crista-castrensis*

Costa **short** and **double**, or none; pseudoparaphyllia usually present.
- Alar cells in **transverse rows** and inflated; leaves **sharply serrulate** above; E, BC, WA — *Brotherella*
- Alar cells in **triangular areas**, inflated or not; leaves entire to serrulate; WS — *Hypnum*†

Group P9 – Leaves undulate or rugose (irregular undulations)

Group P9

Leaves with a **narrow**, **single** costa.
- Leaves **rugose**; shoots **round**; paraphyllia **lacking**.
  - Leaf cells **prorulose**; WS* — *Rhytidium rugosum*

Leaves with a **short**, **double** costa or none.
- Plants **julaceous** and growing in wet (submerged) areas; WS — *Scorpidium scorpioides*
- Plants **not** julaceous; leaves **complanate** & **undulate**; on rocks or trees; WS* — *Neckera*†

Group P10 – Leaves dimorphic (two forms on the same axis)

Group P10

None

Group P11 – Leaves with awns, hair-points or hyaline apices

Group P11

Leaves with a **narrow**, **single** costa.
  Leaf cells **smooth**.
    Cell walls **nodulose** (wavy) throughout; WS — *Racomitrium*†
    Cell walls **straight**.
      Leaf apex **flat**, **filiform** and **serrate**; leaves **abruptly** acuminate; N* (S to NC) — *Cirriphyllum*
Leaves with a **short**, **double** costa or none; apex **hyaline** or abruptly contracted to long **setaceous** point.
  Leaf cells **papillose**; leaf apex **hyaline**.
    Leaf cells with **1** or **more**, simple to **forked** papillae; WS — *Hedwigia ciliata*
  Leaf cells **smooth**, leaf apex hyaline or yellow.

Group P12 – Plants thread-like (leaves <1mm)

Group P12

Leaves to **1 mm**; costa **variable**; cells **rounded**-**elliptic**; pseudoparaphyllia **lanceolate**; N,W — *Pseudoleskeella*
Leaves **0.5-0.8 mm**; costa none or **short** and **double**; cells **rhombic**; paraphyllia **few**; WS* — *Homomallium*
Leaves **0.15-0.5 mm**; costa none or **short** and **double**; cells **rhombic**; paraphyllia **none**; WS — *Platydictya*

Group P13 – Costa double and more than 1/3 leaf length

Group P13

Note: see Group 20 also for several of these mosses where costa form is variable within a single plant.

Costa **>2/3** the leaf length with branches of ±equal length.
  Leaf cells **smooth**; plants in flat **mats**; secondary stems **prostrate**.
Costa **1/3-2/3** the leaf length with branches of ±equal length.
  Leaf cells **prorulose**.
    Stems **red**.
      Plants **regularly 2-3**-pinnate with **stepwise** flat fronds; WS* — *Hylocomium splendens*
      Plants **irregularly** branched; leaves **plicate** with broad flat tip; WS* — *Rhytidiadelphus triquetrus*†
    Stems **green**; plants **loosely** pinnate; leaves **decurrent**; costa **variable**; WS(N) — *Heterocladium dimorphum*†
  Leaf cells **smooth**.
    Paraphyllia **abundant**; leaf **serrate** in upper half; leaves **not** decurrent; E — *Loeskeobryum brevirostre*
    Paraphyllia **lacking.**
      Leaves **spinulose**-**serrate** all around and **decurrent**; NE, N — *Hylocomiastrum umbratum*†
      Leaves **entire** to somewhat serrulate; costa often **variable**.
        Leaves slenderly long **decurrent**; costa branches often **unequal**; WS — *Plagiothecium*†
        Leaves **not** distinctly decurrent.
          Alar cells **subquadrate** and slightly **porose**; in rich, open **fens**; N — *Pseudocalliergon turgescens*
          Alar cells **quadrate** or **inflated**; on rocks in **mountain streams**; WS — *Hygrohypnum*†

Group P14 – Costa single and narrow; leaves with distinct decurrencies

Group P14

Leaf cells **pleuripapillose**; decurrencies broad to **auriculate**.
  Costa ±**subpercurrent**; leaf margins **crenulate** from projecting papillae; N* — *Anomodon*†
Leaf cells distinctly **prorulose**; E — *Bryhnia*
Leaf cells **smooth** or indistinctly ornamented.
  Plants **arching** and ±regularly **pinnate**; leaf apical cells **shorter** than medial cells; W — *Eurhynchium*†
  Plants **neither** dendroid, arching-pinnate, **nor** complanate; apical cells **similar** in size to medial cells.
    Leaves **minutely prorulose** with **twisted** apices; cells **3**-**4:1**; E — *Bryhnia novae-angliae*
    Leaves **smooth** with plane **or** twisted apices; cells mostly >**4:1**; WS — *Brachythecium*†

Group P15 – Costa single and narrow; leaves with a distinct marginal border

Group P15

Leaves bordered with **cilia**.
- Cilia from leaf base **to apex**; paraphyllia **polymorphous**, lacinate, ciliate & few to abundant; E — *Thelia*
- Cilia at leaf **base only**; paraphyllia **filiform** and abundant; WS* — *Helodium*

Leaves bordered with **linear** cells.
- Leaf margins **serrulate** to **serrate**.
  - Shoots **angular**; leaves **conduplicate**; plants **submerged** part of year; SE — *Brachelyma subulatum*
  - Shoots **round**; leaves **plane** with **multistratose** borders.
    - Leaves ±**ovate** and acute with **serrulate** marginal cells; E — *Platylomella lescurii*
- Leaf margins **entire**; on rocks and tree trunks.

Group P16 – Costa single and narrow; leaves with distinct alar cells

Group P16

Alar cells **inflated** and **hyaline**, or **yellow**.
- Paraphyllia **present**.
  - Stem leaves **plicate**; paraphyllia **filamentous** and **abundant**; WS — *Palustriella*
  - Stem leaves **plane**; paraphyllia **foliose** and either abundant or few; WS* — *Cratoneuron*
- Paraphyllia **lacking**.
  - Leaves broadly **rounded** at tip.
    - Leaves **without** an apiculus; alar cells thin-walled; in fens and swamps; N — *Calliergon*
  - Leaves **acuminate** or bluntly **acute**.
    - Leaves **falcate-second**.
      - In **fens** or other nutrient rich waters.
        - Alar cells **numerous** in **large** conspicuous groups; WS* — *Drepanocladus*
      - On **rocks** in or along **streams**; alar cells **subquadrate** to **oblong**; WS — *Hygrohypnum*
    - Leaves **straight**.
      - Leaves narrowed to long, **channeled acumen**; WS* — *Campylium polygamum*
      - Leaves ovate-lanceolate and **narrowed** to an **acumen**; WS* — *Drepanocladus aduncus* var. *kneiffii*
      - Leaves **acuminate**; alar cells often in broad **decurrencies**; WS — *Brachythecium*†

Alar cells **small** and **subquadrate**.
- Leaves ±broadly **oblong-ovate**.
  - Shoots ±**julaceous**.
    - Leaves abruptly **apiculate**; plants **erect**; in **lawns** and gardens; WC, NY — *Pseudoscleropodium purum*
    - Leaves **rounded** to acute; plants **prostrate**; on **rocks** in or along **streams**; WS — *Hygrohypnum*
  - Shoots **neither** julaceous **nor** complanate; **creeping** stems and erect branches; E — *Forsstroemia producta*†
- Leaves **ovate** to **ovate-lanceolate**.
  - Leaf margins **serrate** above.
    - Branching **irregular** to sub-pinnate; medial cells >**2:1**; WS(WC & SA) — *Isothecium*
  - Leaf margins **entire** to serrulate.
    - Leaf cells distinctly **papillose**; leaf acumen **pale**; WS(E) — *Lindbergia brachyptera*†
    - Leaf cells ±**smooth**; leaf apices **green**.
      - Shoots **not** julaceous; costa **slender**; exostome teeth **fragmentary**; SE — *Clasmatodon parvulus*
- Leaves ±**lanceolate**; shoots **not** julaceous; plants **prostrate**.
  - Leaves narrowed to long, **channeled acumen** and ±**squarrose-recurved**; WS* — *Campylium*†
  - Leaves and cells **lacking** any of the above unique characters.
    - Alar cells **symmetrically** arranged; WS — *Brachythecium*†

Group P17 – Costa short and double, or none; leaves with distinct decurrencies

Group P17

Leaf cells **smooth**; costa short and double, or about 1/2 leaf length

Leaf margins serrulate to **serrate** all around; alar cells abruptly **inflated**; WS* *Herzogiella striatella*†

Leaf margins **entire** or with serrulate tips.

Alar cells **poorly** differentiated; WS *Plagiothecium*

Group P18 – Costa short and double, or none; leaves with a distinct marginal border

Group P18

Leaves bordered with **cilia**; paraphyllia few to abundant (costa usually single); E *Thelia*

Group P19 – Costa short and double, or none; leaves with distinct alar cells

Group P19

Alar cells **inflated,** and **hyaline** or **yellow**.

Leaves distinctly **falcate-secund**.

Plants **regularly** pinnate, feather like; **flat** oblong, **triangular** fronds; WS* *Ptilium crista-castrensis*

Plants **irregularly** pinnate to unbranched.

Plants in **calcareous** wet areas; leaves concave and apiculate; WS* *Scorpidium scorpioides*

Plants **on rocks** in mountain **streams** or wet places; leaves ovate and concave; WS *Hygrohypnum*

Plants in **other** habitats.

Stems with a **hyalodermis**; alar cells in large, almost decurrent areas; WS *Hypnum*

Stems **lacking** a hyalodermis; leaf apices serrate to serrulate.

Alar cells **subquadrate** and in ±**triangular** group; apices **serrate**; SE *Heterophyllium*

Alar cells **oblong** and in ±**triangular** group; apices **serrulate**; E, NW *Brotherella*

Alar cells **oblong** and in **rows** 1(-2) cells wide; apices ±**entire**; E *Pylaisiadelpha tenuirostris*

Alar cells **few** with short-oblong cells above; apices **serrulate**; WS *Hypnum*

Leaves **homomallous**; alar cells abruptly and strongly inflated as "**bubble**" cells; E *Sematophyllum*

Leaves **neither** falcate-secund **nor** homomallous.

Stem leaves **without** a setaceous point, acute, acuminate or apiculate.

Leaves **squarrose-recurved**; alar cells oblong and ±inflated; WS* *Rhytidiadelphus squarrosus*†

Leaves **erect** to **spreading**; alar cells hyaline.

Plants **erect**; stems with a **hyalodermis**; alar cells in **auricles**; WS *Calliergonella cuspidata*

Plants **prostrate**; alar cells **not** in auricles.

Cells at leaf insertion **enlarged** in 1 or 2 **distinctive rows**.

Alar cells **not** rounded to the insertion.

Alar cells **strongly** inflated as "**bubble**" cells; setae ~3 **cm**; E *Sematophyllum*

Cells at leaf insertion **not** in a distinctive row; leaves **>1mm**.

Leaves **serrulate** throughout and **decurrent**; alar cells **thin**-walled; WS* *Herzogiella*

Leaves **entire**, **not** decurrent; alar cells **thick**-walled; WS *Callicladium haldanianum*

Alar cells **quadrate** to **short** oblong.

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P19 ***Continued from above***

Alar cells **quadrate** to **short** oblong.
- Leaves distinctly **secund** or **falcate-secund**; leaf cells **smooth**.
  - Leaf cells **smooth**.
    - Plants with clusters of axillary **brood branchlets** at tips of erect branches; WS* *Platygyrium*
    - Plants **without** brood bodies.
      - Leaves **ovate** and **concave**; plants of wet places and in mountain streams; WS *Hygrohypnum*
      - Leaves **lacking** any of the above unique characters.
        - Costa **shorter** with branches **joining** at the base; pseudoparaphyllia common; WS *Hypnum*
- Leaves **straight**, or indistinctly falcate-secund.
  - Leaves **wide**-**spreading** to squarrose-recurved and with a long, **channeled acumen**; WS* *Campylium*†
  - Leaves **flattened** into one plane, i.e., shoots **complanate**.
    - Leaves serrulate **throughout**; stem **hyalodermis** present; WS* *Herzogiella turfacea*
    - Leaves serrulate in **upper half**; stem hyalodermis **lacking**; E *Isopterygium tenerum*
    - Leaves **entire** except at apex; alar cells **numerous**; WS (not WC) *Entodon*
  - Leaves ±**concave** and **imbricate**, i.e., shoots ±**julaceous**.
    - Stems **red**; leaf apical cells **undifferentiated**; alar cell walls **thick** and **orange**; WS *Pleurozium schreberi*
  - Leaves **lacking** any of the above unique characters.
    - Branches strongly **curved** when dry; straight when moist.
      - Leaf cells **>5:1**; **5-20** quadrate alar cells at the **basal angles**; WS* *Pylaisiella*
      - Leaf cells **~3:1**; **numerous** oblate alar cells extending up **leaf margins**; E, AZ *Leucodon*
    - Branches **loosely curved** when dry.
      - Plants with clusters of axillary **brood branchlets** at tips of erect branches; WS* *Platygyrium*
    - Branches ±**straight** when dry.
      - Stems **without paraphyllia**.
        - Leaves **>1 mm**; cells **smooth**.
          - Alar cells extending up the margins for **<1/6** of leaf length.
            - Leaves **acuminate**.
              - Stem leaves **serrulate** throughout; WS* *Herzogiella seligeri*
            - Leaves mostly **obtuse** to **acute**; WS (not WC) *Entodon*
          - Alar cells extending up margin for **>1/3** leaf length; E *Forsstroemia trichomitria*†

Group P20 – Costa of uncommon or variable form

Group P20

Costa of **uncommon** form.
Costa **variable** on **same plant** (single or double or variations of these in different leaves).
Costa **usually variable** (double, double with a long branch, Y-shaped, single, forked or short and double).
Found on **rocks** or **wet** places in **mountain** streams; WS *Hygrohypnum*
Costa **mostly double** (1/3-2/3 leaf length), but sometimes single or short and double.
Stems loosely **pinnate**; leaves **dimorphic** and **decurrent**; on soil, rock and trees; WS(N) *Heterocladium*
Stems **scarcely** branched; leaves **neither** dimorphic **nor** decurrent; fens; N *Pseudocalliergon turgescens*
Costa **mostly single** within the genus or the given species.
Costa rarely to often **forked** (with or without a spine), Y-shaped or with lateral **spurs**.
Plants **large** and ±robust; stem leaves typically **>2** mm.
Leaves **serrulate** to near base with **short** and **broad** apical cells; WS *Platyhypnidium riparioides*†
Leaves **entire**, broad, concave and with apical cells **similar** to medial cells.
Leaves abruptly **apiculate** (**reflexed**); **weedy** habitats; WC, NY *Pseudoscleropodium purum*
Leaves **rounded** to bluntly acute; plants of **fens** and **swamps**; N *Calliergon*
Plants **medium** in size; stem leaves typically **1-2** mm.
Leaf margins strongly **serrate**; alar cells distinct and **quadrate**; E, WC *Isothecium*
Leaf margins **entire**; costa occasionally Y-shaped; in bogs; WS* *Drepanocladus simplicissimus*†
Costa occasionally to frequently **short** and **double**.
Leaf margins **ciliate**; E *Thelia*†
Leaf margins ±**entire**; secondary stems sub-pinnately **branched**; E *Forsstroemia trichomitria*†
Costa **mostly short** and **double** within the genus or the given species.
Costa often **double** with **one** or **both** branches to 1/2 leaf length.
Leaves **decurrent**; leaf margins mostly entire; WS *Plagiothecium*
Leaves **not decurrent**.
Leaf margins **serrulate** to **dentate**; branches **terete** (round); E *Myurella siberica*†
Leaf margins serrulate **above**; branches **complanate**; E, SW *Taxiphyllum*
Costa occasionally to often **single**.
Plants **thread-like**; leaves to 1 mm; N, W *Pseudoleskeella tectorum*†

***Note**: Only the genera in **normal** type (NOT in brackets) in the Skeleton to Freely Branched Mosses are included in the following Groups.*

***Reminder**: Definitions for cell length to breadth ratios are found in the Introduction, the Overview and at the end of this section. An expanded explanation of the difference between "Distinct" and "Indistinct" surface ornamentation is found in the Introduction.*

Group P21 – Cells long (>8:1), distinctly papillose or prorulose

Group P21

Leaf cells **papillose**; WS* *Chryso-hypnum diminutivum*
Leaf cells **prorulose; s**hoots **straight** (dry); leaves **smooth** & **decurrent**; E, AK *Bryhnia*†

Group P22 – Cells long, smooth or indistinctly ornamented[#]; costa single (long and narrow)

Group P22

Shoots **complanate**.
- Leaves **serrulate** throughout with **twisted** tips; in **mesic** habitats; WS* — *Steerecleus serrulatus*
- Leaves **entire** and wide **spreading**.
  - Leaves **distant**; alar cells **few** and short-to-long **rectangular**; WS — *Leptodictyum riparium*†

Shoots **triangular**; leaves **keeled**, **3-ranked** and slenderly acuminate; in wet places; WS* — *Dichelyma*

Shoots **lacking** any of the above unique characteristics.
- Plants **large** and ±**pinnately** branched; basal cells **porose**.
  - Shoots **prostrate** to arching; leaves **plane**; W — *Eurhynchium*†
- Plants with **irregular** branching; leaves spreading and lanceolate.
  - Cells at branch leaf apex much **shorter** than median cells; costa ending in **spine**.
    - Plants **aquatic** (on rocks in flowing water); branch leaves **1.2 mm** or longer; WS — *Platyhypnidium*
    - Plants on moist humic **soil**; branch leaves **<1.2 mm**; WS — *Eurhynchium*†
  - Cells at apex **similar** to medial cells; costal spine or tooth present or absent.
    - Costa **distinct**; brood bodies **lacking**; WS — *Brachythecium*†
    - Costa **indistinct** at mid-leaf; **gemmae** or rhizoids often at back of costa; WS — *Conardia compacta*
- Plants **small**, on **tree trunks**; leaves **serrulate** and ±**homomallous**; E — *Homalotheciella subcapillata*

[#] Cells with low papillae or short projections.

Group P23 – Cells long, smooth or indistinctly ornamented[#]; costa double (long or short) or none

Group P23

Leaves with a **long**, double costa; E — *Loeskeobryum brevirostre*

Leaves with a **short**, double costa or **none**.
- Plants **aquatic**, submerged part of year; cells **not** porose; leaves keeled or flat; WS — *Fontinalis*
- Plants **not aquatic**.
  - Rhizoids **papillose**; stem **hyalodermis** well or moderately developed.
    - Alar cells **inflated** or **quadrate**; leaves ±**serrate** throughout; WS* — *Herzogiella*
    - Alar cells ±**undifferentiated**; leaves **entire**; WS* — *Isopterygiopsis*
  - Rhizoids **smooth**; stem hyalodermis **lacking**.
    - Leaf apical cells **shorter** than medial cells; pseudoparaphyllia **foliose**; E, SW — *Taxiphyllum*
    - Leaf apical cells **similar** to medial cells in length..
      - Alar cells **quadrate**; pseudoparaphyllia **filamentous**; E — *Isopterygium*
      - Alar cells ±**undifferentiated**; pseudoparaphyllia **lacking**.
        - Leaves **complanate** and **serrate** above; brood bodies often present; WS — *Pseudotaxiphyllum*

[#] Cells with low papillae or short projections.

Group P24 – Cells intermediate (3-8:1), distinctly papillose or prorulose

Group P24

Leaf cells **papillose**.
Leaf cells **prorulose**.
- Costa **long** and **single**.
- Costa **short** and **double**; plants small and creeping.
  - Plants **dull**; axillary **brood bodies** present; cells **thick**-walled; WS* *Pterigynandrum filiforme*

Group P25 – Cells intermediate, smooth or indistinctly ornamented[#]; costa single and narrow

Group P25

Leaves **falcate-secund**.
- Leaves **keeled**, **3-ranked**, slenderly acuminate; plants periodically **submerged**; WS* *Dichelyma*
- Leaves **plicate**; capsules short and asymmetric; plants of **upland** habitats; WS *Brachythecium*†

Leaves **straight**.
- Plants on **tree trunks**.
  - Plants of **medium** size.
  - Plants **small** to very small.
    - Leaves with **serrulate** margins and long-**acuminate** apices; branches ±**julaceous**; WS *Fabronia*
    - Leaves with **entire** margins and gradually **acuminate** apices; E *Anacamptodon splachnoides*
- Plants on **soil** in mesic to wet habitats.
  - Plants with **julaceous** shoots; leaves broadly ovate and concave.
  - Plants n**ot** julaceous.
    - Leaves broadly **oblong** to ovate, **concave** and with **rounded** to cucullate apices.
    - Leaves ovate **lanceolate**, ±**plane** and with mostly **acuminate** apices.
      - Apical cells much **shorter** than median cells; costa ending in a **spine**; WS *Eurhynchium*†
      - Apical cells **similar** to medial cells in length.
        - Costa **percurrent** to excurrent.
          - Costa very **wide** (75-140μ); leaf margins ±**entire**; WS *Hygroamblystegium*†
          - Costa **narrow** (<35μ); leaf margins serrulate to **serrate** above; WS *Brachythecium*†
        - Costa **1/2** to **3/4** leaf length.
          - Leaf margins **serrulate** above to throughout.
            - Cells **3-5:1**; capsules ±**cylindric** and **yellowish**; WS *Amblystegium serpens*†
            - Cells **>5:1**; capsules ±oblong-**ovoid** and **reddish**; WS *Brachythecium*†
          - Leaf margins ±**entire**.
            - Leaves ±wide-**spreading**; capsules ±**cylindric** and **yellowish**; WS *Leptodictyum*†
            - Leaves ±**erect**; capsules ±oblong-**ovoid** and **reddish**; WS *Brachythecium*†

[#] Cells with low papillae or short projections.

Group P26 – Cells intermediate (3-8:1), smooth or indistinctly ornamented[#] costa short and double or none

Group P26

Plants growing in **aquatic** habitats.
- Plants **trailing** from a single attachment point in flowing water; leaves keeled or flat; WS — *Fontinalis*
- Plants **not** trailing from a single attachment point.
  - Plants **large** and **sparsely** branched; foliose **pseudoparaphyllia**; in fens; N — *Pseudocalliergon turgescens*

Plants growing in **terrestrial** habitats; plants small to medium in size.

Group P27 – Cells short (<3:1) and distinctly papillose or prorulose

Group P27

Leaf cells **pleuripapillose** (1-5 papillae per cell).
- Leaves **fragile** above a short ovate base, appressed (dry) and spreading (wet); E — *Haplohymenium triste*
- Leaves **not** fragile.
  - Cells **nodulose** (wavy) throughout the leaf; WS — *Racomitrium*
  - Cells **neither** nodulose **nor** porose.
    - Leaf margins **papillose**-**crenulate**; basal, interior cells **pellucid**; E — *Anomodon*
    - Leaf margins **entire** to **serrulate** throughout; basal, interior cells **not** pellucid.

Leaf cells strictly **unipapillose**.
- Leaves **appressed** (dry), **squarrose** (wet), ±lanceolate & with a **pale acumen**; WS(E) — *Lindbergia brachyptera*†
- Leaves **not** squarrose (wet).
  - Costa **long** and **single**.
    - Leaf margins **serrulate** to **serrate** throughout; costa **pellucid**; W, AK — *Claopodium*
    - Leaf margins **entire** to subserrulate above; costa **opaque** and often **flexuose** above; E, OR — *Leskea*†
  - Costa **short** and **double** or none; leaf margins dentate to **spinulose**-**dentate**; E — *Myurella*†

Leaf cells **prorulose** at back, especially at upper ends of leaves.
- Leaves strongly **dimorphic** (stem and branch leaves dissimilar); WS(N) — *Heterocladium dimorphum*†
- Leaves **not** dimorphic.
  - Costa **short** and **double** or **none**.
    - Branches **julaceous**; leaves **rounded**-**ovate** and **obtuse**; WS(N) — *Myurella julacea*†
    - Branches **terete**; leaves ovate-**lanceolate** and **acuminate**; E — *Schwetschkeopsis fabronia*

Group P28 – Cells short (<3:1) and smooth or indistinctly ornamented[#]

Group P28

Costa long and **single**.
- Shoots usually with dense **clusters** of axillary brood **branchlets**; often on bark; WS — *Leskeella nervosa*
- Shoots **julaceous** when **dry**; leaves wide spreading wet.
  - Capsules **immersed**; usually on bark; alar cells **transversely oblong**; SE — *Cryphaea ravenelii*†
- Shoots **neither** julaceous **nor** complanate.
  - Leaf apices **acute** to **acuminate**.
    - Leaf cell walls **sinuose** to **nodulose** (wavy edges); WS — *Racomitrium*
    - Leaf cell walls **straight**.
      - Upper leaf cells >**2:1**; basal cells at insertion usually **enlarged** and **yellowish**.
        - Costa >**35*μ*** at base; yellowish cells usually in **2-3** rows; WS — *Hygroamblystegium tenax*†
        - Costa <**35*μ*** at base; yellowish cells usually in a **single** row; WS — *Amblystegium varium*†
      - Upper leaf cells **1-2:1**.
        - Costa **subpercurrent** (>2/3 the leaf length).
          - Costa strongly **flexuose** above; leaves coarsely **serrate** above; S — *Herpetineuron toccoae*
          - Costa ±**straight**; leaves ±**entire**; cells **obscurely** papillose; E, OR — *Leskea*†
        - Costa **shorter** (1/3 – 2/3 the leaf length).
          - Leaf apex **symmetric** and acute to acuminate; **dryer** bark; SE, OH — *Clasmatodon parvulus*

Costa **short** and **double** or none.

[#] Cells with low papillae or short projections.

Cells = medial, laminal cells; cells ~2/3 of the way from insertion to apex, midway between the costa and the margin.

Length to breadth **ratios** of medial, laminal cells:

Long cells: >8:1; commonly termed linear or linear-flexuose.
Intermediate cells: 3-8:1; commonly termed elongated, oblong-rhomboidal, fusiform., or elliptical.
Short cells: <3:1; commonly termed isodiametric, quadrate, rounded-quadrate, or rhombic.

End.