ARTIFICIAL KEYS TO USNEA SUBG. USNEA IN NORTH AMERICA

June 1995

See "Natural" keys to various sections, etc., for fuller descriptions and distinctions, for the species included in these artificial keys. I will eventually try to delete the numerous cross-references in those, once I have more useable keys and descriptions for the natural groups (Clerc insists it is feasible).

These artificial keys are still at a very preliminary stage, and the initial choices are essentially among different "natural" groups; the keys could be made more user-friendly (usually the exact opposite of "natural") by incorporating more details on chemistry, distribution, and reasonably obvious features. The pendulous species of Oregon have been revised by Sherry Pittam, but I have not yet seen her treatment. Clerc says he has a key to species of northeastern parts of the continent, and is working on one for the western species. Until these become available, you're stuck with this attempt of mine (lots of luck!). Since Clerc has virtually all my Usnea specimens on loan (unfortunately, this was just after I had given up in disgust and typed and glued labels for most of them, putting each under one of three "trashbag" names), I have made no attempt to incorporate my numerous unknowns into these keys.

I-A. PENDULOUS, FERTILE

1. Branches (at least the main ones) ± angular, flattened or irregular in cross-section, or strongly pitted, furrowed, or excavated. Apothecia rare (at least in temperate N. America). 2

1. Branches ± terete, and at most weakly or occasionally sculpted. 3

2. Branch segments distinctly ridged or angulate; medulla very thin (10-15%) and compact; axis very thick (45-65%). Gonioides. 2a

2. Branches not angular, but sculpted, limp; fibrils absent to few. ..... (Foveatae: U. cavernosa)

2a. Soralia present. Branches distinctly and sharply angular, 5-sided in section, stiff; fibrils numerous. K+ red, P+ orange, containing norstictic acid and fatty acids. Appalachian-Great Lakes area. ..... (U. angulata)

2a. Soralia absent. Branch segments not alate but distinctly ridged, edges of segments not opening longitudinally; medulla not visible; salazinic or caperatic acid present. Mexico. ..... U. gonioides

3. Cortex absent, or very fragile, scaly and falling off, revealing the medulla in many places. Surface ± white to greenish, at most somewhat brownish when wet. Apothecia rather are. Florida. ..... (Laevigatae subsect. Amabiles: U. amabilis)

3. Cortex persistent, not fragile. 4

4. Medulla or axis red, pink, or yellow. 5

4. Medulla and axis not red, pink, or yellow. 6

5a. Thallus without soralia. Mexico. ..... U. cristatula

5a. Thallus with soralia. Fibrils numerous. Apothecia rare. (If fibrils absent and apothecia common, see U. pachyclada). 5b

5b. Thallus dark gray-green, mostly 15-30 cm long (but rarely to 80 cm). Containing barbatic, diffractaic, and accessory squamatic acid and accessory medullary pigment. ..... (U. ceratina)
5b. Thallus uniformly whitish straw to almost white, often 30-50 cm long. ..... (U. californica)

6a. Central axis ochraceous brown, brittle. Mexico. ..... U. himantodes
6a. Central axis white, not brittle. 6b

6b. Fibrils or cilia ± numerous. Surface smooth, with few or no papillae and never distinctly tuberculate. Medulla thick and lax. Thallus pale green, turning brown in herbarium. Apothecia frequent. Thallus appearing densely spinulose and strigose. ..... Glabratae subsect. Scabridae: U. subelegans

6b. Fibrils absent or few, or if abundant, then surface with papillae and/or tubercles. 7

7. Fibrils abundant at least on some areas. 8
7. Fibrils absent or few. 10

8a. Thallus (at least trunk) usually orange-brown pigmented. Soralia absent. Mexico. ..... U. firma

8a. Thallus not orange-brown pigmented. 8b
8b. Cortex vitreous and hard. 8c
8b. Cortex not vitreous and hard. 8d

8c. Medulla K-. Base not conspicuously annulated, tinged with red. Mexico. ..... U. vitrea

8c. Medulla K+ yellow or red. Mexico. ..... U. papillata

8d. Soralia absent. Mexico. ..... U. sanctaeritae
8d. Not as above. 8e

8e. Thallus with grayish tone. Medulla dense or in part somewhat lax. Branchlets many. ..... Barbatae subsect. Floridae: U. concinna

8e. Thallus pale or bright green, without grayish tone. Barbatae subsect. Dasypogae. 9

9. Papillae rather variable, for the most part pointed, very unevenly distributed, especially abundant on parts of branches with few papillae, ± absent form certain parts, sometimes the surface almost bare, with only rare obtuse papillae. Margin of apothecia without fibrils. ..... U. intermedia
9. Papillae numerous and crowded, in general regularly distributed, small, short and blunt. Fibrils abudnatn and noticeable but not crowded, often divided or covered by spinules. Margin of apothecia with very fine fibrils. ..... U. caucasica

10. Thallus hairlike, very slender (0.3-0.7 mm diam.), the surface surface very smooth (or slightly foveolate), without papillae. 11

10. Thallus coarser, the branches over 1 mm thick, or if slender and hairlike, then the surface with wrinkles, warts, tubercles, or papillae. 13

11. Axis thinner than medulla. Branches at most slightly annulate. ..... Stramineae subsect. Amoenae: U. trichinella
11. Axis thicker than medulla. Branches strongly annulate. ..... Barbatae subsect. Dasypogae: U. trichodes

12. Surface warty-rugose. Apothecia infrequent. Barbatae subsect. Scabratae. 13

12. Surface not rugose. 18

13. Soredia present. Thallus not brownish when fresh. 14

13. Soredia absent. Thallus brownish when fresh. 17

14. Medulla K-. Thallus pale glaucous green. Branches uniformly ca. 1 mm thick. ..... U. scabiosa

14. Medulla K+ red, or if K- then thallus pale straw green or branches 1-2 mm thick. 15

15. Branches up to 2 mm thick. ..... U. maxima

15. Branches 0.5-1(-1.8) mm thick. 16

16. Medulla K+ yellow then red. Thallus rather compressed. ..... U. scabrata ssp. scabrata

16. Medulla K-. Thallus less compressed. ..... U. scabrata ssp. nylanderiana

17. Medulla rather dense, K+ slowly but distinctly red, or K-. Thallus brownish green, dirty greenish or dark greenish; surface strongly pleated, foveolate-scrobiculate, excavated with depressions and covered with extremely abundant and crowded, sharp-pointed cylindrical papillae and broad obtuse tubercles intergrading with wrinkles. ..... U. rugulosa

17. Medulla K-. Thallus dark, olive green; surface almost smooth and partly apppearing varnished, but frequently tuberculate along entire length; tubercles rather unifrom, sometimes developing into rugae; papillae absent, or rather frequent on basal part. ..... U. sylvatica

18. Thallus with tubercles or coarse papillae. Apothecia numerous or rare. Barbatae subsect. Tortuosae. 19

18. Thallus finely papillate. Barbatae. 22

19. Medulla in outer part roseate. ..... U. pachyclada

19. Medulla entirely white. 20

20. Medulla K+ yellow then red. Apothecia rare. ..... (U. prostrata)

20. Medulla K-. Apothecia very frequent. 21

21. Medulla lax to very lax. CMA 50:200:320. Thallus not very rigid. Apothecia mostly 0.4-0.7 cm across. ..... U. faginea

21. Medulla dense. CMA 50-75:120-200:300-450. Thallus very rigid. Apothecia 0.5-1.5 cm across. Thallus shrubby to subpendent when mature; branches mostly divergent along the entire length of the thallus. Apothecia numerous; soralia and isidia absent; protocetraric acid present, K-, P+ orange..... U. rigida s. lato

22. Sorediate or isidiate. Apothecia rare. 23

22. Not sorediate or isidiate. Apothecia common or not. 26

23. Branches ± uniform or the middle distinctly thickest; not fusiform attenuate. ..... U. catenulata

23. Branches distinctly thickest above the base, or visibly attenaute. 24

24. Thallus usually with numerous annular cracks. ..... (U. chaetophora sensu Mot.)

24. Thallus at most weakly annulate. 25

25. Thallus to 20 cm long, rigid. ..... (U. freyi)

25. Thallus to 40 cm long, more supple. ..... U. alpina

26. Branches ca. 1.5 cm thick. Medulla lax to sublax. Thallus to 15-30 cm long. Primary branches ashy sea green (dirty subglaucous gray-green), darkening,abundantly papilate. Fibrils rather rare. ..... Barbatae subsect. Floridae: U. montana

26. Branches to 0.7 cm thick. Barbatae subsect. Dasypogae. 27

27. Thallus usually with numerous annular cracks. ..... U. chaetophora

27. Thallus ± continuous, not annulate. Branches 0.5-0.7 mm thick, ± uniform in thickness or the middle distinctly thickest; not fusiform attenuate. ..... (U. flagellata)

I-B. PENDULOUS, STERILE, WITH ISIDIA OR SOREDIA

1. Cortex distinctly reddish (when fresh). ..... Rubigineae: U. mirabilis
1. Cortex not reddish when fresh; sometimes turning reddish brown in herbarium. 2

2. Central axis ochraceous brown, brittle. ..... U. mexicana
2. Central axis not ochraceous brown. 2b
    2b. Axis or medulla red or pink or yellow (sometimes very faint). 3
    2b. Axis and medulla white. 4
3. Thallus dark gray green, mostly 15-30 cm long (but rarely to 80 cm). ..... **U. ceratina**
3. Thallus uniformly whitish straw to almost white, often 30-50 cm long. ..... U. californica
    4. Thallus branch segments distinctly ridged or angulate; medulla very thin (10-15%) and compact; axis very thick (45-65%). 4b
    4. Thallus ± terete to irregular in section, not angular. 5

4b. Branch segments distinctly alate, with trapezoid-like segments; edges of wings eroded, opening longitudinally, and exposing the medulla; nortstictic acid present. ..... Gonioides: U. angulata
4b. Branch segments not alate but distinctly ridged, edges of segments not opening longitudinally; medulla not visible; salazinic or caperatic acid present. Mexico. .... U. transitoria

5. Branches regularly and conspicuously segmented, with distinct regeneration areas between the segments. 5a
5. Branches irregularly segmented, without regeneration areas between segments. 5b

5a. Pseudocyphellae conspicuous, often in patches on main branches; longitudinal cracks present; cortex vitreous and hard; stictic acid or unknown secondary substances UP1 and UP2 present. Mexico. ..... U. malmei
5a. Without conspicuous pseudocyphellae; longitudinal cracks absent; cortex mat to shiny, and soft; salazinic acid present. Mexico, eastern U.S. ..... U. merrillii

5b. Thallus ± pitted or deformed; surface smooth and polished, shiny. ..... Stramineae subsect. Stramineae: U. dimorpha
5b. Thallus not pitted or deformed, or if so, then surface tuberculate and/or papillate. 6
    6. Thallus limp, very soft. 7
    6. Thallus stiffer, harder. 11
7. Cortex thin and papery. Branching irregular. Glabratae. 8
7. Cortex thicker, not papery. Barbatae. 10
    8. Branchlets and fibrils ± common. ..... subsect. Scabridae: U. fufurosula
    8. Branchlets and fibrils rare. subsect. Glabratae. 9

9. Soredia in semiglobose soralia 1-2 mm diam., on lateral branches. CMA 50-60:400-600:250-300. ..... U. fallax

9. Soredia in minute soralia. CMA 60-75:340-350:150-250. ..... U. deformis

10. Papillae absent but sparse irregular tubercles present. subsect. Dasypogae. ..... U. leucosticta

10. Papillae very numerous and crowded; tubercles absent. subsect. Comosae. ..... U. extensa

11. Papillae absent but coarse tubercles present, or papillae very low (short), farinose, very few in U. hesperina v. liturata. Ceratinae. 12

11. Papillae raised, smooth, often numerous, especially on main branches. 13

12. Medulla K+ and especially KC+ yellow then red-brown. North Carolina. ..... **U. hesperina**

12. Medulla K-, KC-. ..... **U. ceratina**

13. Thallus surface scabrous, ± rugose; fibrils usually few or absent, but sometimes numerous. Barbatae subsect. Scabratae. 14

13. Thallus surface not scabrous or rugose; fibrils usually numerous but sometimes few or absent. Barbatae subsect. Dasypogae. 17

14. Medulla K-. Thallus pale glaucous green. Branches under 1 mm diam. ..... U. scabiosa

14. Medulla K+ red, or if K-, then thallus pale straw green or branches 1-2 mm thick. 15

15. Branches up to 2 mm thick, slightly bluish green. Medulla K-. ..... U. maxima

15. Branches 0.5-1(-1.8) mm thick, pale clear yellowish green or straw green, in herbarium dusky straw color. Medulla K+ or K-. 16

16. Medulla K+ yellow then deep red or red-brown; thallus rather compressed. ..... U. scabrata ssp. scabrata

16. Medulla K-; thallus less compressed. ..... U. scabrata ssp. nylanderiana

17. Soredia farinose, without isidia. 18

17. Soredia isidiate (isidia sometimes sparse). 20

18. Soralia mostly on thicker branches, rare on branchlets. Axis 4 x as thick as medulla. Medulla dense. ..... U. silesiaca

18. Soralia common on lateral branches and tips. Axis only slightly thicker than medulla. Medulla lax. 19

19. Medulla and axis thick relative to cortex. Thallus ca. 25 cm long. ..... U. arnoldii

19. Medulla and axis thinner relative to cortex. Thallus ca. 5-15(-20) cm long. ..... U. extensa

20. Fibrils ± numerous at least on some branches. 21

20. Fibrils absent or very few. 25

21. Medulla K-. 22

21. Medulla K+ yellow then reddish. U. filipendula s. lato 22

22. Thallus 10-40 cm long, elongated and narrowed, not darkened at base. ..... U. alpina

22. Thallus 5-15(-20) cm long, rigid and scarcely elongated, darkened at base. ..... U. freyi

23. Primary branches minutely papillate; secondary branches distinctly tuberculate, often

very much so. Thallus 20-30 cm long (to 75 cm on Pacific coast); fibrils often few. Thallus usually ashy to dusky green. Medulla thinner than axis. ..... U. filipendula s. str.

23. Branches for the most part uniformly ± clearly papillate, with long pointed papillae, mixed with blunt, farinose tubercles. 24

24. Thallus 20-30 mm long, not beardlike or strigose; fibrils not dense. Thallus bright clear green, in herbarium straw green. Medulla thinner than axis. ..... U. sublaxa

24. Thallus to 15 cm long, much branched, "bearded" and almost strigose, with thin spinulose branchlets and dense but rather irregularly distributed fibrils. Thallus deep green. Medulla and axis equal in thickness. ..... U. esthonica

25. Thallus hairlike; branches to 0.7 mm diam. 26

25. Thallus not hairlike; at least the main branches usually thicker than 0.7 mm. 27

26. Branches typically without papillae. ..... (U. capillaris)

26. Thicker branches with pointed papillae. ..... U. fibrillosa

27. Primary branches at most very indistinctly papillate or tuberculate; secondary branches very rare. ..... U. catenulata

27. Primary branches distictly papillate; secondary branches ± common. 28

28. Papillae absent or very minute and sparse; tubercles abundant. ..... U. subscabrata

28. Papillae ± numerous. 29

29. Primary branches minutely papillate; secondary branches distinctly tuberculate, often very much so. Thallus 20-30 cm long (to 75 cm on Pacific coast); fibrils often few. Thallus usually ashy to dusky green. Medulla thinner than axis. ..... U. filipendula s. str.

29. Branches for the most part uniformly ± clearly papillate, with long pointed papillae, mixed with blunt, farinose tubercles. ..... U. sublaxa

I-C. PENDULOUS, STERILE, WITHOUT ISIDIA OR SOREDIA

1. Thallus with little or no cortex except on branchlets. 2
1. Thallus with cortex throughout. 3

2. Axis I+ deep blue-violet. ..... Longissimae: U. longissima

2. Axis I-. ..... Laevigatae subsect. Amabiles: U. amabilis

3. Axis or medulla red or pink. Medulla K+ red, P+ orange (norstictic acid). (If only the outer part of the medulla roseate, see U. pachyclada). ..... Ceratinae: U. merrillii
3. Axis and medulla white. 4

4. Thallus ± distinctly ridged or angular in cross-section, rigid. Gonioides. 4a

4. Thallus terete to irregular in cross-section, not angular, or if so then ± soft and limp. 5

4a. ..... U. duriuscula
4a. Not as above. Branch segments not alate but distinctly ridged, edges of segments not opening longitudinally; medulla not visible; salazinic or caperatic acid present. Mexico. .....U. gonioides

5. Cortex usually thin and papery, smooth and often without papillae, yellow brown or brown, at least in herbarium. 6
5. Cortex thicker, not papery, usually with papillae, at most brown after a long time in the herbarium...... 8

6. Thallus ± articulate; fibrils usually absent. Thallus ca. 15 cm long, greenish straw colored; papillae absent. ..... Stramineae subsect Amoenae: U. trichinella

6. Thallus not articulate. Glabratae subsect. Ossoleucae. 7

7. Thallus 18-24 cm long, pale straw or nearly yellow; fibrils almost always simple, almost non-papillate. Medulla K+ yellow then reddish. ..... U. subplicata
7. Thallus to 15 cm long, pale ashy green, becoming reddish tan in old herbarium specimens; fibrils almost always branched, rather distinctly papillate. Medulla K-. ..... U. finkii

8. Branches distinctly foveate; papillae absent; cortex thin (4-8%); central axis often sinuous. ..... U. cavernosa

8. Branches not foveate; papillae usually present; cortex thicker; axis rarely sinuous. Barbatae. 8a

8a. Central axis ochraceous brown, brittle. Mexico. ..... U. himatodes
8a. Central axis neither ochraceous brown nor brittle. 8b

8b. Medulla with pink or yellow pigment (sometimes very faint); CK+ deep yellow orange; diffractaic acid present. Mexico. ..... U. cristatula
8b. Medulla not pigmented; C-, CK-, or CK+ reddish orange; diffractaic acid absent. 8c

8. Surface scabrous, with ± distinct wrinkles. ..... (subsect. Scabratae: U. scabiosa)

8. Surface not scabrous; if wrinkled then branches hair-like and strongly annulate. 9

9. Thallus hair-like, under 0.7 mm diam. 10
9. Thallus coarser. 13

10. Branches strongly annulate. 11

10. Branches at most weakly annulate. 12

11. Without fibrils. ..... U. trichodea

11. With fibrils (mostly near the base). ..... U. chaetophora

12. Abundantly papillate. ..... U. flagellata

12. Without papillae. ..... (U. capillaris)

13. Cortex mat and soft; base conspicuously annulated, tinged with orange. Medulla K-; protocetraric acid as main secondary substance. Mexico. ..... U. firma

13. Cortex and base otherwise. 13a

13a. Cortex vitreous and hard. 13b

13a. Cortex otherwise. 13c

15. Medulla K+ yellow or red. Pseudocyphellae conspicuous, often in patches on main branches, with longitudinal cracks. Papillae frequent. Unknown secondary substances UP1 and UP2 present. Mexico. ..... U. papillata

13b. Medulla K-. Pseudocyphellae inconspicuous. Base not conspicuously annulated, tinged with red. Protocetraric acid absent. Mexico. ..... U. vitrea

13c. Surface smooth, at most indistinctly papillate or tuberculate. 13d

13c. Surface with distinct papillae and/or tubercles. subsect. Dasypogae. 14

13d. Cortex matt. Conspicuous pseudocyphellae and longitudinal cracks absent. Cortex thin, soft. Salazinic acid present. Mexico. ..... U. sanctaeritae

13d. Cortex shiny. ..... subsect. Tortuosae: U. prostrata

14. Thallus distinctly "beardlike". ..... (U. catenulata)

14. Thallus not so distinctly beardlike. 15

15. Papillae rather variable, for the most part pointed, very unevenly distributed, especially abundant on parts of branches with few papillae, ± absent form certain parts, sometimes the surface almost bare, with only rare obtuse papillae. Margin of apothecia without fibrils. ..... U. intermedia

15. Papillae numerous and crowded, in general regularly distributed, small, short and blunt. Fibrils abudnatn and noticeable but not crowded, often divided or covered by spinules. Margin of apothecia with very fine fibrils. ..... U. caucasica

II-A. TUFTED TO SUBPENDULOUS, FERTILE

1. Axis or medulla red or pink. Ceratinae. 2
1. Axis and medulla white (or yellow?). 4
2. "Papillae" wide, often remaining undeveloped so that ramuli are few; lateral branchlets tend to be long and closely spaced in groups interspersed with unextended "papillae". ..... U. strigosa ssp. rubiginea
2. "Papillae" medium in width, typically extending ± regularly into ramuli. 3
3. Ramuli typically regularly interspersed with short lateral branchlets (fibrils); cortical lumina small (ca. 1-2 um wide); CMA 85-100:200-325:175-400; thallus clear gray green turning yellowish. ..... U. strigosa ssp. major
3. Ramuli less regularly arranged, but not closely grouped; cortical lumina large (ca. 2-5 um wide); CMA 75:175:250; thallus persistently gray-green. ..... U. strigosa ssp. strigosa
4. Thallus bluntly angular, flattened, deformed, to 3 mm thick, in herbarium greenish brown to reddish brown. ..... Dendriticae subsect. Cladocarpae: U. horrida
4. Thallus ± terete. 5
5. Cortex rather thin, papery, smooth to rarely indistinctly papillate, often turning brown in herbarium. Medulla thick and loose. Axis thin. 6
5. Cortex thicker, not papery. 9
6. Thallus densely spinulose-strigose. Glabratae subsect. Scabridae. 7
6. Thallus not densely spinulose-strigose. Glabratae subsect. Ciliiferae. 8
7. Thallus relatively large (3-5 cm long), pale, pure green, in herbarium finally pale brownish. Medulla very lax. CMA 50-80:225-345:225-345. ..... U. cirrosa v. cirrosa
7. Thallus small (2-3 cm long), dark (in herbarium pure brown). Medulla moderately dense. CMA 50:200:150. ..... U. cirrosa v. ramillosa
8. Cilia relatively few, not perpendicular. ..... Glabratae subsect. Ciliiferae: U. australis
8. Cilia numerous, ± perpendicular. ..... Glabratae subsect. Ciliiferae: U. ciliifera
9. Medulla or axis yellow (?). ..... U. endochrysea
9. Medulla and axis white. 10
10. Small red spots scattered over branches and ramuli. ..... U. michauxii
10. Without red spots. 11
11. Medulla K+ yellow or red, P+ yellow or orange. 12
11. Medulla K-, P+ or P-. 17
12. Medulla K+ yellow, P+ yellow (thamnolic acid). ..... U. florida
12. Medulla K+ red, P+ orange. 13
13. Medulla lax. Primary branches ± dusky or black. 14
13. Medulla dense. 15
14. Containing salazinic acid. Thallus 3-16 cm long (rarely more). Barbatae subsect. Floridae: U. arizonica
14. Containing norstictic acid. ..... Barbatae subsect. Floridae: U. tristis
15. Axis very thick, 3 x medulla. ..... U. retifera
15. Axis and medulla equal or nearly so. 16
16. Thallus ca. 2.5-6 cm long and wide. ..... U. evansii

16. Thallus usually ca. 8 cm long. ..... U. erinacea

17. Apothecia infrequent, minute (ca. 2 mm diam.), the margin with few or no fibrils. Medulla thick, dense to very dense. ..... (Ceratinae: U. mexicana)

17. Apothecia common, larger, the margin with fibrils. 18

18. Medulla K-, P+ red-orange (protocetraric acid). With few or no acute papillae. Thallus very stiff. Medulla thin and ± dense. Apothecia 4-5 mm diam., the margin with fibrils. North Carolina. ..... Setulosae: **U. subscabrosa**

18. Medulla K-, P-, with squamatic, bourgeanic, or hypothamnolic acids, or no medullary substances. ..... U. florida

ADD:

Thallus intense green, clouded sea green or dusky green. Base black; cortex matt; papillae large. Containing salazinic acid. U. florida group. ..... U. subfusca v. subfusca

II-B. TUFTED TO SUBPENDULOUS, STERILE, WITH ISIDIA OR SOREDIA. ON BARK OR WOOD.

1. Thallus when fresh at least partly with distinct red or rosy color (sometimes only visible in section). Rubigineae. 2
1. Thallus not reddish or rosy when fresh, but sometimes turning red-brown in herbarium. 3

> **2. Cortex pure red or rose, or yellowish green but with pure red spots.** ..... U. rubicunda
> **2. Cortex partly green (brown in herbarium), partly dark lurid reddish.** ..... U. pennsylvanica

3. Axis or medulla red or pink. Ceratinae. 4
3. Axis or medulla white (or yellow). 5

> **4. With few if any fibrils. Medulla K--.** ..... U. mutabilis
> **4. With ± dense covering of fibrils.** ..... U. subcomosa

5. Thallus ± strongly foveloate or scrobiculate (pitted, furrowed or excavated), soft, rather limp, without papillae. Foveatae. 6
5. Thallus ± terete, stiffer, often with papillae. 7

> **6. Isidia very short, not spinule-like; soralia ± distinct or becoming confluent, almost farinose, giving the thallus a leprose appearance.** ..... U. variolosa
> **6. Isidia long, very abundant, especailly on upper part, giving a characteristic shaggy spinulose appearance; distinct soralia not present.** .....U. hirta

7. Axis yellow. Branching dichotomous. ..... Glabratae: U. wirthii
7. Axis white (to dirty orange, brown, or blackish). 8

> **8. Isidia present.** ..... KEY II-B-1
> **8. Isidia absent.** ..... KEY II-B-2

II-B-1. TUFTED TO SUBPENDULOUS, WITHOUT REDDISH PIGMENTS, STERILE, WITH ISIDIA, WITH OR WITHOUT SOREDIA. ON BARK OR WOOD.

1. Thallus not exactly terete, ± foveolate, soft and limp; papillae absent. Base not blackened. Medulla lax, K- or rarely K+. Isidia very short, not spinule-like; soralia ± distinct or becoming confluent, almost farinose, giving the thallus surface a leprose appearance (variolosa morph) or long, very abundant, especially on upper part, giving characteristic shaggy spinulose appearance; distinct soralia not present. (typical morph) Foveatae. ..... U. hirta

1. Thallus ± terete, not foveolate, hard or soft; papillae present or not. Base blackened or not. Medulla dense or lax, K+ or K-. 2

> **2. Cortex ± thin and papery, often turning brown in herbarium; papillae often absent; lateral branches often basally constricted.** 3
>
> **2. Cortex not papery, usually not turning brown (however, see U. dalmatica); papillae usually numerous; lateral branches usually not basally constricted (however, see U. fragilescens).** 9

3. Thallus clear pale straw yellow, little changed in herbarium. Medulla thin (200 um). Surface densely papillate. Axis 200 um thick, equal to medulla. Medulla K+ red. ..... Glabratae subsect. Xanthopogae: U. condensata

3. Thallus pale green to whitish or ashy green, soon turning brown in herbarium. Medulla thick and lax. 4

> **4. Thallus densely spinulose and strigose (spines 0.5-1 mm long), but without fibrils.** Thallus soft, ashy green when fresh. Axis 400-450 um, thicker than medulla and cortex. Medulla K+ yellow then red. Texas, Mexico. .....Glabratae subsect. Scabridae: U. dasaea (syn. U. spinulifera)
>
> **4. Thallus with no spinules and few or no fibrils.** Glabratae subsect. Glabratae. 5

5. Medulla K-. ..... U. subhirta

5. Medulla K+ red. 6

> **6. Thallus without papillae, 5-10 cm long.** ..... U. dolosa
>
> **6. Thallus papillate, at least on the thicker branches, usually not more than 3-5 cm long and wide.** 7

7. Thallus yellow-gray or gray. ..... U. confusa

7. Thallus pale clear green or glaucous green. Thallus shrubby to subpendent when mature. Apothecia absent or sparse. Cortex shiny. Medulla lax, thick; axis thin. Soralia numerous, minute, smaller than half branch diameter, but often coalescing and then forming largera soralia-like patches. U. cornuta s. lato. 8

> **8. Branches to 1 mm thick; papillae numerous.** ..... U. intexta
>
> **8. Branches inflated to 2 mm above; papillae indistinct, very blunt.** ..... U. subpectinata

9. Surface almost always finely papillate; medulla often rather lax. Barbatae subsect. Comosae**.** 10

9. Surface smooth, without papillae; medulla dense. Protocetraric acid. Florida. ..... Setulosae: U. subscabrosa

> **10. Axis 500 um or more thick, much thicker (ca 5x) than cortex or medulla.** 11

10. Axis thinner, equal to medulla or at most 2-3 x thicker. 13

11. Branching isotomic dichotomous near base. Base conspicuously blackened, rarely for only a short distance; cortex bearing numerous annular cracks, especially at base; cortex thick (10-20%); medulla compact, thin (7-15%); soralia larger than half branch diameter, isidiate at least when young. ..... U. madeirensis

11. Branching irregular, not distinctly dichotomous nor isotomic. 12

12. Soralia initially tuberculate but becoming concave. Often with barbatic acid. ..... U. substerilis

12. Soralia tuberculate (convex), generally not much expanded. Usually without barbatic acid; sometimes with alecotrialic acid. ..... U. diplotypus

13. Medulla thicker than or ± equal to axis. 14

13. Medulla thinner than axis. 15

14. Thallus blackish green to olive or dusky, in herbarium turning brown. ..... U. dalmatica

14. Thallus nearly white to pale olive or clear green. Base generally distinctly blackened; soralia scattered over secondary branches and apices, rarely fully excavate, isidiate at least when young; low papillae present on main branches (x 50). (If trunk thinner at its base, sparsely branched over its whole length, and primary branches long and fusiform, see v. fragilescens) ..... U. fragilescens v. mollis

16. Thallus pale green to ashy or straw green. 17

17. Thallus pale green to greenish white or almost straw color; medulla lax. ..... U. stuppea

17. Thallus deeper or darker in color, ashy or straw green; medulla dense. 18

18. Soralia slightly excavate, ulcer-like, longitudinally stretched (at least when mature), isidiate only when young. Salazinic and barbatic acids. ..... U. wasmuthii

18. Soralia tuberculate, slightly raised, often isidiate when mature. Squamatic acid, or thamnolic acid ± barbatic acid. ..... U. subfloridana (with its many subspecies and varieties)

II-B-2. TUFTED TO SUBPENDULOUS, WITHOUT REDDISH PIGMENTS, STERILE, WITH SOREDIA, WITHOUT ISIDIA. ON BARK OR WOOD.

1. Cortex ± thin and papery, turning brown in herbarium; papillae often absent; branches often basally constricted. 2

1. Cortex not papery, not turning brown; papillae usually present; branches not basally constricted. Barbatae subsect. Comosae. 5

2. Medulla thin and dense. ..... Glabratae subsect. Ossoleucae: U. occidentalis

2. Medulla thick and lax. Glabratae subect. Glabratae. 3

3. Soralia large when mature, finally efflorescent, excavate, extending to the full width of the branches and sometimes encircling them, the whole circumference being thus sorediate. Thallus usually less than 4 cm long. Usnic acid alone, or protocetraric, ± fumarprotocetraric, ± barbatic acids. ..... U. glabrata

3. Soralia much smaller and less distinct, in most species minute. 4

4. Thallus yellow-gray or gray. ..... U. confusa

4. Thallus ± dark dull gray-green. ..... U. cornuta s. lato (including U. inflata)

5. Axis slightly orange. ..... U. perplexans

5. Axis white. 6

6. Branches and tips flexuous. ..... U. laricina

6. Branches not noticeably flexuous. 7

7. Soralia excavate when mature, ± broadly eroded, often becoming confluent and then revealing the central axis of the small branches. Fibrils usually present on the apices. U. lapponica s. lato. 8

7. Soralia even, plane or slightly concave, not excavate (except in psoromic acid strain of U. glabrescens; also see U. wasthmuthii), derived from pseudocyphellae which enlarge and not by sloughing of the adjacent cortex, distinctly rounded, widely spaced, rarely revealing the central axis. Fibrils absent on the apices. U. glabrescens s. lato 10

8. Thallus usually irregularly branched. ..... U. monstrosa

8. Thallus ± regularly dichotomously branched. 9

9. Branching mostly isotomic dichotomous. Stictic (major), norstictic, and ± diffractaic acids. Soralia irregularly shaped, ± confluent, deeply excavate, often reaching the central axis, never with isidia, white medullary rings along annular cracks usually rather thick . ..... U. fulvoreagens (= U. glabrescens s. lato according to Halonen et al. 1998)

9. Branching mostly anisotomic. Salazinic acid, or usnic acid only. Branches often ± deformed and/or foveolate, sometimes irregularly swollen; base pale or blackened; medulla usually ± thick (12-30%). Never with stictic acid group. ..... U. lapponica s. str.

10. Medulla lax to rather lax. Thallus to ca. 4-5 cm tall, but often less; branches smooth, thick to the tips (not attenuate). ..... U. compacta

10. Medulla dense. Thallus 6-10 cm tall and wide; branch tips ± slender and elongate, or thick. 11

11. Main branches to 2 mm thick; lobe tips thick; color straw green or pale yellow (or dark gray-green?), unchanged in herbarium. ..... U. betulina

11. Main branches 1-1.5 mm thick; lobe tips elongated, hairlike, comiform; color yellowish white, straw green or pale to bright ashy green, becoming tan in herbarium. Thallus rather large, often subpendent; fibrils rather few; papillae usually low; soralia ± discrete, rounded and

plane to only slightly excavate, rarely with sparse isidia when young. 12

12. Medulla thin, K+ yellow or red. Norstictic, plus stictic or salazinic. Soralia not excavate. ..... U. glabrescens ssp. glabrescens
12. Medulla K-, P+ yellow. Psoromic. Soralia somewhat excavate. ..... U. glabrescens [ssp. glabrellla?]

ADD:

Soralia plane to slightly tuberculate; papillae abundant; thallus often more than 4 cm long. Salazinic, bourgeanic, ± constictic acids. Hypermaritime. ..... U. esperantiana

Cortex distinctly glossy and translucent; fibrils often fasciculate; papillae low, nearly indistinct to absent; soralia distinctly tuberculate when present. ..... U. nidulans s. lato

Thallus milky straw color to whitish green. ..... U. kujalae

Note: Many of the taxa keyed out as being isidiate (e.g., U. subscabrosa, U. spinulifera, U. subhirta, U. wasthmuthii) often become nonisidiate.

II-C. TUFTED TO SUBPENDULOUS, ON ROCK.

After Clerc & Herrera-Campos, 1997

1. Cortex with red pigment, especially conspicuous close to the basal part; lateral branches not narrowed at attachment point. Baja California. ..... (U. rubicunda)

1. Cortex without red pigment or if spot-like red pigment present, then lateral branches distinctly narrowed at attachment point. 2

> **2. Medulla C+ yellow, CK+ deep yellow-orange, with pink pigment in the medulla; diffractaic acid present.** California; Mexico. ..... (U. ceratina)
>
> **2. Medula C-, CK-, and K-, or CK+ and K+ orange-red, without a pink pigment; diffractaic acid absent.** 3

3. Medulla with wine red pigment; soralia punctiform, with numerous isidiomorphs; papillae absent; fatty acids of the murolic group present; medulla K-, P-. ..... (U. mutabilis)

3. Medulla without wine red pigment; soralia punctiform or large, with or without isidiomorphs; papillae present or absent; fatty acids of the murolic group absent; medulla usually K+ or P+ (rarely both reactions negative, e.g., in U. cornuta s. lato). 4

> **4. Medulla with yellow pigment; lateral branches distinctly narrowed at point of attachment; cortex glossy; either norstictic or psoromic acids in soralia.** California. ..... (U. wirthii)
>
> **4. Medulla without yellow pigment; lateral branches narrowed or not at point of attachment; cortex glossy or mat; norstictic or psoromic acids present but not restricted to the soralia.** 5

5. Medulla K- and P+ red-orange; protocetraric acid as main substance. 6

5. Medulla K+ and P+ yellow to red-orange; never protocetraric acid as main substance. 9

> **6. Large tubercles with white summits present; short isidiomorph-like fibrils occuring on fibercles; soralia absent.** Chihuahua. ..... L. nashii Clerc & Herrera-Campos
>
> **6. Large tubercles, and isidiomorph-like fibrils absent; soralia mostly present.** Usually on bark or wood. 7

7. Lateral branches distinctly narrowed at point of attachment; thallus erect-shrubby with divergent branches. ..... (U. cornuta, chemotype 6))

7. Lateral branches not narrowed at point of attachment; thalus subpendant to pendant with ± parallel branches. 8

> **8. Cortex distinctly glossy to vitreous; main branches not conspicuously annulated.** ..... (U. subscabrosa)
>
> **8. Cortex mat; main branches distinctly annulated, especially close to basal part.** ..... (U. hesperina)

9. Base jet black; soralia large, ± circular, reaching the whole branch diameter when mature and often encircling the branch, slightly concave, with few isidiomorphs; lateral branches not narrowed at point of attachement; salazinic acid alone. Chihuahua. ..... U. ammannii Clerc & Herrera-Campos

9. Basal part of trunk pale or brownish to reddish pigmented; soralia rarely reaching the whole branch diameter when mature, never encircling the branch, of irregular shape, level with cortex to slightly tuberculous, with few or numerous isidiomorphs; lateral branches usually slightly to distinctly narrowed at point of attachment; salazinic acid not alone (but in the main substance in one chemotype of U. cornuta). 10

10. Cortex mat; soralia ± tuberculous and convex when mature, usually reaching 1/2 branch diameter or more, with numerous and clustered isidiomorphs; fibercles usually absent. Arizona, Chihuahua, Sinaloa. ..... U. halei Clerc

10. Cortex glossy to vitreous; soralia ± level with cortex, punctiform, rarely enlarged (see, however, U. dasea), occurring on fibercles or not; isidiomorphs present or absent, clustered or single; fibercles absent to numerous. 11

11. Isidiomorphs thick, usually not clustered but often sitting alone on soralium, black-tipped, always present; soralia punctiform, never enlarged, ± tuberculous, numerous, densely dispoed, occurring on fibercles. Arizona, Sonora, Chihuahua, Baja California Sur. ..... U. amblyoclada (Müll. Arg.) Zahlbr.

11. Isidiomorphs thin, clustered, never black-tipped or absent; soralia punctiform to ± enlarged, especially on terminal branches, ± level with cortex, occurring on cortex at the start or on fibercles. Usually on bark or wood. 12

12. Fibrils short and spinulose, densely but ± irregularly covering restricted parts (rarely the entire length) of branches; soralia enlarged to 1/2 branch diameter or more when mature, often slightly fusiform, not coalescing; galbinic acid present. ..... (U. dasaea)

12. Fibrils usually longer and slender, scattered on whole thallus; soralia punctiform, often coalescing and forming extensive larger soralia-like areas; galbinic acid absent. California. ..... (U. cornuta s. lato)

ADD?

U. scholanderi
U. fragilescens v. fragilescens

II-D. THALLUS TUFTED, WITHOUT REDDISH PIGMENTS, STERILE, WITHOUT ISIDIA OR SOREDIA

None of the tufted species reported from North America would seem to fit here, but forms of various sorediate/isidiate species with few or immature soralia (e.g., U. kujalae) may belong here. I know of at least one undetermined species from Washington State that definitely belongs here.

ADDITIONAL SPECIES
(To be added also to the "Natural" keys)

Containing stictic, constictic, cryptostictic and menegazzaic acids, with traces of norstictic. .....U. "aciculifera"

Containing protocetraric, norstictic, or psoromic, with an accessory medullary pigment. ..... U. dasaea

..... U. aculeata Mot.

..... U. affinis Mot.

..... U. graciosa Mot.

..... U. roseola Mot.

..... U. variegata Stirton

..... U. xanthopoga Nyl.