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A Key to *Xanthoparmelia* in North America, Extracted from the World Keys of Hale 1990

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Abstract. *The worldwide Hale keys to the 406 species of* Xanthoparmelia *are here extracted for the 55 species occurring in North America and Mexico.*

The last published work of Mason E. Hale was his complete world monograph of the lichen genus *Xanthoparmelia* (1990). With 406 species studied—using thin-layer chromatography, scanning electron microscopy, computer-generated keys and descriptions, plus worldwide field experience—it makes available a thorough study of this common genus. The keys are so long and comprehensive that I thought it would assist North American lichenologists if the parts dealing with the species occurring in North America and Mexico were extracted and made available in a separate key. Hence this compilation.

Hale was a strong believer in the use of chemical characters in the recognition of species and the key reflects this. As the users of this extracted key may not have available the laboratory facilities for TLC or HPLC, they may have to resort to the less sensitive microcrystal tests for which references are in Asahina (1936), Hale (1969), and Thomson (1967), which have illustrations of the crystals of the dominant diagnostic substances. If the reaction color tests are pale the concentrations are likely to be too dilute to give good MC tests. Salazinic acid yields boat-shaped red crystals in GAo-T, norstictic acid yields yellow "butterflies" or yellow druses in GAo-T, barbatic acid yields small, oblique, rhombic crystals in GE, diffractaic acid yields swirling, feathery needles in GE or GAW (see Asahina 1936), psoromic acid yields radiating colorless needles in GE or very fine yellowish radiating needles in GAo-T. For fumarprotocetraric acid the P+ red color test helps but in this case TLC is necessary for proof.

(Note: For those using the original Hale key to the isidiate species with black underside, there are problems with couplets 16 and 35 in that the chemical contents listed for the subsequent species contradict the key. The problem has been corrected in this extract.)

KEY TO NORTH AMERICAN XANTHOPARMELIA

1. Sorediate species, underside black, thallus tightly adnate with areolate center, lobes 0.2–0.5 mm wide, on rocks, western U.S. ..... X. MOUGEOTII (Schaer.) Hale
1. Esorediate 2
2.(1) Terricolous species 3
2. Saxicolous species 16
3.(2) Thallus free-growing, breaking apart into separate lobes or remaining intact; lobes moderately to strongly convoluted, sometimes forming tubes 4
3. Thallus forming intact, usually orbicular, colonies or rosettes loosely attached on pebbles or compacted soil, in part becoming free-growing; lobes plane below, canaliculate with a raised yellowish rim below, or weakly convoluted 12
4. Medulla K− (fatty acids); thallus breaking apart into strongly convoluted tubes, western U.S. ..... X. LIPOCHLOROCHROA Hale & Elix
4. Medulla K+ yellow or yellow becoming red (norstictic, salazinic, or stictic acids) 5
5.(4) Salazinic acid present 6
5. Norstictic or stictic acid present 9
6.(5) Surface white maculate 7
6. Surface not white maculate 8
7.(6) Colonies more or less intact, lobes narrow, 1.3–3 mm wide, western North America ..... X. CAMTSCHADALIS (Ach.) Hale
7. Thallus breaking into separate lobes, lobes plane to weakly convoluted, contorted and twisted, western North America ..... X. IDAHOENSIS Hale
8.(6) Lobes strongly convoluted, scattered, western North America ..... X. CHLOROCHROA (Tuckerman) Hale
8. Lobes weakly convoluted, forming compact rosettes, western North America ..... X. WYOMINGICA (Gyel.) Hale
9.(5) Norstictic acid present, lacking stictic acid 10
9. Stictic acid present with connorstictic and norstictic acids 11
10.(9) Lower surface dark brown to nearly black, rhizines lacking, western U.S. ..... X. NORCHLOROCHROA Hale
10. Lower surface pale to brown, rhizines present, western U.S. ..... X. NEOCHLOROCHROA Hale
11.(9) Lobes more or less strongly inrolled, breaking apart, western U.S. ..... X. VAGANS (Nyl.) Hale
11. Lobes weakly convoluted, thallus intact, teretelaciniate at center, known only from Colorado ..... X. NEOWYOMINGICA Hale
12.(3) Thallus pale brown below 13
12. Thallus black below 15
13.(12) Salazinic acid present 14
13. Stictic acid present, lobes pale brown to brown

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below, center of thallus with terete secondary laciniae, known only from Colorado ..... X. NEOWYOMINGICA Hale

14.(13) Lobes becoming moderately convoluted, to 5 mm wide, rhizines moderate to dense, western North America ..... X. WYOMINGICA (Gyel.) Hale

14. Lobes flat and plane to barely convoluted, 1–4 mm wide, rhizines sparse to moderate, western North America ..... X. TARACTICA (Krempelh.) Hale

15.(12) Lobes strongly convoluted, 2–7 mm wide, lower surface smooth to rugose, rhizines lacking, western North America ..... X. NORCHLOROCHROA Hale

15. Lobes flat and plane or rarely convolute, weakly convoluted or semiterete, very narrow, less than 1 mm wide, lower surface rugose, sparsely rhizinate, western U.S. ..... X. PLANILOBATA (Gyel.) Hale

16.(2) Isidiate species 17

16. Thallus lacking soredia or isidia 37

17.(16) Lower surface brown 18

17. Lower surface black 30

18.(17) Medulla K− (or slowly K+ faint yellow) 19

18. Medulla distinctly and quickly K+ yellow or K+ yellow then red (norstictic, salazinic, or stictic acids) 26

19.(18) Isidia globose, short and unbranched, less than 0.2–0.3 mm high, usually hollow and often erumpent with pale tips; P+ yellow (psoromic acid), thallus adnate to loosely adnate, lobes > 7 mm, western U.S. (*P. kurokawae* Hale is a synonym) ..... X. LAVICOLA (Gyel.) Hale

19. Isidia subglobose (immature) to cylindrical, more than 0.2 mm, tips darkening, solid; P−, P+ red, or P+ yellow but lacking psoromic acid 20

20.(19) Medulla C+ red (lecanoric acid), western North America ..... X. JORANADIA (Nash) Hale

20. Medulla C− 21

21.(20) Medulla P+ red or yellow 22

21. Medulla P− 23

22.(21) Medulla P+ yellow (psoromic acid); western U.S. ..... X. LAVICOLA (Gyel.) Hale

22. Medulla P+ red or orange red (fumarprotocetraric acid); subtropical U.S. and Central America ..... X. SUBRAMIGERA (Gyel.) Hale

23.(21) Hypoprotocetraric acid present; western U.S., Mexico ..... X. WEBERI (Hale) Hale

23. Hypoprotocetraric acid absent 24

24.(21) Diffractaic acid present, western North America, Mexico ..... X. AJOENSIS (Nash) Egan

24. Diffractaic acid lacking, 3-α-hydroxybarbatic acid present; southwestern U.S. and Mexico ..... X. MOCTEZUMENSIS Nash

25.(18) Stictic acid present; widely distributed across North America ..... X. PLITTII (Gyel.) Hale

25. Stictic acid lacking; western North America 26

26.(25) Salazinic acid present with only traces of norstictic acid 27

26. Norstictic acid the major metabolite, salazinic acid lacking or in nearly equal concentration 28

27.(26) Barbatic acid present; California ..... X. SCHMIDTII Hale

27. Barbatic acid lacking; western U.S. ..... X. MEXICANA (Gyel.) Hale

28.(26) Barbatic acid present; western U.S. ..... X. SCHMIDTII Hale

28. Barbatic acid lacking 29

29.(28) Hyposalazinic acid present; western North America ..... X. MARICOPENSIS Nash & Elix

29. Norstictic acid present; North America ..... X. DIERYTHRA (Hale) Hale

30.(17) Medulla K−, P+ red (fumarprotocetraric acid); southeastern U.S. ..... X. PIEDMONTENSIS (Hale) Hale

30. Medulla K+ yellow or yellow turning red; stictic, norstictic, or salazinic acids present 31

31.(30) Thallus tightly adnate, often appearing areolate at center 32

31. Thallus adnate to loosely adnate 34

32.(31) Isidia not erumpent, white-tipped, cylindrical; stictic, norstictic, constictic acids present; U.S. ..... X. SUBSTENOPHYLLOIDES Hale

32. Isidia erumpent (epicorticate); contents similar to above but with either cryptostictic or menegazziaic acid 33

33.(32) Lobes sublinear, 0.2–0.8 mm wide; isidia globose, not branched, 0.08–0.2 mm diameter; containing stictic, constictic, norstictic, cryptostictic, and menegazziaic acids; Mexico ..... X. CONGENSIS (B. Stein) Hale

33. Lobes subirregular, 0.8–2 mm wide, isidia globose to becoming irregularly inflated and branched; same contents as above but lacking menegazziaic acid; Mexico ..... X. AMABLEANA (Gyel.) Hale

34.(31) Salazinic acid present (+ trace norstictic); thallus loosely attached; isidia 0.1–1.5 mm diam., to 1 mm high, tips blackened; worldwide including North America ..... X. AUSTRALASICA Galloway

34. Salazinic acid absent, norstictic acid present 35

35.(34) Isidia in part lobulate and decumbent, 0.06–0.15 mm diam.; North America ..... X. NORHYPOPSILA Hale

35. Isidia cylindrical, simple to coralloid 36

36.(35) Lobes adnate to loosely adnate, subirregular, isidia partly globose, becoming cylindrical to densely coralloid, black-tipped; with stictic, constictic, cryptostictic, norstictic, connorstictic, and traces of other acids; pantemperate ..... X. CONSPERSA (Ach.) Hale

36. Lobes elongate, more or less separate, sublinear; isidia cylindrical; with stictic, constictic, and norstictic acids; southeastern U.S. X. ISIDIASCENS Hale

37.(16) Lower surface pale 38

37. Lower surface black 56

38.(37) Medulla C+ red (lecanoric acid); west Texas ..... X. ARIDA Egan & Derstine

38. Medulla C− (or C+ pale orange if barbatic acid is present) 39

39.(38) Medulla K+ yellow or yellow turning red 40

39. Medulla K− 49
40.(39) Surface white maculate; U.S. and Canada ..... X. SOMLOENSIS (Gyel.) Hale
40. Surface continuous, not white maculate 41
41.(40) Thallus loosely attached to nearly free-growing on pebbles or soil; lobes more or less convoluted 42
41. Thallus very tightly to loosely adnate on rock, rarely on soil; lobes plane, not convoluted 43
42.(41) Some terete laciniae present; stictic and norstictic acids present; known only from Colorado ..... X. NEOWYOMINGICA Hale
42. Terete laciniae lacking; salazinic acid present; western North America ..... X. WYOMINGICA (Gyel.) Hale
43.(41) Stictic acid present 44
43. Salazinic or norstictic acid, or both, present 46
44.(43) Lobes becoming terete in center of thallus; stictic, constictic, norstictic acids; Mexico ..... X. TOLUCENSIS Hale
44. Lobes plane or convolute; stictic, constictic, norstictic acids present 45
45.(44) Lobes subirregular, crowded, imbricate, often becoming laciniate; eastern U.S. and Mexico ..... X. CUMBERLANDIA (Gyel.) Hale
45. Lobes sublinear, contiguous to subimbricate, lacking laciniae; southeastern U.S. ..... X. NEOTARACTICA Hale
46.(43) Norstictic acid present as the major metabolite; western U.S. ..... X. CALIFORNICA Hale
46. Salazinic acid present, norstictic acid absent or in trace amounts 47
47.(46) Thallus very tightly adnate, with areolate center; lobes 0.5–1.0 mm wide; Mexico ..... X. NEORIMALIS (Elix & Armstrong) Elix & Nash
47. Thallus tightly to loosely adnate; center lobate; lobes 0.6–3.0 mm wide 48
48.(47) Thallus tightly adnate to adnate; collected with rock substrate; lobes subirregular, 0.8–2 mm wide ("intergrades with *X. coloradoensis*"); western U.S. and Mexico ..... X. LINEOLA (Berry) Hale
48. Thallus adnate to loosely adnate, usually collected without substrate; lobes sublinear, 1.5–3 mm wide; western North America ..... X. COLORADOENSIS (Gyel.) Hale
49.(39) Medulla P+ orange-red or yellow (fumarprotocetraric, protocetraric, or psoromic acids) 50
49. Medulla P− 52
50.(49) Medulla P+ yellow; psoromic acid present; southwestern U.S. ..... X. PSOROMIFERA (Kurokawa) Hale
50. Medulla P+ orange-red; fumarprotocetraric acid present 51
51.(50) Thallus loosely adnate; physodalic acid present; eastern U.S., Mexico ..... X. MONTICOLA (Dey) Hale
51. Thallus tightly adnate to adnate, more or less areolate at center; physodalic acid lacking; western U.S. ..... X. NOVOMEXICANA (Gyel.) Hale
52.(49) Barbatic acid present; thallus adnate; western U.S. (Texas) ..... X. BARBATICA (Elix) Egan
52. Barbatic acid lacking 53
53.(52) Diffractaic acid present; western U.S. ..... X. TUCSONENSIS (Nash) Egan
53. Diffractaic acid lacking 54
54.(53) Lichesterinic acid present; Rocky Mountains ..... X. MONTANENSIS Hale
54. Lichesterinic acid lacking 55
55.(54) Thallus adnate to loosely adnate; unknown fatty acids present; western U.S. ..... X. SUBDECIPIENS (Vain.) Hale
55. Thallus tightly adnate; constipatic acid present; western U.S. and Mexico ..... X. OLEOSA (Elix & Armstrong) Elix & Nash
56.(37) Thallus very tightly adnate to tightly adnate, center often appearing areolate, always collected along with rock substrate; lobes 0.2–0.8 mm broad; medulla K+ yellow, stictic acid present; western U.S. ..... X. NEOCONSPERSA (Gyel.) Hale
56. Thallus adnate to loosely adnate, center lobate, collected with or without rock substrate, lobes more than 1 mm wide 57
57.(56) Medulla K− 58
57. Medulla K+ yellow or yellow turning red 61
58.(57) Medulla P+ orange-red or yellow 59
58. Medulla P−, hypoprotocetraric acid present; southwestern U.S. ..... X. DISSENSA (Nash) Hale
59.(58) Fumarprotocetraric acid present; lobes tightly adnate, 1–2 mm wide, south-central U.S. ..... X. HYPOMELAENA (Hale) Hale
59. Fumarprotocetraric acid lacking, psoromic acid present 60
60.(59) Lobes narrow, 0.4–1.0 mm wide; thallus rugose and crowded, western U.S. (Sonoran Desert) ..... X. HUACHUCENSIS (Nash) Egan
60. Lobes broad, 1.5–3 mm wide, thallus expanded, not crowded; southwestern U.S. ..... X. NIGROPSOROMIFERA (Nash) Egan
61.(57) Stictic acid the principal metabolite; eastern U.S. ..... X. ANGUSTIPHYLLA (Gyel.) Hale
61. Salazinic acid present; U.S. and Canada ..... X. TASMANICA (Hook. & Tayl.) Hale

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