Illustration Sources

Ref. Code	
ABR	Abrams, L. 1923–1960. Illustrated flora of the Pacific states. Stanford University Press, Stanford, CA.
ADD	Addisonia. 1916–1964. New York Botanical Garden, New York. Reprinted with permission from *Addisonia*, vol. 18, plate 579, Copyright © 1933, The New York Botanical Garden.
AND	Anderson, E. and Woodson, R.E. 1935. The species of *Tradescantia* indigenous to the United States. Arnold Arboretum of Harvard University, Cambridge, MA. Reprinted with permission of the Arnold Arboretum of Harvard University.
ANN	Hollingworth A. 2005. Original illustrations. Published herein by the Botanical Research Institute of Texas, Fort Worth. Artist: Anne Hollingworth.
ANO	Anonymous. 1821. Medical botany. E. Cox and Sons, London.
ARM	Annual Rep. Missouri Bot. Gard. 1889–1912. Missouri Botanical Garden, St. Louis.
BA1	Bailey, L.H. 1914–1917. The standard cyclopedia of horticulture. The Macmillan Company, New York.
BA2	Bailey, L.H. and Bailey, E.Z. 1976. Hortus third: A concise dictionary of plants cultivated in the United States and Canada. Revised and expanded by the staff of the Liberty Hyde Bailey Hortorium. Cornell University. Macmillan Publishing Company, New York. Reprinted with permission from William Crepet and the L.H. Bailey Hortorium. Cornell University.
BA3	Bailey, L.H. 1900–1902. Cyclopedia of American horticulture. Macmillan Publishing Company, New York.
BB2	Britton, N.L. and Brown, A. 1913. An illustrated flora of the northern United States, Canada and the British possessions. Charles Scribner's Sons, New York.
BEA	Beal, E.O. and Thieret, J.W. 1986. Aquatic and wetland plants of Kentucky. Kentucky Nature Preserves Commission, Frankfort. Reprinted with permission of Kentucky State Nature Preserves Commission.
BES	Bessey, C. 1888. Grasses and forage plants of Nebraska. Nebraska State Agricultural Society, Lincoln.
BML	Bot. Mus. Leafl. 1932–1986. Botanical Museum. Harvard University, Cambridge, MA. Reprinted with permission of Botanical Museum. Harvard University.
BOT	Bot. Gaz. (Crawfordsville). 1875+. University of Chicago Press, Chicago, IL. Reprinted from Botanical Gazette, vol. 91, page 104, figs. 1–4, author, H.I. Featherly, ed. H.C. Cowles, Copyright © 1931, with permission from University of Chicago Press.
BR1	Britton, N.L. 1908. North American trees. Henry Holt and Company, New York.
BR2	Britton, N.L. 1918. Flora of Bermuda. Charles Scribner's Sons, New York.
BRU	Nixon, E.S. 1985. Trees, shrubs, and woody vines of East Texas. Bruce Lyndon Cunningham Productions, Nacogdoches, Texas. Reprinted with permission of Bruce Lyndon Cunningham (artist).
BT2	Lipscomb, B.L. 1999. Original illustrations from the SMU herbarium. Published by the Botanical Research Institute of Texas, Fort Worth.
BT3	Shinners, L.H., Whitehouse, E., and Mueller, P. 1999. Original illustrations from the SMU herbarium. Published by the Botanical Research Institute of Texas, Fort Worth.
BTT	Brittonia. 1931/35+. New York Botanical Garden, New York. Reprinted with permission from *Brittonia*, vol. 21, no. 1, page 78, fig. 1, Copyright © 1969, Brittonia, vol. 48, no. 1, page 108, fig. 2, Copyright © 1996, The New York Botanical Garden.
CAB	Cabrera, A.L., ed. 1965–1970. Flora de la provincia de Buenos Aires. Instituto Nacional de Tecnologia Agropecuaria, Buenos Aires. Reprinted with permission of Instituto Nacional de Tecnologia Agropecuaria.
CHT	Chittenden, F.J. 1956. The Royal Horticultural Society dictionary of gardening. Royal Horticultural Society, Oxford. Reprinted with permission of the Royal Horticultural Society.
CJS	Ceylon J. Sci., Sect. A, Bot. 1901-1956. University of Peradeniya, Peradeniya, Sri Lanka. Used with permission of the University of Peradeniya.
CLU	Clute, W.N. 1905. The fern allies of North America north of Mexico. Fredrick A. Stokes Company, New York.
CO1	Correll, D.S. and Correll, H.B. 1972. Aquatic and wetland plants of southwestern United States. Environmental Protection Agency, Washington, DC.

CRO Cronquist, A., Holmgren, A.H., Holmgren, N.H., Reveal, J.L., and Holmgren, P.K. 1972–1977. Intermountain flora: Vascular plants of the intermountain West, U.S.A. Columbia University Press, New York. Reprinted with permission from Intermountain Flora: Vascular Plants of the Intermountain West, U.S.A. by A. Cronquist, A.H. Holmgren, N.H. Holmgren, J.L. Reveal, and P.K. Holmgren, Vol. 6, page 257 and 373, Copyright ©1977, The New York Botanical Garden.

CUM Contr. Univ. Michigan Herb. 1939+. University Herbarium, Ann Arbor, MI. Reprinted with permission of the University of Michigan Herbarium.

CUR Bot. Mag. 1787+. Royal Botanic Gardens, Kew, England. Reprinted with permission of the Royal Botanic Gardens, Kew.

DEA Deam, C. 1929. Grasses of Indiana. Indiana Department of Conservation, Indianapolis.

DIL Dillenius, J.J. 1732. Hortus elthamensis seu plantarum rariorum. Sumptibus Auctoris, London.

DOR Dormon, C. 1942. Wild flowers of Louisiana. Department of Conservation, New Orleans.

EN1 Engler, A. 1900–1953. Das pflanzenreich. Duncker and Humbolt, Berlin. Reprinted with permission of Duncker and Humbolt GmbH, Verlagsbuchhandlung, Berlin.

EN2 Engler, A. and Prantl, K. 1887–1915. Die naturlichen pflanzenfamilien. Gebrueder Borntraeger, Stuttgart. Originally published in "Die Naturlichen Pflanzenfamilien," reprint 1958/60 by J. Cramer in der Gebruder Borntraeger Verlagsbuchhandlung, D-14129 Berlin D–70176 Stuttgart. http://www.schweizerbart.de.

F&L Field & Lab. 1932–1970. Southern Methodist University Press, Dallas, TX.

FAS Fassett, N.C. 1957. A manual of aquatic plants. University of Wisconsin Press, Madison. © 1957. Reprinted by permission of The University of Wisconsin Press.

FIE Fieldiana, Bot. 1895+. Field Museum of Natural History, Chicago, IL.

FLN Fl. Neotrop. Monogr. 1967+. New York Botanical Garden, New York. Reprinted with permission from *The Alismataceae. Flora Neotropica*, vol. 64, page 12, fig. 3f, page, 43, fig. 22D, and page 72, fig. 41a, Copyright © 1994, Robert Haynes, and The New York Botanical Garden. *The Burmaniaceae*. *Flora Neotropica*, Vol. 42, page 77, fig. 31b, Copyright © 1986, The New York Botanical Garden. *The Limnocharitaceae. Flora Neotropica*, Vol. 56, page 23, fig. 13a, Copyright © 1992, The New York Botanical Garden.

FNA Flora of North America Editorial Committee, eds. 1993+. Flora of North America. Oxford University Press, New York. Artists: Barbara Alongi (*Calopogon tuberosus*, *Corallorhiza wisteriana*, *Habenaria repens*, *Hexalectris warnockii*, *Malaxis unifolia*, *Platanthera clavellata*, *Platanthera nivea*, *Platythelus querceticola*, *Ponthieva racemosa*, *Rhynchospora indianolensis*, *Rhynchospora latifolia*, *Spiranthes cernua*, *Spiranthes longilabris*, *Spiranthes odorata*, *Spiranthes parksii*, *Spiranthes vernalis*, *Tipularia discolor*, *Zeuxine strateumatica*); Bobbie Angell (*Juniperus ashei*, *Juniperus virginiana*); Laurie Lange (*Azolla mexicana*, *Ceratopteris thalictroides*, *Marsilea macropoda*, *Marsilea vestida*, *Pleopeltis polypodioides* subsp. *michauxiana*, *Salvinia minima*); John Myers (*Pistia stratiotes*, *Scleria reticularis*, *Thalia dealbata*, *Wolffiella oblonga*); Susan A. Resnicek (*Carex planispicata*, *Carex shinnersii*); L.A. Vorobik (*Pennisetum orientale*); L.A. Vorobik and K. Klitz (*Sacciolepis indica*); L.A. Vorobik and H. Padzírková (*Eremochloa ophiuroides*, *Imperata cylindrica*); L.A. Vorobik and C. Roché (*Bouteloua gracilis*, *Eragrostis lehmannia*, *Eragrostis polytricha*, *Urochloa ramosa*); Yevonn Wilson-Ramsey (*Commelina virginica*, *Cyperus floribundus*, *Cyperus pseudothyrsiflorus*, *Erythronium mesochoreum*, *Hypoxis curtissii*, *Luzula bulbosa*, *Luzula echinata*, *Tradescantia occidentalis*, *Xyris ambigua, Xyris caroliniana*, *Xyris scabrifolia*); Elizabeth Zimmerman (*Eleocharis erythropoda*, *Eleocharis macrostachya*, *Eleocharis ravenellii*, *Eleocharis reverchonii*, *Eleocharis rostellata*, *Eleocharis tenuis* var. *verrucosa*). From volumes 2, 22, 23, 25, and 26. Courtesy of the Flora of North America Association.

FUC Fuchs, L. 1542. De historia stirpium commentarii insignes. Isingrin, Basel.

FVA Valdés, B., Talavera, S., and Fernández-Galiano, E., eds. 1987. Flora vascular de Andalucía occidental. Ketres Editoria, S.A. Barcelona.

G&F Gard. & Forest. 1888–1897. The Garden and Forest Publishing Co., New York.

GAR Gartenflora. 1852–1938. Verlag von Ferdinand Enke, Stuttgart.

GEO Georgia, A.E. 1916. A manual of weeds. The Macmillan Company, New York.

GHS Gentry, H.S. 1972. The Agave family in Sonora. Agricultural Handbook no. 399. United States Department of Agriculture, Washington, DC.

GLE Gleason, H.A. 1952. The new Britton and Brown illustrated flora of the northeastern United States and adjacent Canada. New York Botanical Garden, New York. Reprinted with permission from the *New Britton and Brown Illustrated Flora of the northeastern United States and Adjacent Canada* by Henry A. Gleason, vol. 1, pages 71, 89, 95, 108, 114, 127, 169, 213, 217, 218, 239, 241, 251, 253, 255, 256, 263, 264, 266, 268, 274, 277, 287, 289, 293, 369, 380, 402, 404, 408, 409, 410, 413, 414, 416, 418, 423, 429, 438, 443, 444, 450, 452, 460, 462, 467, 469, 470, 474, Copyright © 1952, The New York Botanical Garden.

GO1 Gould, F.W. and Box, T.W. 1965. Grasses of the Texas coastal bend. Texas A&M University Press, College Station. Reprinted with permission from Lucile Gould Bridges and Texas A&M University Press.

GO2 Gould, F.W. 1975. The grasses of Texas. Texas A&M University Press, College Station. Reprinted with permission from Lucile Gould Bridges and Texas A&M University Press.

GO3 Gould, F.W. 1951. Grasses of the southwestern United States. University of Arizona Press, Tucson. Figures from *Grasses of the Southwestern United States*, by Frank Gould. © 1951, 1978, the Arizona Board of Regents. Reprinted by permission of the University of Arizona Press.

GO4 Gould, F.W. 1978. Common Texas grasses: An illustrated guide. Texas A&M University Press, College Station. Reprinted with permission from Lucile Gould Bridges and Texas A&M University Press.

GR3 Fernald, M.A. 1950. Gray's manual of botany, 8th ed. Reprinted with permission of the Library of the Gray Herbarium, Harvard University, Cambridge, MA.

GR4 Gray, A. 1908. Gray's new manual of botany. 7th ed. American Book Co., New York.

GSA Gibbs Russell, G.E., Watson, L., Koekemoer, M., Smook, L., Barker, N.P., Anderson, H.M., and Dallwitz, M.J. 1991 (reprinted ed.). Grasses of southern Africa. Mem. Bot. Surv. S. Africa 58. National Botanic Gardens/Botanical Research Institute, Pretoria, South Africa. Illustration by C. Bartman. Reprinted with permission of the National Botanic Gardens/Botanical Research Institute.

GWO Godfrey, R.K. and Wooten, J.W. 1979–1981. Aquatic and wetland plants of southeastern states. University of Georgia Press, Athens. Reprinted with permission of the University of Georgia Press, Copyright ©1979, 1981.

HDW Woodcock, H.B.D. and Stearn, W.T. 1950. Lilies of the world. Charles Scribner's Sons, New York.

HEA Diggs, G., Lipscomb, B., and O'Kennon, R.J. 1999. Shinners and Mahler's illustrated flora of North Central Texas. Original illustrations by Linda 'Linny' Heagy, Copyright © 1999. Botanical Research Institute of Texas, Fort Worth.

HEB Heagy, L. 2005. Original illustrations. Published herein by the Botanical Research Institute of Texas. Fort Worth. Artist: Linda 'Linny' Heagy. Copyright ©2005.

HI1 Hitchcock, A.S. 1935. Manual of the grasses of the United States. United States Department of Agriculture, Washington, DC.

HI2 Hitchcock, A.S. 1950. Manual of the grasses of the United States (2nd ed.). United States Department of Agriculture, Washington, DC.

HIG Hignight, K.W., Wipff, J.K., and Hatch, S.L. 1988. Grasses (Poaceae) of the Texas cross timbers and prairies. Texas Agricultural Experiment Station, College Station.

HO1 Hooker, W.J. 1829–1840. Flora boreali-americana. Treuttel and Wurtz, Paris.

HOL Holmgren, N.H. 1998. Illustrated companion to Gleason and Cronquist's manual. The New York Botanical Garden, New York. Reprinted with permission from *Illustrated Companion to Gleason and Cronquist's Manual* by N.H. Holmgren, pages 750, 762, 789, 794, and 802, Copyright © 1998, The New York Botanical Garden.

HUT Hutchinson, J. and Dalziel, J.M. 1927–1936. Flora of west tropical Africa. The Crown Agents for the Colonies, London.

JAA J. Arnold Arbor. 1920–1990. Arnold Arboretum of Harvard University, Cambridge, MA. Reprinted with permission of the Arnold Arboretum of Harvard University.

JEM J. Elisha Mitchell Sci. Soc. 1884+. North Carolina Academy of Science, Durham, NC. Reprinted with permission of North Carolina Academy of Science.

JEP Hickman, J.C. ed. 1993. The Jepson manual: Higher plants of California. University of California Press, Berkeley. Reprinted from The Jepson manual, J. Hickman, Ed., 1993, with permission from the Jepson Herbarium. © Regents of the University of California.

JON Jones, F.B. 1982. Flora of the Texas coastal bend (3rd ed.). Welder Wildlife Foundation, Sinton, TX. Reprinted with permission of the Welder Wildlife Foundation.

KEW Bull. Misc. Inform. 1887–1942. Royal Botanic Gardens, Kew, England. Reprinted with permission of the Royal Botanic Gardens, Kew.

KIR Kirkia. 1960+. Ministry of Agriculture, Harare, Zimbabwe. Reprinted with permission from the Ministry of Agriculture and Nozipo Nobanda, Harare, Zimbabwe.

KNO Knobloch, I.W. and Correll, D.S. 1962. Ferns and fern allies of Chihuahua, Mexico. Texas Research Foundation, Renner.

LAM Lamarck, J.B.A.P.M. 1791–1823. Tableau encyclopedique et methodique des trois regnes de la nature. Chez Pancouke, Paris.

LEI Leithead, H.L., Yarlett, L.L., and Shiflet, T.N. 1971. 100 native forage grasses in 11 southern states. Agricultural Handbook No. 389. Soil Conservation Service. United States Department of Agriculture, Washington, D.C.

LIN Lindleyana. 1986+. American Orchid Society, Inc., West Palm Beach, FL. Reprinted with permission from the American Orchid Society.

LUN Lundell, C.L. 1961–1969. Flora of Texas. Texas Research Foundation, Renner.

LYN Lynch, D. 1981. Native & naturalized woody plants of Austin & the Hill Country. St. Edwards University, Austin, TX. Reprinted with permission of artist: Nancy McGowan.

MAC Mackenzie, K.K. 1940. North American Cariceae. New York Botanical Garden, New York. Reprinted with permission from North American Cariceae by K.K. Mackenzie, vol. 1, plates 25, 26, 27, 33, 34, 35, 36, 37, 41, 44, 46, 49, 61, 62, 64, 66, 74,78, 106, 108, 120, 165, 167, 172, 174, 175, 176, 182, 185, 186, 199, 215, 217, 233, 251, 253, Copyright ©1940, vol. 2, plates 276, 288, 292, 297, 299, 301, 305, 307, 312, 313, 314, 315, 316, 328, 329, 340, 349, 376, 378, 379, 401, 402, 403, 464, 466, 491, 495, 500, 507, 529, 530, 531, 532, 533, 536, Copyright ©1940, The New York Botanical Garden.

MAR Martius, C.F.P. 1840–1906. Flora Brasiliensis, Monachii (Munich).

MAS Mason, H.L. 1957. A flora of the marshes of California. University of California Press, Berkeley. Reprinted with permission of the University of California Press.

MCV McVaugh, R. 1983+. Flora Novo-Galiciana. University of Michigan Herbarium, Ann Arbor.

MIB Michigan Bot. 1962+. Michigan Botanical Club, Ann Arbor. Reprinted with permission from John Thieret.

MO1 Mohlenbrock, R.H. 1970. The illustrated flora of Illinois, flowering plants: Flowering rush to rushes. Southern Illinois University Press, Carbondale and Edwardsville. "Commelinaceae—*Commelina diffusa*" page 183, figure 77. Originally published in the work: *The Illustrated Flora of Illinois, Flowering Plants: Flowering rush to rushes* ©1970 by the Board of Trustees, Southern Illinois University.

MOH Mohlenbrock, R.H. 1976. The illustrated flora of Illinois, sedges: *Cyperus* to *Scleria*. Southern Illinois University Press, Carbondale and Edwardsville. "Cyperaceae—*Lipocarpha drummondii*" page 128, figure 92. Originally published in the Work: *The Illustrated Flora of Illinois, Sedges: Cyperus to Scleria* ©1976 by the Board of Trustees, Southern Illinois University.

MRA Fiddlehead Forum. 1974+. The American Fern Society,New York. Reprinted with permission of Robbin C. Moran.

NIC Nicholson, G. 1885–1888. The illustrated dictionary of gardening. L. Upcott Gill, London.

NOV Novon. 1991+. Missouri Botanical Garden Press. Illustration of *Eleocharis occulta* by Elizabeth Hollister Zimmerman, © Flora of North American Association; Illustration of *Carex kraliana* by Susan Reznicek, © Flora of North America Association.

NVE Nees von Esenbeck, T.F.L. 1843. Genera plantarum florae germanicae. Henry and Cohen, Bonn.

OBA Ames, O. 1905–1922. Orchidaceae. Houghton, Mifflin and Co., New York and The Merrymount Press, Boston.

PBL Pammel, L.H., Ball, C.R. and Lamson-Scribner, F. 1904. The grasses of Iowa part II. Iowa Department of Agriculture, Des Moines.

PES Pesman, M.W. 1962. Meet flora Mexicana. Dale Stewart King, Globe, AZ. Unable to locate copyright owner, author deceased.

PHY Phytologia. 1933+. Michael J. Warnock, Huntsville, TX. Reprinted with permission from Michael J. Warnock.

PMB Brown, P.M. 2002. Wild orchids of Florida. University Press of Florida, Gainesville. Used with permission of Paul Martin Brown.

PMC Brown, P.M. 2003. The wild orchids of North America, north of Mexico. University Press of Florida, Gainesville. Used with permission of Paul Martin Brown.

PNW Hitchcock, C.L., Cronquist, A., Ownbey, M., and Thompson, J.W. 1955–1969. Vascular plants of the Pacific northwest. University of Washington Press, Seattle. Reprinted with permission of the University of Washington Press.

POW Powell, A.M. 1988. Trees & shrubs of Trans-Pecos Texas. Big Bend Natural History Association, Inc., Alpine, TX. Reprinted with permission from Jim Henrickson and Michael Powell.

RAD Radford, A.E., Ahles, H.E., and Bell, C.R. 1968. Manual of the vascular flora of the Carolinas. University of North Carolina Press, Chapel Hill. From *Manual of the vascular flora of the Carolinas* by C. Ritchie Bell, Harry E. Ahles, and Albert E. Radford. Copyright ©1969 by the University of North Carolina Press. Used by permission of the publisher.

RCA Rep. Commiss. Agric. 1862–1893. United States Government Printing Office, Washington, DC.

REE Reed, C.F. 1970. Selected weeds of the United States. Agricultural Handbook no. 366. United States Department of Agriculture, Washington, DC.

RHO Rhodora. 1899+. New England Botanical Club, Cambridge, MA.

RJG George, Robert J. 2005. Original illustrations. Published herein by the Botanical Research Institute of Texas, Fort Worth. Artist: Robert J. George.

ROE Roedner, B.J., Hamilton, D.A., and Evans, K.E. 1978. Rare plants of the Ozark Plateau. North Central Forest Experiment Station. Forest Service. United States Department of Agriculture, St. Paul, MN.

ROL Rollan, M.G. 1985. Claves de la flora de España, 2nd ed. Ediciones Mundi-Prensa, Madrid. Reprinted with permission of Ediciones Mundi-Prensa.

RYD Rydberg, P.A. 1932. Flora of the prairies and plains of central North America. Dover Publications Inc., New York.

SA2 Sargent, C.S. 1905. Manual of the trees of North America (exclusive of Mexico). Houghton, Mifflin and Company, Boston.

SA3 Sargent, C.S. 1890–1902. The silva of North America. Houghton, Mifflin and Company, Boston.

SBM Syst. Bot. Monogr. 1980+. American Society of Plant Taxonomists, Ann Arbor, MI. Reprinted with permission of the American Society of Plant Taxonomists and Gordon C. Tucker.

SCB Smithsonian Contr. Bot. 1969+. Smithsonian Institution Press, Washington, DC.

SHI Shinners, L.H. 1958. Shinners' spring flora of the Dallas-Fort Worth area Texas. Lloyd Shinners, Dallas, TX.

SID Sida. 1962+. Botanical Research Institute of Texas, Fort Worth.

SIL Silveus, W.A. 1933. Texas grasses: Classification and descriptions of grasses. W.A. Silveus, San Antonio, TX.

SIN Chein, P. and Chih-tsun, T. (eds.). 1985. Flora reipublicae popularis Sinicae. Academia Sinica, Beijing. From Flora Reipublicae Popularis Sinicae, Tomus 16(1) with permission of the publisher.

SM1 Small, J.K. 1933. Manual of the southeastern flora. University of North Carolina Press, Chapel Hill. From *Manual of the southeastern flora* by John Kunkell Small. Copyright ©1933 by John Kunkell Small, renewed 1961 by Kathryn Small Gerber. Used by permission of the Publisher.

SM3 Small, J.K. 1938. Ferns of the southeastern states. The Science Press, Lancaster, Pennsylvania.

STE Steyermark, J.A. 1963. Flora of Missouri. Iowa State University Press, Ames. Reprinted with permission of the Missouri Department of Conservation.

TAY Taylor, W.C. 1984. Arkansas ferns and fern allies. Milwaukee Public Museum, Milwaukee, WI. Reprinted with permission of the Milwaukee Public Museum and W.C. Taylor.

TOR Bull. Torrey Bot. Club. 1870+. Torrey Botanical Society, Lancaster, PA. Reprinted with permission of the Torrey Botanical Society.

USB U.S.D.A. Bull. 1895–1901. United States Department of Agriculture, Washington, DC.

USC U.S.D.A. Circ. 1895–1901. United States Government Printing Office, Washington, DC.

USD Stefferud, A. (ed.). 1948. Grass: The yearbook of agriculture 1948. United States Department of Agriculture, Washington, DC.

USH Contr. U.S. Natl. Herb. 1890–1974. United States Government Printing Office, Washington, DC.

VAS Vasey, G. 1890–1891. Grasses of the Southwest. Bulletin No. 12. United States Department of Agriculture. Division of Botany, Washington, DC.

VGI Veroff. Geobot. Inst. E.T.H. Stiftung Rubel Zurich. 1961+. Geobotanischen Institut E.T.H., Zurich. Reprinted with permission of Geobotanischen Institut E.T.H.

VIN Vines, R.A. 1960. Trees, shrubs and woody vines of the southwest. University of Texas Press, Austin. Reprinted from *Trees, Shrubs and Woody Vines of the Southwest* by Robert A. Vines, illustrated by Sarah Kahlden Arendale, Copyright ©1960. By permission of the University of Texas Press, Austin.

YAT Yatskievych, G. 1999. Steyermark's flora of Missouri. Missouri Department of Conservation, Jefferson City. Reprinted with permission of the Missouri Department of Conservation.

Phylogeny/Classification of the Pteridophyte, Gymnosperm, and Monocot Families of East Texas, Based on Cronquist (1981, 1988) and Others

This phylogeny/classification is modified from those of Cronquist (1981, 1988), Lellinger (1985), and Hickman (1993). The synopses of subclasses are from Hickman (1993) and Woodland (1997). A classification system including all families of vascular plants can be found in Mabberley (1987, 1997). Figure 173 is a diagram of relationships of subclasses of flowering plants as envisioned by Cronquist (1988). Figure 174 (from Zanis et al. 2003) in Appendix 3 is a more recent view of flowering plant phylogeny incorporating molecular data.

Ferns and Similar Plants

SPORE-BEARING

Division PSILOPHYTA

- Order Psilotales
  - Psilotaceae

Division LYCOPODIOPHYTA

- Order Lycopodiales
  - Lycopodiaceae
- Order Selaginellales
  - Selaginellaceae
- Order Isoetales
  - Isoetaceae

Division EQUISETOPHYTA

- Order Equisetales
  - Equisetaceae

Division POLYPODIOPHYTA

- **SUBCLASS OPHIOGLOSSIDAE**
  - Ophioglossaceae
- **SUBCLASS OSMUNDIDAE**
  - Osmundaceae
- **SUBCLASS SCHIZAEIDAE**
  - Anemiaceae
  - Lygodiaceae
  - Pteridaceae
- **SUBCLASS GLEICHENIIDAE**
  - Polypodiaceae
- **SUBCLASS HYMENOPHYLLIDAE**
  - Dennstaedtiaceae
  - Thelypteridaceae
  - Aspleniaceae
  - Dryopteridaceae
  - Blechnaceae
- **SUBCLASS MARSILEIDAE**
  - Marsiliaceae
- **SUBCLASS SALVINIIDAE**
  - Azollaceae
  - Salviniaceae

Gymnosperms

"NAKED SEEDS,"
SEEDS NOT ENCLOSED IN AN OVARY;
USUALLY WITH CONES

Division GNETOPHYTA

- Order Ephedrales
  - Ephedraceae

Division PINOPHYTA

(CONIFEROPHYTA)

- Order Coniferales
  - Cupressaceae
  - Pinaceae

Angiosperms

"VESSEL SEEDS,"
SEEDS ENCLOSED IN AN OVARY;
FLOWERS PRESENT

Division MAGNOLIOPHYTA

Class MONOCOTYLEDONAE
(LILIOPSIDA)

SUBCLASS ALISMATIDAE

Pistils simple; herbs, ± aquatic

- Order Alismatales
  - Limnocharitaceae
  - Alismataceae
- Order Hydrocharitales
  - Hydrocharitaceae
- Order Najadales
  - Potamogetonaceae
  - Ruppiaceae
  - Zannichelliaceae

SUBCLASS ARECIDAE

Inflorescence often of many small flowers, enfolded or subtended by prominent bract(s); pistil usually compound; palm-like to minute aquatics

- Order Arecales
  - Arecaceae (Palmae)
- Order Arales
  - Acoraceae
  - Araceae
  - Lemnaceae

ANGIOSPERMS *(MONOCOTS CONTINUED)*

SUBCLASS COMMELINIDAE

Flowers small and subtended by chaffy bracts, or sepals and petals unlike; generally wind-pollinated; pistil compound

- Order Commelinales
  - Xyridaceae
  - Mayacaceae
  - Commelinaceae
- Order Eriocaulales
  - Eriocaulaceae
- Order Juncales
  - Juncaceae
- Order Cyperales
  - Cyperaceae
  - Poaceae (Gramineae)
- Order Typhales
  - Sparganiaceae
  - Typhaceae

SUBCLASS ZINGIBERIDAE

Inflorescences often with showy colored bracts; sepals and petals unlike; flowers usually animal-pollinated; pistil compound

- Order Bromeliales
  - Bromeliaceae
- Order Zingiberales
  - Cannaceae
  - Marantaceae

SUBCLASS LILIIDAE

Flowers ± showy, insect-pollinated; sepals and petals generally similar; pistil compound

- Order Liliales
  - Pontederiaceae
  - Lilaceae (including Alliaceae, Alstroemeriaceae, Amaryllidaceae, Anthericaceae, Asparagaceae, Colchicaceae, Convallariaceae, Hemerocallidaceae, Hyacinthaceae, Hypoxidaceae, Melanthiaceae, Nartheciaceae, Themidaceae, Tofieldiaceae, and Trilliaceae)
  - Iridaceae
  - Agavaceae (including Nolinaceae)
  - Smilacaceae
  - Dioscoreaceae
- Order Orchidales
  - Burmanniaceae
  - Orchidaceae

ANGIOSPERMS *(DICOTS)*

Class DICOTYLEDONAE (in Volumes 2 & 3)

(MAGNOLIOPSIDA)

SUBCLASS MAGNOLIIDAE

Pistils generally simple; perianth parts and stamens free, generally many, spiraled

- Order Magnoliales
  - Magnoliaceae
  - Annonaceae
- Order Laurales
  - Calycanthaceae
  - Lauraceae
- Order Piperales
  - Saururaceae
- Order Aristolochiales
  - Aristolochiaceae
- Order Nymphaeales
  - Nelumbonaceae
  - Nymphaeaceae
  - Cabombaceae
  - Ceratophyllaceae
- Order Ranunculales
  - Ranunculaceae
  - Berberidaceae
  - Menispermaceae
- Order Papaverales
  - Papaveraceae
  - Fumariaceae

SUBCLASS HAMAMELIDAE

Mostly woody; flowers ± in unisexual catkins, without perianth, typically wind-pollinated

- Order Hamamelidales
  - Platanaceae
  - Hamamelidaceae
- Order Urticales
  - Ulmaceae
  - Cannabaceae
  - Moraceae
  - Urticaceae
- Order Leitneriales
  - Leitneriaceae
- Order Juglandales
  - Juglandaceae
- Order Myricales
  - Myricaceae
- Order Fagales
  - Fagaceae
  - Betulaceae

ANGIOSPERMS *(DICOTS)*

SUBCLASS CARYOPHYLLIDAE

Mostly herbaceous; petals free (or absent and sepals petal-like, sometimes fused); placentas basal or free-central; stamens developing from inner to outer—centrifugal

- Order Caryophyllales
  - Phytolaccaceae
  - Nyctaginaceae
  - Aizoaceae
  - Cactaceae
  - Chenopodiaceae
  - Amaranthaceae
  - Portulacaceae
  - Basellaceae
  - Molluginaceae
  - Caryophyllaceae
- Order Polygonales
  - Polygonaceae

SUBCLASS DILLENIIDAE

Petals ± free, sometimes fused (if 0, sepals not petal-like); pistil usually compound; placentas generally parietal (or axile);
stamens developing from inner to outer; leaves mostly simple

- Order Theales
  - Theaceae
  - Elatinaceae
  - Clusiaceae (Guttiferae)
- Order Malvales
  - Tiliaceae
  - Sterculiaceae
  - Malvaceae
- Order Nepenthales
  - Sarraceniaceae
  - Droseraceae
- Order Violales
  - Cistaceae
  - Violaceae
  - Tamaricaceae
  - Passifloraceae
  - Cucurbitaceae
  - Loasaceae
- Order Salicales
  - Salicaceae
- Order Capparales
  - Capparaceae
  - Brassicaceae (Cruciferae)
- Order Ericales
  - Cyrillaceae
  - Clethraceae
  - Ericaceae (including Monotropaceae)
- Order Ebenales
  - Sapotaceae
  - Ebenaceae
  - Styracaceae
  - Symplocaceae
- Order Primulales
  - Myrsinaceae
  - Primulaceae

SUBCLASS ROSIDAE

Petals usually free; stamens more than petals or opposite them, developing from outer to inner—centripetal; pistil compound or sometimes simple; placentas most often axile; leaves compound or simple

- Order Rosales
  - Hydrangeaceae
  - Crassulaceae
  - Saxifragaceae
  - Rosaceae
- Order Fabales
  - Fabaceae
- Order Proteales
  - Elaeagnaceae
- Order Podostemales
  - Podostemaceae
- Order Haloragales
  - Haloragaceae
- Order Myrtales
  - Lythraceae
  - Thymelaeaceae
  - Onagraceae
  - Melastomataceae
- Order Cornales
  - Cornaceae
  - Nyssaceae
  - Garryaceae
- Order Santalales
  - Viscaceae
- Order Rafflesiales
  - Rafflesiaceae
- Order Celastrales
  - Celastraceae
  - Aquifoliaceae
- Order Euphorbiales
  - Euphorbiaceae
- Order Rhamnales
  - Rhamnaceae
  - Vitaceae
- Order Linales
  - Linaceae
- Order Polygalales
  - Malpighiaceae
  - Polygalaceae
  - Krameriaceae
- Order Sapindales
  - Sapindaceae
  - Hippocastanaceae
  - Aceraceae
  - Anacardiaceae
  - Simaroubaceae
  - Meliaceae
  - Rutaceae
  - Zygophyllaceae
- Order Geraniales
  - Oxalidaceae
  - Geraniaceae
  - Balsaminaceae
- Order Apiales
  - Araliaceae
  - Apiaceae (Umbelliferae)

SUBCLASS ASTERIDAE

Predominantly herbaceous; petals ± fused; stamens equal in number to or fewer than petals and alternate them; pistil compound, generally of 2 carpels

- Order Gentianales
  - Loganiaceae
  - Gentianaceae
  - Apocynaceae
  - Asclepiadaceae
- Order Solanales
  - Solanaceae
  - Convolvulaceae
  - Cuscutaceae
  - Menyanthaceae
  - Polemoniaceae
  - Hydrophyllaceae
- Order Lamiales
  - Boraginaceae
  - Lamiaceae (Labiatae)
  - Verbenaceae
  - Phrymaceae
- Order Callitrichales
  - Callitrichaceae
- Order Plantaginales
  - Plantaginaceae

ANGIOSPERMS *(DICOTS CONTINUED)*

- Order Scrophulariales
  - Buddlejaceae
  - Oleaceae
  - Scrophulariaceae
  - Orobanchaceae
  - Acanthaceae
  - Pedaliaceae
  - Bignoniaceae
  - Lentibulariaceae
- Order Campanulales
  - Sphenocleaceae
  - Campanulaceae
- Order Rubiales
  - Rubiaceae
- Order Dipsacales
  - Caprifoliaceae
  - Valerianaceae
  - Dipsacaceae
- Order Asterales
  - Asteraceae (Compositae)

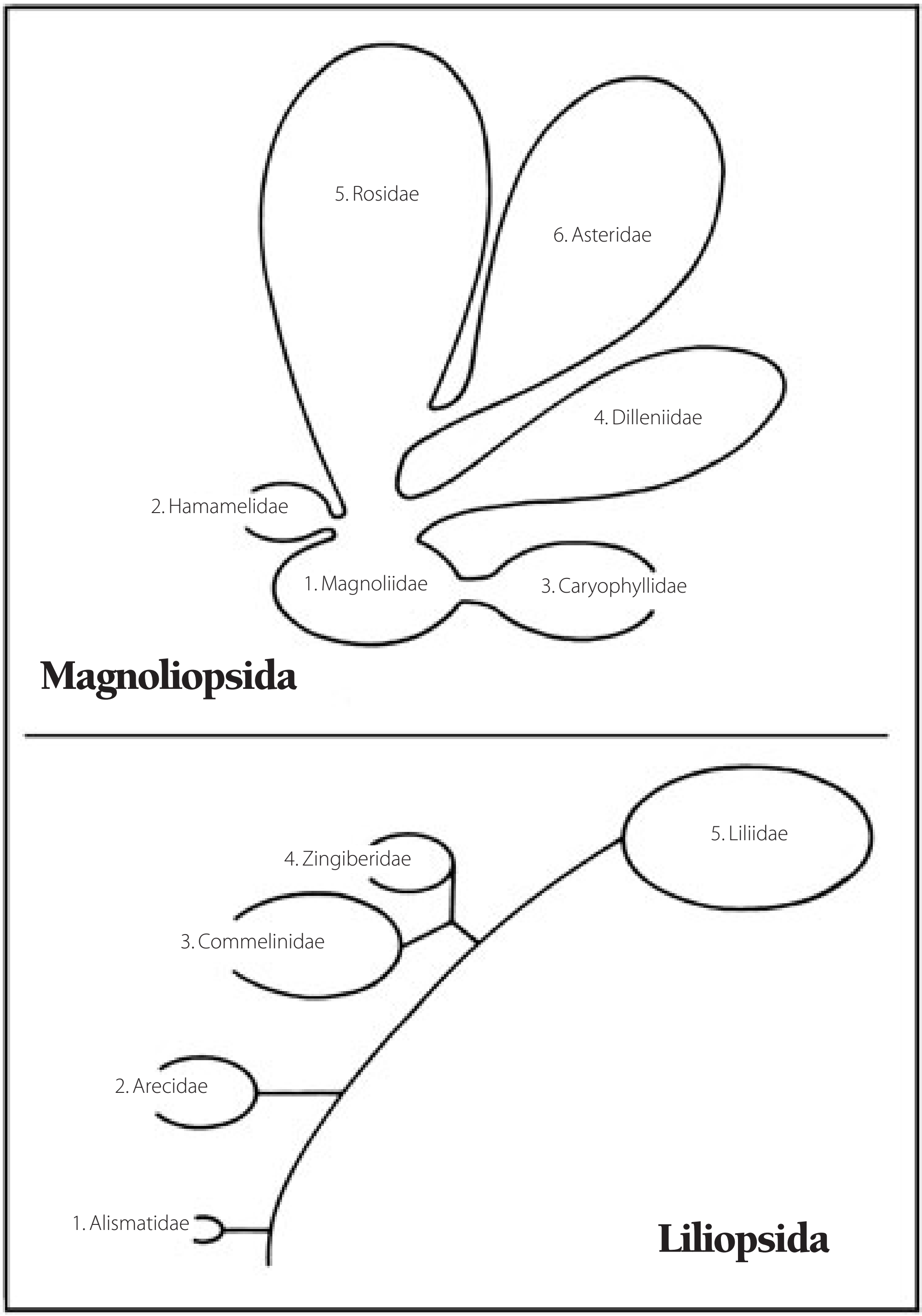

Fig. 173/Diagram of relationships of subclasses of flowering plants. Reprinted by permission from *The Evolution and Classification of Flowering Plants,* 2nd ed., pages 263 and 457, Authur Cronquist, copyright 1988, The New York Botanical Garden, Bronx, NY.

Phylogeny/Classification of Flowering Plant Families Based on the Angiosperm Phylogeny Group (APG II 2003)

This phylogeny/classification is based on the work of Angiosperm Phylogeny Group (APG II 2003). It differs from the Cronquist phylogeny (Appendix 2) in a number of ways including being based on molecular data and reflecting the influence of cladistics. Figure 174 (from Zanis et al. 2003) may be helpful in understanding some of the relationships presented here.

EARLY DIVERGING FAMILIES

Not placed in an order

Nymphaeaceae
Cabombaceae (included in Nymphaeaceae but acceptable to recognize according to APG)

Ceratophyllales

Ceratophyllaceae

MAGNOLIIDS

Laurales

Calycanthaceae
Lauraceae

Magnoliales

Annonaceae
Magnoliaceae

Piperales

Aristolochiaceae
Saururaceae

MONOCOTS

Acorales

Acoraceae

Alismatales

Alismataceae
Araceae (including Lemnaceae)
Hydrocharitaceae
Limnocharitaceae
Potamogetonaceae (including Zannichelliaceae)
Ruppiaceae
Tofieldiaceae

Asparagales

Alliacaeae
Amaryllidaceae (inlcuded in Alliaceae but acceptable to recognize according to APG)
Asparagaceae
Agavaceae (included in Asparagaceae but acceptable to recognize according to APG; including Anthericaceae)
Hyacinthaceae (included in Asparagaceae but acceptable to recognize according to APG)
Ruscaceae (included in Asparagaceae but acceptable to recognize according to APG; including Convallariaceae and Nolinaceae)
Themidaceae (included in Asparagaceae but acceptable to recognize according to APG)
Hypoxidaceae
Iridaceae
Orchidaceae
Hemerocallidaceae (included in Zanthorrhoeaceae but acceptable to recognize according to APG)

Dioscoreales

Burmanniaceae
Dioscoreaceae
Nartheciaceae

Liliales

Alstroemeriaceae
Colchicaceae
Liliaceae
Melanthiaceae (including Trilliaceae)
Smilacaceae

Arecales

Arecaceae

Commelinales

Commelinaceae
Pontederiaceae

Poales

Bromeliaceae
Cyperaceae
Eriocaulaceae
Juncaceae
Mayacaceae
Poaceae
Sparganiaceae
Typhaceae
Xyridaceae

Zingiberales

Cannaceae
Marantaceae

EUDICOTS

Proteales

Nelumbonaceae
Platanaceae (included in Proteaceae but acceptable to recognize according to APG)

Ranunculales

Berberidaceae
Menispermaceae
Papaveraceae
Fumariaceae (included in Papaveraceae but acceptable to recognize according to APG)
Ranunculaceae

CORE EUDICOTS

Caryophyllales

Aizoaceae
Amaranthaceae (including Chenopodiaceae)
Basellaceae
Cactaceae
Caryophyllaceae
Droseraceae
Molluginaceae
Nyctaginaceae

Phytolaccaceae
Polygonaceae
Portulacaceae
Tamaricaceae

Santalales

Loranthaceae

Saxifragales

Crassulaceae
Haloragaceae
Hamamelidaceae
Saxifragaceae

ROSIDS

Not placed in an order

Vitaceae

Geraniales

Geraniaceae

Myrtales

Lythraceae
Melastomataceae
Onagraceae

EUROSIDS I

Zygophyllaceae
Krameriaceae (included in Zygophyllaceae but acceptable to recognize according to APG)

Celastrales

Celastraceae

Cucurbitales

Cucurbitaceae

Fabales

Fabaceae
Polygalaceae

Fagales

Betulaceae
Fagaceae
Juglandaceae
Myricaceae

Malpighiales

Clusiaceae
Elatinaceae
Euphorbiaceae
Hypericaceae
Linaceae
Malpighiaceae
Passifloriaceae
Podostemaceae
Salicaceae
Violaceae

Oxalidales

Oxalidaceae

Rosales

Cannabaceae
Elaeagnaceae
Moraceae
Rhamnaceae
Rosaceae
Ulmaceae
Urticaceae

EUROSIDS II

Brassicales

Brassicaceae (including Capparaceae)

Malvales

Cistaceae
Malvaceae (including Tiliaceae)
Thymelaeaceae

Sapindales

Anacardiaceae
Meliaceae
Rutaceae
Sapindaceae (including Aceraceae and Hippocastanaceae)
Simaroubaceae (including Leitneriaceae)

ASTERIDS

Cornales

Cornaceae
Nyssaceae (included in Cornaceae but acceptable to recognize according to APG)
Hydrangeaceae
Loasaceae

Ericales

Balsaminaceae
Clethraceae
Cyrillaceae
Ebenaceae
Ericaceae
Myrsinaceae
Polemoniaceae
Primulaceae
Sapotaceae
Sarraceniaceae
Styracaceae
Symplocaceae
Theaceae

EUASTERIDS I

Not placed in an order

Boraginaceae (including Hydrophyllaceae)

Garryales

Garryaceae

Gentianales

Apocynaceae (including Asclepiadaceae)
Gentianaceae
Loganiaceae
Rubiaceae

Lamiales

Acanthaceae
Bignoniaceae
Lamiaceae
Lentibulariaceae
Martyniaceae
Oleaceae
Orobanchaceae
Pedaliaceae
Phrymaceae
Plantaginaceae (including Callitrichaceae)
Scrophulariaceae
Verbenaceae

Solanales

Convolvulaceae (including Cuscutaceae)
Solanaceae
Sphenocleaceae

EUASTERIDS II

Apiales

Apiaceae
Araliaceae

Aquifoliales

Aquifoliaceae

Asterales

Asteraceae
Campanulaceae
Menyanthaceae

Dipsacales

Caprifoliaceae
Dipsacaceae (included in Caprifoliaceae but acceptable to recognize according to APG)
Valerianaceae (included in Caprifoliaceae but acceptable to recognize according to APG)

TAXA OF UNCERTAIN POSITION

Not placed in an order

Rafflesiaceae

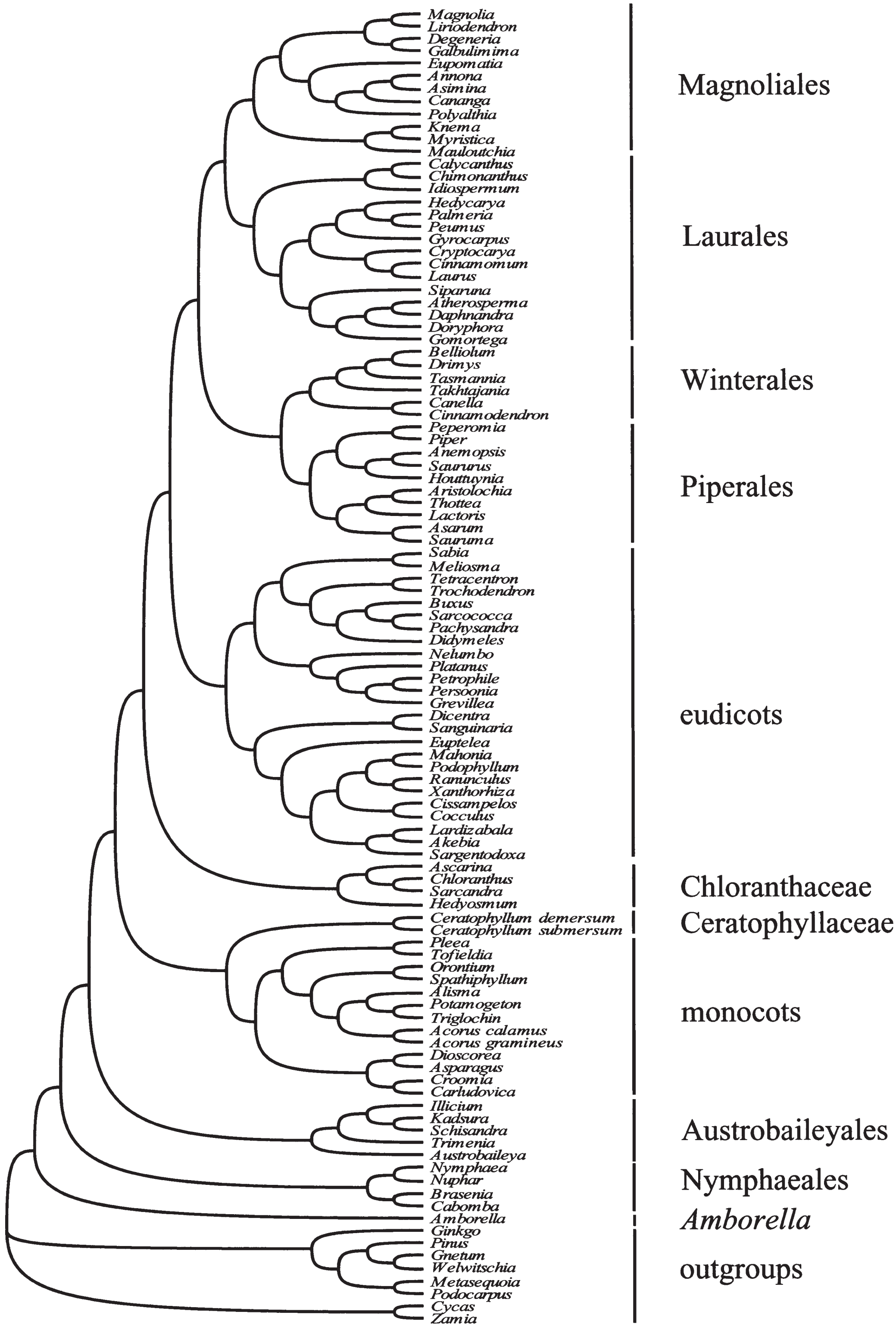

Fig. 174/Phylogenetic tree of the flowering plants based on molecular sequence data from six genes (modified from Zanis et al. 2003; used with permission of Missouri Botanical Garden Press).

Subfamilial and Tribal Phylogeny/Classification of East Texas Poaceae (Grass Family)

There has been a tremendous increase in the understanding of grass relationships in recent years, primarily due to the advent of molecular systematics (e.g., Grass Phylogeny Working Group 2000, 2001). As a consequence, there have been major changes in grass taxonomy. Many traditional relationships have been shown to be based on superficial morphological similarities and convergent evolution. On the other hand, early agrostologists, using limited characteristics, made significant breakthroughs which are still considered correct today. Currently, the Poaceae is considered to be composed of twelve subfamilies: Bambusoideae, Anomochlooideae, Pharoideae, Puelioideae, Ehrhartoideae, Centrothecoideae, Pooideae, Arundinoideae, Danthonioideae, Aristidoideae, Chloridoideae, and Panicoideae (Grass Phylogeny Working Group 2001), with representatives of nine of these occurring in East Texas. The subfamilies, tribes, and genera of the 410 species of Poaceae found in East Texas are listed below. While the relationships among the grass subfamilies are not perfectly known, much progress has been made in this regard and is now widely available (Grass Phylogeny Working Group 2001; www.virtualherbarium.org/grass/gpwg/default.htm). Based on multiple molecular data sets and morphological data (Grass Phylogeny Working Group 2001), the three earliest diverging grass lineages are the Anomochlooideae, Pharoideae, and Puelioideae, which together account for only 30 species of grasses. All remaining extant grasses fall into a clade which is composed of two lineages, informally known as the PACCAD clade and the BEP clade (Grass Phylogeny Working Group 2001) (Fig. 175). The largest group, the PACCAD clade, which consists of the Panicoideae, Arundinoideae, Chloridoideae, Centothecoideae, Aristidoideae, and Danthonioideae, is now widely recognized as monophyletic and contains more than half of all species of Poaceae (Kellogg 2003). The other large group, the BEP clade, is composed of the Bambusoideae, Ehrhartoideae, and Pooideae. Its monophyly is still an unresolved question, with placement of the Pooideae as sister to the PACCAD clade almost equally parsimonious (Grass Phylogeny Working Group 2001). All East Texas grass species fall within the BEP (three subfamilies) and PACCAD (six subfamilies) clades, and all nine subfamilies listed below are now widely accepted as being monophyletic groups (Grass Phylogeny Working Group 2001). The subfamilial and tribal placement of the genera given below follows *Flora of North America North of Mexico* volumes 24 (Flora of North America Editorial Committee ined.) and 25 (Flora of North America Editorial Committee 2003) and Grass Phylogeny Working Group (2001).

BEP Grasses

Subfamily **BAMBUSOIDEAE**
- Tribe **Bambuseae**
  - *Arundinaria*
  - *Bambusa*
  - *Phyllostachys*

Subfamily **EHRHARTOIDEAE**
- Tribe **Oryzeae**
  - *Leersia*
  - *Luziola*
  - *Oryza*
  - *Zizania*
  - *Zizaniopsis*
- Tribe **Ehrharteae**
  - *Ehrhartia*

Subfamily **POOIDEAE**
- Tribe **Triticeae**
  - *Aegilops*
  - *Elymus*
  - *Hordeum*
  - *Secale*
  - *Triticum*
- Tribe **Bromeae**
  - *Bromus*
- Tribe **Poeae**
  - *Briza*
  - *Cynosurus*
  - *Dactylus*
  - *Desmazeria*
  - *Festuca*
  - *Lolium*
  - *Parapholis*
  - *Phalaris*
  - *Poa*
  - *Schlerochloa*
  - *Vulpia*
- Tribe **Aveneae** (recognized by Watson & Dalwitz 1992; put in Poeae by Grass Phylogeny Working Group 2001)
  - *Agrostis*
  - *Aira*
  - *Alopecurus*
  - *Anthoxanthum*
  - *Avena*
  - *Cinna*
  - *Holcus*
  - *Koeleria*
  - *Limnodea*

(continuation of **Aveneae**)

Phalaris
Phleum
Polypogon
Rostraria
Sphenopholis
Trisetum

Tribe **Meliceae**
Glyceria
Melica

Tribe **Stipeae**
Nassella
Piptochaetium

Tribe **Brachyelytreae**
Brachyelytrum

Tribe **Diarrheneae**
Diarrhena

PACCAD GRASSES

Subfamily **ARUNDINOIDEAE**

Tribe **Arundineae**
Arundo
Phragmites

Subfamily **CHLORIDOIDEAE**

Tribe **Cynodonteae**
Buchloe
Bouteloua
Chloris
Ctenium
Cynodon
Dactyloctenium
Distichlis
Eleusine
Enteropogon
Eragrostis
Erioneuron
Eustachys
Gymnopogon
Hilaria
Leptochloa
Monanthochloe
Muhlenbergia
Schedonnardus
Spartina
Sporobolus
Tragus
Trichloris
Trichoneura
Tridens
Triplasis
Tripogon
Willkommia
Zoysia

Tribe **Pappophoreae**
Pappophorum

Subfamily **CENTOTHECOIDEAE**

Tribe **Centotheceae**
Chasmanthium

Subfamily **DANTHONIOIDEAE**

Tribe **Danthonieae**
Cortaderia
Danthonia

Subfamily **ARISTIDOIDEAE**

Tribe **Aristideae**
Aristida

Subfamily **PANICOIDEAE**

Tribe **Paniceae**
Anthenantia
Axonopus
Cenchrus
Dichanthelium
Digitaria
Echinochloa
Eriochloa
Oplismenus
Panicum
Paspalidium
Pennisetum
Sacciolepis
Setaria
Steinchisma
Stenotaphrum
Urochloa

Tribe **Andropogoneae**
Arthraxon
Andropogon
Bothriochloa
Coix
Coelorachis
Dichanthium
Elionurus
Eremochloa
Heteropogon
Imperata
Microstegium
Miscanthus
Saccharum
Schizachyrium
Sorghastrum
Sorghum
Themeda
Trachypogon
Tripsacum
Zea

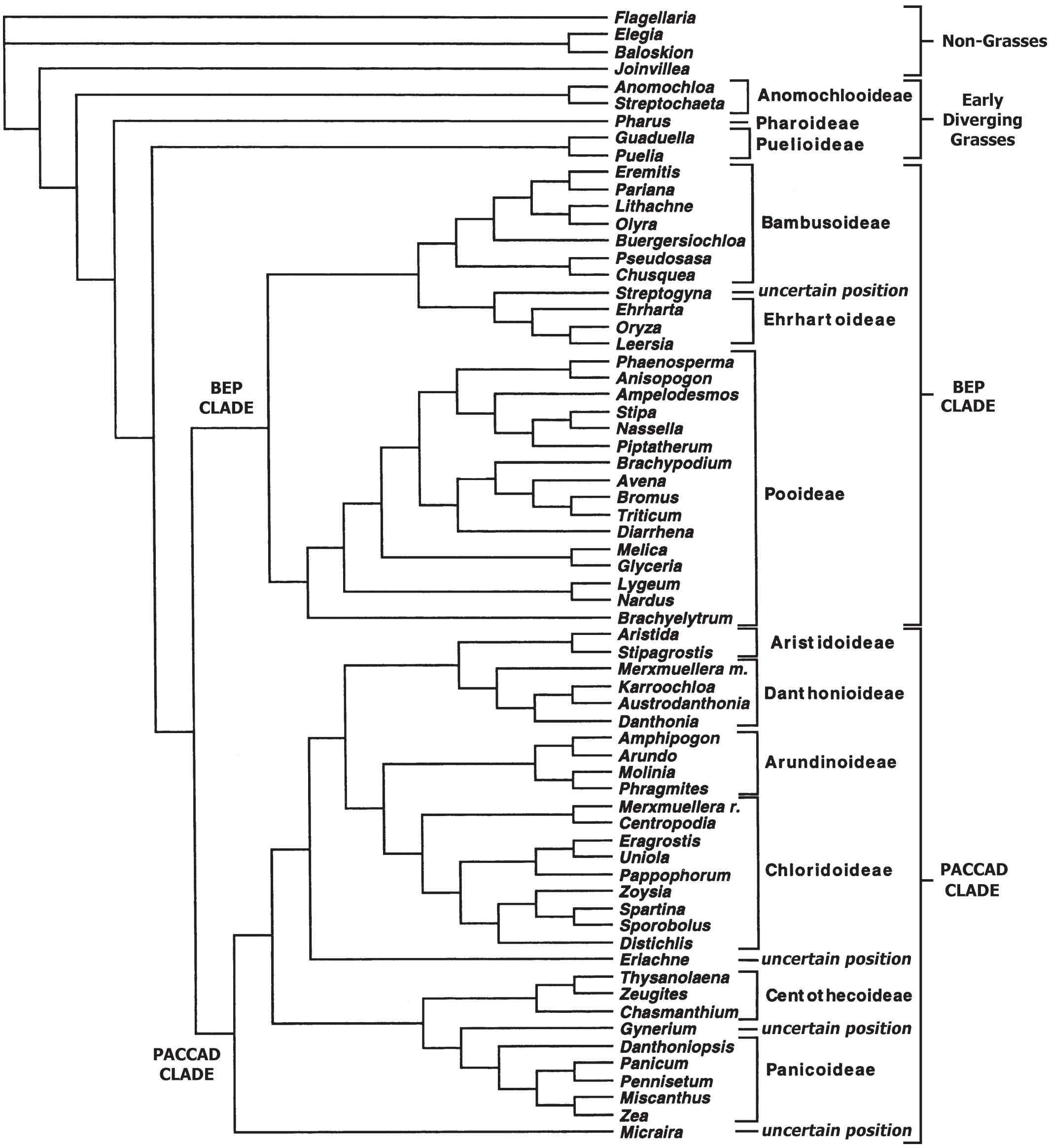

FIG. 175/SINGLE MOST PARSIMONIOUS TREE FOR THE GRASSES AND RELATIVES BASED ON EIGHT DATA SETS (SIX MOLECULAR DATA SETS, CHLOROPLAST RESTRICTION SITE DATA, AND MORPHOLOGICAL DATA) (GRASS PHYLOGENY WORKING GROUP 2001; USED WITH PERMISSION OF MISSOURI BOTANICAL GARDEN PRESS).

TAXONOMY, CLASSIFICATION, AND THE DEBATE ABOUT CLADISTICS[1]

Plant taxonomy is the science that deals with the *identification, nomenclature,* and *classification* of plants. The term plant systematics (or systematic botany) is often used synonymously with plant taxonomy (as is done here) but sometimes has the connotation of mainly using recently developed techniques such as chromosomal studies, electron microscopy, or molecular biology to answer questions about plant relationships. From the definition of plant taxonomy, it follows that the primary goals of the discipline are to:

- 1) identify and describe all the various kinds of plants;
- 2) develop a uniform, practical, and stable system of naming plants—one that can be used by both plant taxonomists and others needing a way to precisely communicate information about plants [The naming system for plants follows the International Code of Botanical Nomenclature (Greuter et al. 1994)]; and
- 3) arrange plants with common characteristics into groups that reflect their relationships—in other words, to develop a scheme of classification that is useful. Similar species are thus put into the same genus, similar genera into the same family, etc. (Lawrence 1951; Porter 1967; Radford et al. 1974; Jones & Luchsinger 1986).

Since the time of Darwin, a primary goal of plant taxonomists has been to reflect phylogeny or evolutionary history in the system of plant classification. While this basic premise is agreed on by virtually all botanists, in recent years there has been heated debate between two main schools of taxonomists:

- 1) traditional taxonomists practicing what is sometimes referred to as "Linnaean classification" (Brummitt 1997), a system based on a hierarchy of formal ranks (e.g., family, genus, etc.) and binomial nomenclature (two-part scientific names consisting of a genus name and specific epithet); and
- 2) cladists (whose method of constructing phylogenies is based on the work of the German entomologist Willi Hennig) practicing phylogenetic classification (referred to as cladonomy by Brummitt (1997)). It should be noted that in a clade-based classification system, there are no formal ranks, including the genus, and no binomial nomenclature (de Queiroz & Gauthier 1992; Brummitt 1997; Lidén et al. 1997; Cantino 1998).

In some cases, the classification systems produced by traditional taxonomists and cladists are similar. However, as a result of their different methods, in many instances the classification and nomenclature systems produced are quite different.

Traditional taxonomists, while attempting to have a classification system based on evolutionary relationships, also try to reflect the amount of evolutionary change undergone by groups. They argue that classification is "... more than just branching patterns of evolution" (Stussey 1997). To use an animal example discussed in more detail below, because birds are so different from other vertebrates (e.g., fly, have feathers), they are treated as a different class of animal even though they evolved *from within* the class known as reptiles. Traditional taxonomists also try to incorporate other goals, including practicality and stability, into the classification system (see Brummitt (1997) for a detailed discussion of traditional classification). An example of a classification system produced by a traditional taxonomist can be seen in the work of Cronquist (1981, 1988) whose classification of flowering plants is given (with modifications) in Appendix 2.

The basic goal of cladistics (often referred to as "phylogenetic systematics"), and the only one that is considered important, is that classification should reflect the branching pattern of evolution. Thus one of the central principles of cladistics is that only monophyletic groups (= a common ancestor and all

[1]Reprinted from Diggs et al. (1999).

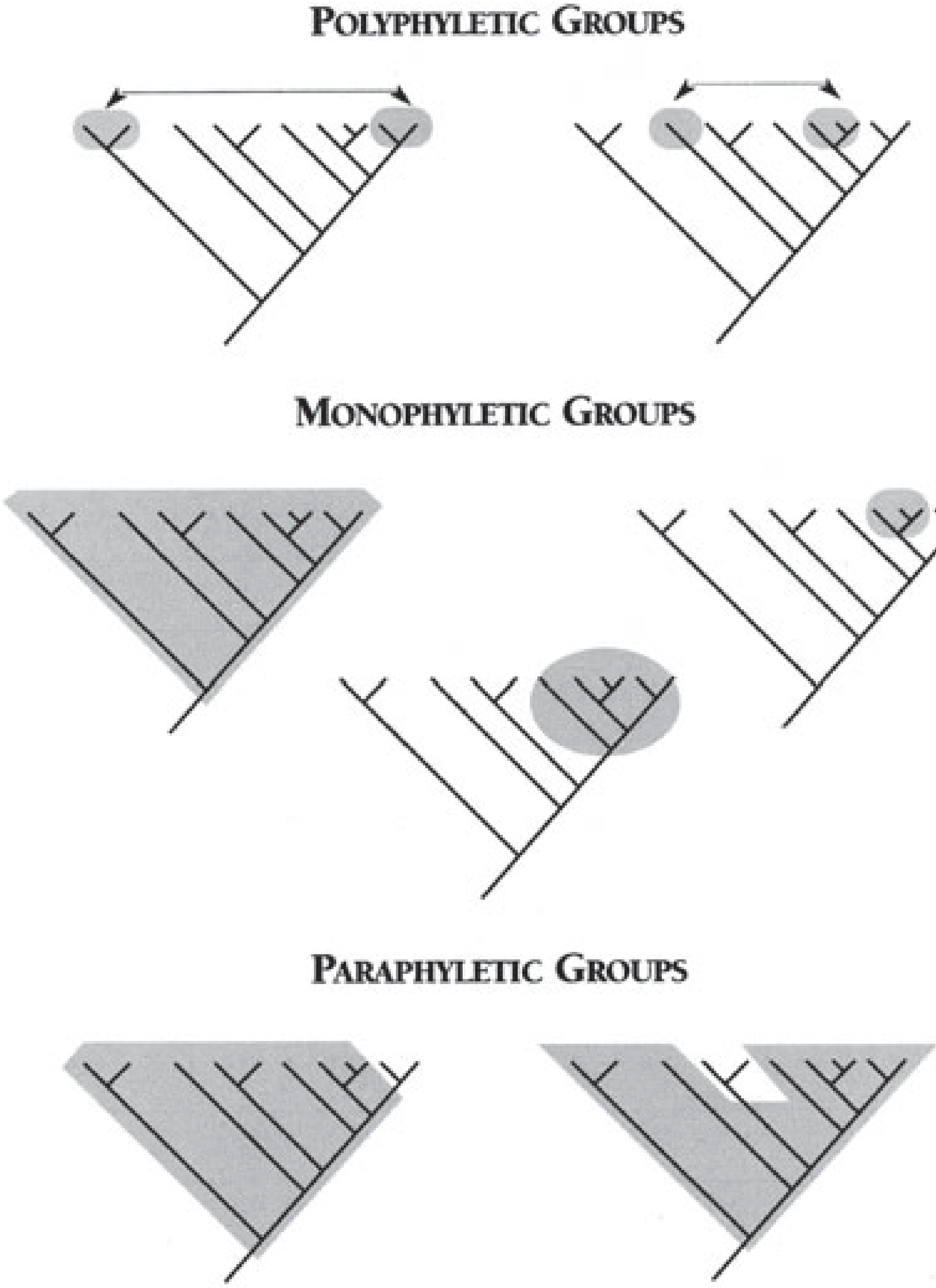

FIG. 176/DIAGRAMMATIC REPRESENTATION OF POLYPHYLETIC, MONOPHYLETIC, AND PARAPHYLETIC GROUPS. FIGURE PRODUCED BY BRIT/AUSTIN COLLEGE; REPRODUCTION OF THIS IMAGE DOES NOT REQUIRE COPYRIGHT PERMISSION.

its descendants) should be given taxonomic recognition (Fig. 176). These groupings should be based on shared derived characteristics or character states, which are referred to as synapomorphies. Every organism is a mosaic of ancestral characteristics (= pleisomorphies) inherited with little or no change from some remote ancestor and derived characteristics (= apomorphies), which reflect more recent evolutionary change (Futuyma 1986). Apomorphies are thus characteristics that have changed evolutionarily and are different from the characteristics of a distant ancestor. All of the species that share an apomorphic characteristic are considered to be derived from a single common ancestor (because they inherited the derived characteristic from that common ancestor). The derived/apomorphic characteristic that they share is referred to as a synapomorphy. Mammals are thus considered a monophyletic group because they share a number of synapomorphies (e.g., produce milk, have hair, are warm-blooded) that were inherited from the common ancestor of the mammals. The unique 4+2 arrangement of stamens in the mustard family is another example of a synapomorphy; this derived characteristic occurred in the ancestor of all the mustards and is shared by, and only by, members of that family. According to cladists, only this type of shared derived characteristic provides evidence of phylogenetic relationships, and therefore only these characteristics should be used in developing a classification system. They say that shared ancestral characteristics—those characteristics two organisms share because they have been retained from a distant common ancestor—do not accurately reflect recent relationships and should therefore not be used. For example, humans and lizards share the ancestral characteristic of four limbs; snakes, however, have no limbs—legs were lost relatively recently in the evolutionary line leading to snakes. Just because humans and lizards have retained the four limbs found in our common vertebrate ancestor does not mean lizards are more closely related to us than lizards are to snakes. In fact, lizards and snakes are closely related (Fig. 177) and have a number of shared derived characteristics that link them.

According to cladists, polyphyletic groups (containing taxa descended from more than one ancestor) and paraphyletic groups (including the common ancestor and some, but not all, of its descendants) should not be recognized (see Fig. 176 for these situations). Further, relationships based on overall similarity (a methodology referred to as phenetics) are not formally recognized—just because two groups appear similar does not necessarily mean they are closely related evolutionarily. For example, the cacti (Cactaceae) and euphorbs (Euphorbiaceae) both have large, desert-adapted, succulent species that are superficially almost indistinguishable but very distantly related evolutionarily. These similarities are due to convergent evolution, a process by which distantly related, or even unrelated, species evolve similar adaptations in the face of similar selection pressures (such as desert-like conditions).

As indicated above, traditional taxonomists since the time of Darwin have attempted to reflect phylogeny in their systems of classification. However, they have used somewhat different methods from cladists—not only shared derived characteristics, but also shared ancestral characteristics have been utilized. Further, in addition to monophyletic groups, paraphyletic groups often have been recognized if they could be defined phenetically. In fact, our current plant classification system contains numerous examples of paraphyletic groups. The evolutionary tree in Figure 178 is a theoretical example of this situation. Species A, B, C, D, and E are all similar morphologically; species F, however, because of adaptation to some extreme environment (e.g., desert), has become very different morphologically. This phenetic difference of species F is reflected in Figure 178 by its distance from the other species. Traditional taxonomists have in general placed species A, B, C, D and E in one genus, and species F in another. Cladists would argue that this is unacceptable because E and F are more closely related than any of the others (they share the most recent common ancestor); the group A, B, C, D, and E is unacceptable because it is paraphyletic. Either A, B, and C have to be put in one genus and D, E, and F in another, or all six have to be put in the same genus. Traditional taxonomists might counter that these solutions do not reflect the tremendous amount of evolutionary change undergone by species F; they in some cases argue that because F is so different phenetically, it should be recognized as a separate group. An actual example can be seen in the case of the Asclepiadaceae (milkweeds) and Apocynaceae (dogbanes), two families recognized by traditional taxonomists (Fig. 179). The milkweeds, like our theoretical species F, are quite distinctive morphologically and, indeed, are widely recognized as monophyletic. However, when cladistic methods are applied, it becomes readily apparent that the Asclepiadaceae are a monophyletic branch derived from within the Apocynaceae, making the dogbane family (with milkweeds excluded) paraphyletic (like our

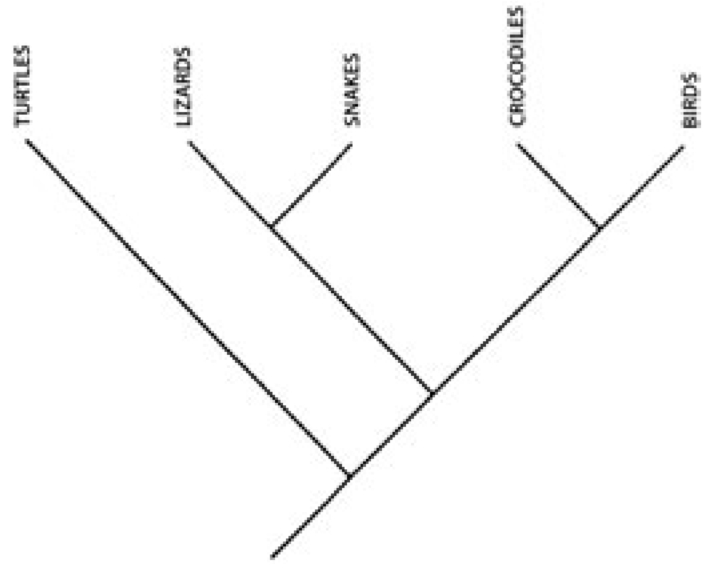

FIG. 177/DENDROGRAM SHOWING RELATIONSHIPS OF SOME VERTEBRATE GROUPS. NOTE THE PARAPHYLETIC NATURE OF THE "REPTILIA." FIGURE PRODUCED BY BRIT/AUSTIN COLLEGE; REPRODUCTION OF THIS IMAGE DOES NOT REQUIRE COPYRIGHT PERMISSION.

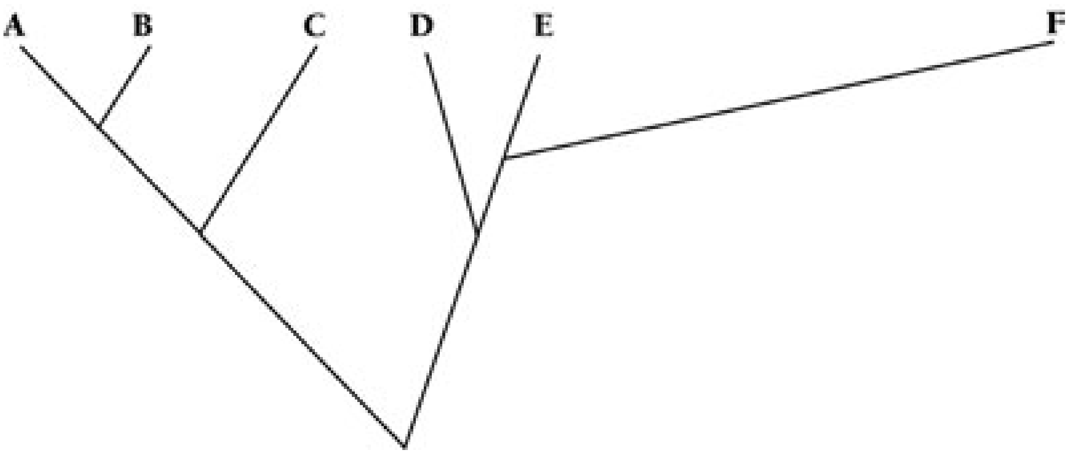

FIG. 178/PHENETIC DISTANCE DIAGRAM; HORIZONTAL DISTANCE BETWEEN SPECIES INDICATES PHENETIC DIFFERENCE. NOTE THAT SPECIES F, WHILE MOST CLOSELY RELATED PHYLOGENETICALLY TO SPECIES E, IS QUITE DIFFERENT IN TERMS OF PHENETICS. FIGURE PRODUCED BY BRIT/AUSTIN COLLEGE; REPRODUCTION OF THIS IMAGE DOES NOT REQUIRE COPYRIGHT PERMISSION.

group A, B, C, D, and E, or like the reptiles with the birds removed). From the cladistic standpoint, the two families thus have to be lumped together into a single more inclusive Apocynaceae (the choice of which name to use is based on the rules of botanical nomenclature) (Judd et al. 1994). To the distress of many traditional taxonomists, the name Apocynaceae is thus used in a very different sense than previously. Traditional taxonomists argue that confusion results from such name changes and that clearly defined and easily recognized groups such as the Asclepiadaceae should be retained. The cladists, on the other hand, emphasize that the methods used by traditional taxonomists result in groups that do not reflect, and in fact actually distort, our understanding of evolutionary history. Cladists further stress that there are specific objective rules by which their characters are chosen and used. Consequently, they consider the results of their analyses repeatable, and in comparison with traditional taxonomy, less subjective.

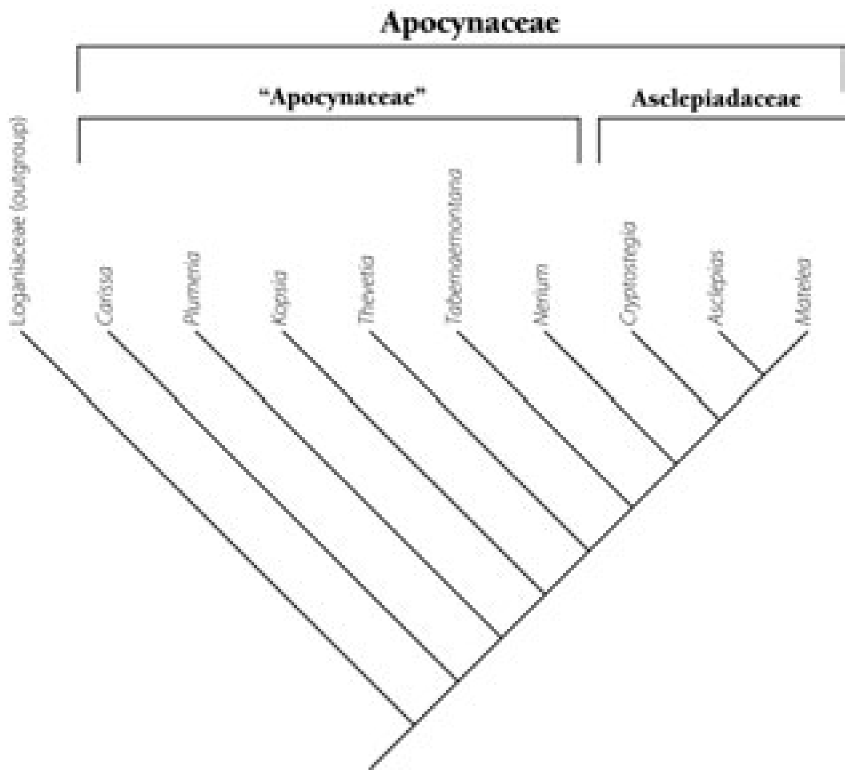

Fig. 179/Dendrogram showing relationship of two closely related families, the "Apocynaceae" and the Asclepiadaceae (modified from Judd et al. (1994); used with permission of the President and Fellows of Harvard College and W.S. Judd).

However, it should be noted that numerous assumptions have to be made in carrying out a cladistic analysis. In particular, because assumptions have to be made as to which character states are derived and which are ancestral, cladistic analyses are subject to various interpretations. Further, in several recent articles (e.g., Brummitt 1997; Sosef 1997) the argument has been made that in a hierarchical system of classification such as that used by plant taxonomists, paraphyletic taxa are inevitable and that a completely cladistic system of classification would be impractical to the point of being nonsensical.

The results of these differing viewpoints are perhaps even more dramatically seen in the case of well known major animal groups. The widely recognized class Reptilia (reptiles) is actually paraphyletic, with turtles representing an early branch and birds arising from within the main body of the group (Fig. 177). Even though birds are very different from other members of the group in many ways (e.g., warm-blooded, have feathers, fly, lack teeth), birds and crocodiles are more closely related to one another than crocodiles are to other reptiles; in other words, from an evolutionary standpoint we should no longer recognize a formal group Reptilia. Some traditional taxonomists argue that the amount of evolutionary change, practicality, stability, and tradition in such cases should override phylogeny, while cladists stress the overwhelming importance of accurately reflecting evolutionary history. In any case, at the very least the recognition of the paraphyletic Reptilia de-emphasizes evolutionary history, such as the close relationship between crocodiles and birds.

This controversy over cladistics is currently very heated, with clearly articulated positions on both sides. Welzen (1997) for example argued that the outdated "Linnaean system" should be abandoned, and de Queiroz (1997) stated, "The Linnaean hierarchy has become obsolete." De Queiroz (1997) also indicated that the "... next stage in the process of evolutionization [of taxonomy] will extend a central role for the principle of descent into the realm of biological nomenclature." Cantino (1998) stated that "Phylogenetic nomenclature is the logical culmination of a revolution that began with Darwin. ..." On the other side of the controversy, Brummitt (1997) and Sosef (1997) argued (as indicated above) that paraphyletic taxa are inevitable and that cladistics is unable to cope with the reticulate evolutionary relationships seen in some groups. They further stated (Brummitt & Sosef 1998) that "... attempts to eliminate paraphyletic taxa from Linnaean classification are logically untenable." For a discussion of some of the methodological, conceptual, and philosophical problems associated with cladistics, see Stuessy (1997); for a discussion of the importance of consistently applying cladistic methods and thus bringing an evolutionary perspective to biological classification and nomenclatural systems, see de Queiroz (1997).

Three things seem clear regarding the controversy:

- 1) This argument over cladistics will not easily or quickly be laid to rest, and thus a clear understanding of cladistic methodology and results is important. Further explanation of cladistics can be found in standard works on plant taxonomy such as Zomlefer (1994), Walters and Keil (1996), and Woodland (1997), or in evolutionary biology texts such as Ridley (1996).
- 2) The implementation of cladistic methodology would result in systems of classification and nomenclature radically different from those currently used; all the implications are not yet clear, but levels in the current hierarchy such as family or genus would no longer have meaning. In fact, if cladistic principles are consistently applied, it will be necessary for the binomial system of nomenclature to be abandoned (de Queiroz & Gauthier 1992; Lidén et al. 1997; Cantino 1998). The potential loss of nomenclatural stability is particularly disturbing to many taxonomists. Detailed discussions of some of the implications can be found in recent articles (e.g., Brummitt 1997; Crane & Kendrick 1997; de Queiroz 1997; Kron 1997; Lidén et al. 1997; Nicolson 1997; Sosef 1997; Stuessy 1997; Welzen 1997; Freudenstein 1998; Backlund & Bremer 1998; Brummitt & Sosef 1998; Cantino 1998; Sanders & Judd 1998; Schander 1998a, 1998b; Welzen 1998).
- 3) Our knowledge of phylogenetic relationships, despite the advances of molecular biology, is still incomplete, and thus all the necessary information for a completely phylogenetic classification system is not yet available. In fact, many groups are poorly known and for some, "... cladistic analysis can yield only the most tentative of hypotheses, subject to drastic change as new relatives are encountered" (Stuessy 1997). There are also methodological problems concerning how the characters used in cladistic analyses are chosen and analyzed (Stuessy 1997). The result can be instability in classification, and more problematically, in nomenclature, if it is linked to a rapidly changing cladistic classification system.

Because of both philosophical and practical implementation problems, Brummitt (1997) pointed out that while the controversy should be debated, it seems unlikely that "Linnaean classification" will soon be abandoned. Brummitt (1997) suggested that both a "Linnaean classification" system and a clade-based phylogeny are desirable because they have different functions. He argued that both be allowed to exist side by side and that the nomenclature of the two should be easily recognized as different (Brummitt 1997). In summarizing his ideas he stated, "... we should not follow traditional practices just because they are traditional, but neither should we adopt new ideas just because they are new. We need to understand the possibilities and appreciate the different objectives and functions of the different options. In the meantime, it seems to me and to many others that the compromise of maintaining Linnaean classification but trying to eliminate paraphyletic taxa is nonsensical and should be abandoned before any more damage is done to existing classifications and nomenclature." Lidén et al. (1997) indicated, "If applied consistently, Phyllis [cladistic methodology] will cause confusion and loss of information content and mnemonic devices, without any substantial scientific or practical advantage. ... any attempts to make Phyllis formal would be disastrous. We can find no conclusive, valid arguments against keeping the body of our current system intact." An interesting point was also made by Stuessy (1997) when he said, "... in this urgent climate of seeking to inventory the world's biota (Anonymous 1994), and requesting funds from the rest of society to do so, it would be highly counterproductive to simultaneously recommend whole-scale change of names of organisms for any reason." While strongly supporting a cladistic system, Welzen (1998) also noted that a compromise between the two types of classification is impossible. He also understood that because of practical reasons it is impossible to abandon Linnaean classification "... because too few cladograms are available to replace the existing system with a complete phylogenetic

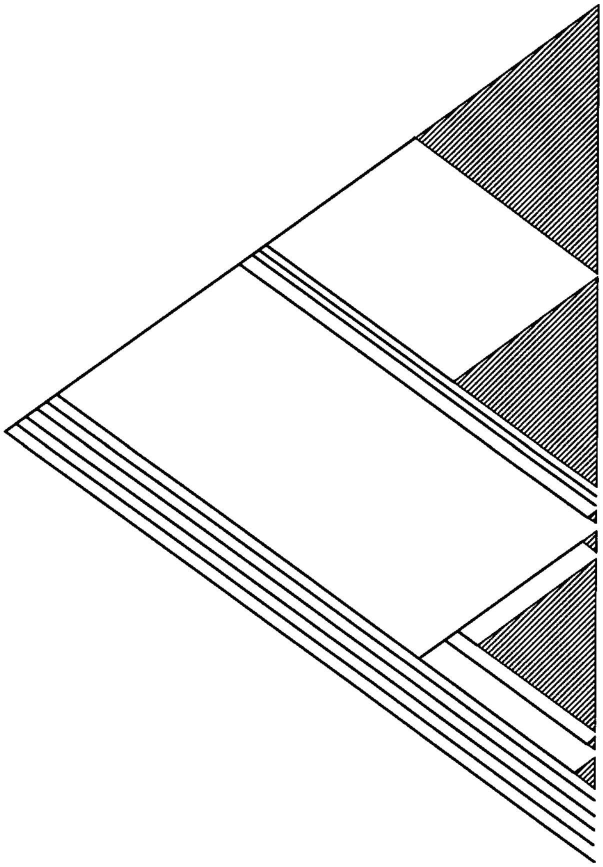

Fig. 180/Major clades of seed plants based on DNA sequence data (from Chase et al. 1993). Note that the monocots arise from within the dicots, making the dicots paraphyletic. Used with permission of the Missouri Botanical Garden Press and M.W. Chase.

classification. Moreover, quite a few cladograms will not be that trustworthy due to the many homoplasies [result of convergent evolution] that have evolved; they will therefore, provide an unstable classification at best." Welzen (1997) went on to say, "I think, therefore, that the best solution is to choose the second option that Brummitt (1997) provides in his paper, namely, 'retaining Linnaean classification, with paraphyletic taxa, but developing alongside it an independent clade-based dichotomous system with its own separate nomenclature.' "

At present there is no complete, generally accepted, higher level cladistic analysis of the flowering plants; consequently in Appendix 2 we have given family, order, and subclass relationships based largely on the work of Cronquist (1981, 1988). While imperfect from the cladistic standpoint, it is a practical and effective way to organize thinking about plant relationships. Steps are currently being taken toward a new consensus on angiosperm relationships based on both cladistic analyses and much new evidence from molecular systematics; one such scenario is seen in Figure 180. One of the most important implications of this figure is that the monocots appear to be derived from within the dicots, making the dicots paraphyletic and thus—according to cladists—inappropriate for formal recognition. It might also be noted that the placement of the paleoherb families (such as the Aristolochiaceae, Piperaceae, and Nymphaeaceae) as branches off the line leading to monocots makes sense in terms of characteristics such as their unusual 3-merous perianth and androecium.

It is important for students to gain some understanding of the phylogenetic relationships of the various plant families. As a result, we have added notes at the end of many family descriptions (e.g., Asclepiadaceae, Apocynaceae, Brassicaceae, Capparaceae) concerning the implications of cladistics. However, while we believe this understanding is essential, we do not feel it is appropriate or even desirable to undertake a familial rearrangement on cladistic grounds in a largely floristic work such as this; consequently, in most cases traditional family boundaries have been maintained.

Categories or Ranks in the Hierarchical System of Plant Classification

The system of classification used by traditional plant taxonomists and reflected in the International Code of Botanical Nomenclature (Greuter et al. 1994) results in the placement of plants into a hierarchical system with the different categories or ranks given such names as class, family, or genus. Every plant species is thus classified in the higher categories. For example, a bluebonnet (*Lupinus texensis*) is in the family Fabaceae (bean family), the subfamily Papilionoideae, the tribe Genisteae, etc. The various categories or ranks are listed below (a number of additional categories can be inserted as needed). Note that not all categories are always used; while every plant species is classified in the categories given below in all capitals (DOMAIN, KINGDOM, CLASS, SUBCLASS, FAMILY, GENUS, and SPECIES), those categories in lower case letters (Subfamily, Tribe, Subspecies, Variety, Form) are often not used.

- **DOMAIN** (sometimes referred to as Superkingdom; all eukaryotic organisms—those with nuclei in their cells—are in Eukaryota; the other two Domains are Archaea and Eubacteria)
  - **KINGDOM** (the Kingdoms include Plantae, Animalia, Fungi, etc.)
    - **DIVISION** (equivalent to Phylum in animal classification; there are nine living divisions of vascular plants; flowering plants are the Division Magnoliophyta)
      - **CLASS** (there are 2 classes of flowering plants: Monocotyledonae & Dicotyledonae)
        - **SUBCLASS** (there are 11 subclasses of flowering plants; see Fig. 173 in Appendix 2)
          - **ORDER** (this level shows relationships between families; it is rarely used by anyone except professional botanists)
            - **FAMILY** (there are ca. 387–685 families of flowering plants, depending on the system of classification used; 202 of these are found in East Texas)
              - **Subfamily** (this level is important for some families such as the Fabaceae; in other families it is not used)
                - **Tribe** (this level is important for some families such as the Asteraceae; in other families it is not used)
                  - **GENUS** (the genus name is the first part of the two-part or binomial scientific name given to each species)
                    - **SPECIES** (the genus name and the specific epithet together make up the scientific name of a species)
                      - **Subspecies** (a subdivision of a species; many species are not divided into subspecies)
                        - **Variety** (many subspecies are not divided into varieties; sometimes varieties are treated in the same sense as subspecies; in other instances the subspecies category is used for grouping varieties within a species)
                          - **Form** (used for minor differences such as flower color)

When studying plants, the most important levels in terms of organizing one's thinking are:

- 1) — Of the nine divisions of vascular plants, is the plant under study a member of Psilophyta (whisk-ferns), Lycophyta (club-mosses), Equisetophyta (Horsetails), Pteridophyta (Ferns), Cycadophyta (Cycads), Ginkgophyta (Ginkgos), Gnetophyta (Joint-firs and relatives), Pinophyta (Conifers), or Magnoliophyta (Flowering plants)?
- 2) **Class** — If a plant is a flowering plant, is it a monocot (in general: herbs, flower parts in 3s, parallel-veined leaves, 1 cotyledon—seed leaf; examples include grasses, lilies, irises, and orchids) or a dicot (in general: herbs to vines, shrubs, or trees, flower parts in 4s or 5s, net-veined leaves, 2 cotyledons; examples include roses, oaks, blueberries, and sunflowers)?

- 3) **Subclass** — According to the Cronquist system (Fig. 173 in Appendix 2), within the dicots there are six subclasses and within the monocots there are five subclasses. These groups can be useful in understanding the relationships among families.
- 4) **Family** — Most botanists consider this the most important level in the classification hierarchy in terms of learning about flowering plants. The first thing a botanist tries to do with an unknown plant is to figure out what family it belongs to. As indicated above, there are ca. 387–685 families of flowering plants depending on the system of classification used (Cronquist 1988; Reveal 1993). Cronquist (1988) recognized 387, while Mabberley (1997) recognized 405. According to the International Code of Botanical Nomenclature (Greuter et al. 1994), with the exception of eight families with long-established names, all families are named after one of the genera in the family and all have the ending -aceae. Even for these eight families, use of alternative names ending in "-aceae" is permitted. These are Compositae (Asteraceae), Cruciferae (Brassicaceae), Gramineae (Poaceae), Guttiferae (Clusiaceae), Labiatae (Lamiaceae), Leguminosae (Fabaceae), Palmae (Arecaceae), and Umbelliferae (Apiaceae).
- 5) **Genus** — Many plants are easily recognized to genus (e.g., oaks—*Quercus*; maples—*Acer*, etc.). The genus name and the specific epithet are always underlined, italicized, or set off in some other manner. Note that the term specific epithet is used for the second part of the binomial referring to the species; the name of a species is a combination of the genus name and the specific epithet. Each binomial is followed by the authority or person who named the plant. For example, the common sunflower was first named botanically by Linnaeus (abbreviated L.) and the full citation of the scientific name includes the genus, specific epithet, and authority: *Helianthus annus* L.

The following is an example of the hierarchical system of classification using *Lupinus texensis*, the Texas bluebonnet. Note that subspecies, variety, and form are not given; not all species are divided below the level of species.

Domain Eukaryota
Kingdom Plantae
Division Magnoliophyta
Class Dicotyledonae
Subclass Rosidae
Order Fabales
Family Fabaceae
Subfamily Papilionoideae
Tribe Genisteae
Genus *Lupinus*
Species *texensis*
Subspecies
Variety
Form

WHAT IS THE WRITER OF A FLORA TO DO? EVOLUTIONARY TAXONOMY OR PHYLOGENETIC SYSTEMATICS?[1, 2]

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ABSTRACT

Plant classification and nomenclature are in a continuing state of flux and heated debate between two opposing schools—**1)** traditional taxonomists supporting "evolutionary" or "Linnaean taxonomy," and **2)** cladists supporting "phylogenetic systematics" or "cladonomy." While it is a multifaceted controversy that has spanned several decades, relatively little attention has been focused specifically on the ramifications for floristics. The two goals of this paper are **1)** to give special emphasis to the implications of the controversy for the writers of floras, and **2)** to provide an overview of some of the arguments in a format accessible to a diverse audience of botanists interested in floristics. We examine some of the issues we have confronted in our floristic work, discuss how we are attempting to balance the strengths and weaknesses of both approaches, and indicate what we believe is the best, albeit imperfect, approach to the writing of floras at the present time. We argue that, for both practical and theoretical reasons, a modified traditional system (binomial nomenclature, ranked hierarchies) be used in floras (allowing paraphyletic groups but eliminating all polyphyletic groups despite some nomenclatural instability). Further, these floras should incorporate information on newly discovered phylogenetic relationships (even if too preliminary, tentative, or inappropriate for nomenclatural change) and discuss these in appropriate family and generic treatments in order to facilitate as complete an understanding of plant evolution as possible.

RESUMEN

La clasificación y nomenclatura de las plantas está en un flujo continuo y debate ardiente entre dos escuelas opuestas—**1)** taxónomos tradicionales que apoyan la "taxonomía Linneana" o la "evolutiva," y **2)** cladistas que apoyan la "sistemática filogenética" o "cladonomía." Mientras esta controversia se ha extendido durante varias décadas, se ha prestado relativamente poca atención a las ramificaciones de la florística. Las dos metas de este artículo son **1)** dar un énfasis especial a las implicaciones de la controversia para los autores de floras, y **2)** ofrecer una visión general de algunos de los argumentos en un formato accesible a una audiencia diversa de botánicos interesados en la florística. Examinamos algunos de los resultados que hemos confrontado en nuestro trabajo florístico, discutimos como hemos intentado equilibrar las bondades y debilidades de ambos métodos, e indicamos lo que creemos que es el mejor, aunque imperfecto, método de escribir floras en la actualidad. Argumentamos que, tanto por razones teóricas como prácticas, se use en las floras un sistema tradicional modificado (nomenclatura binomial, sistema jerarquizado) (que permita grupos parafiléticos pero eliminando todos los grupos polifiléticos aunque causen inestabilidad nomenclatural). Además, estas floras deberían incorporar información sobre las relaciones filogenéticas recién descubiertas (incluso si son demasiado preliminares, tentativas, o inapropiadas para cambios nomenclaturales) y discutir éstas en la familia apropiada y tratamientos genéricos para facilitar una comprensión lo mas completa posible de la evolución de las plantas.

INTRODUCTION

Plant taxonomy is the science that deals with the *identification*, *nomenclature*, and *classification* of plants. The term plant systematics (or systematic botany) is often used synonymously with plant taxonomy (as is done here), but sometimes has the connotation of mainly using recently developed techniques or approaches such as chromosomal studies, electron microscopy, molecular biology, or cladistics to answer questions about plant relationships. From the definition of plant taxonomy it follows that the primary goals of the discipline are to:

[1]Reprinted from Diggs & Lipscomb (2002).

[2]See also Brummitt (2003), Grant (2004), and Barkley et al. (2004a, 2004b) published after this article went to press in 2002.

1) identify and describe all the various kinds of plants;
2) develop a system of naming plants [e.g., International Code of Botanical Nomenclature (Greuter et al. 2000) or potentially a future version of the PhyloCode (2002)]; and
3) arrange plants with common characteristics into groups that reflect their evolutionary relationships (Lawrence 1951; Porter 1967; Radford et al. 1974; Jones & Luchsinger 1986; Judd et al. 1999, 2002).

In terms of nomenclature, the goal of plant taxonomy has been to develop a uniform, practical, and stable system of naming plants—one that can be used by both plant taxonomists and others needing a way to communicate precisely and retrieve information about plants. In the words of Stevens (2002), "The value of any naming system is how effectively it establishes conventions that allow people to communicate and to develop their ideas ..."

Regarding classification, the goal has been to arrange plants with common characteristics into groups that reflect their relationships—in other words, to develop a scheme of classification that is useful—that conveys maximum information and has predictive value. Since the time of Darwin, a primary goal of plant taxonomists has been to reflect phylogeny or evolutionary history in their systems of classification. There are several reasons for this. One is that taxonomists want their classification system to reflect the reality of the evolutionary history of life on earth. Second, a system that reflects evolution should have maximum predictive value and usefulness (since related species should share similarities due to common descent). While this basic evolutionary approach is agreed on by virtually all botanists, in recent years there has been heated debate between two main schools of taxonomists:

1) traditional taxonomists practicing what is sometimes referred to as "Linnaean classification" (Brummitt 1997) or "evolutionary taxonomy." Traditional or evolutionary taxonomists, while attempting to have a classification system based on evolutionary relationships, also try to reflect the amount of evolutionary change undergone by groups. In addition, they try to incorporate other goals, including practicality and stability, into the classification system (see Brummitt 1997 for a detailed discussion of traditional classification). The names "Linnaean classification" or "Linnaean taxonomy" (Stuessy 2000; Forey 2001, 2002; Nicolson 2002), are perhaps inappropriate since the system is very different from that established by Linnaeus. In its more recent version it is perhaps better called "evolutionary taxonomy" (Sanders & Judd 2000) or "evolutionary systematics" (Grant 2001b), signifying the attempt to reflect evolutionary relationships. Grant (2001b) uses the acronym TTES "to include the two subschools of traditional taxonomy and evolutionary systematics." When considered from the standpoint of nomenclature, this is a system that incorporates binomial nomenclature (two-part scientific names consisting of a genus name and specific epithet) and a hierarchy of formal ranks (e.g., family, genus, etc.). The nomenclatural application of this viewpoint has been referred to as the "L-code" and its principles are embodied in the International Code of Botanical Nomenclature (Greuter et al. 2000).

2) cladists, whose method of constructing phylogenies is derived from the ideas of the German entomologist Willi Hennig, practicing "phylogenetic systematics"or "cladistic classification" (referred to as "cladonomy" by Brummitt 1997) based explicitly and solely on phylogenetic relationships. In other words, the overriding goal is that classification should reflect the branching patterns of evolution. It should be noted that in a clade-based classification and resulting nomenclature system, there are no formal ranks, including family or genus, and no formal binomial nomenclature (de Queiroz & Gauthier 1992; Lidén et al. 1997; Cantino 1998; Brummitt 2002). The nomenclatural application of this viewpoint has sometimes been referred to as the "P-code" and its ideas are embodied in the PhyloCode (2002).

Currently, classification and nomenclatural systems are in a state of flux between these two main opposing camps—both of which attempt to reflect evolutionary relationships. Those practicing cladistic systematics have made major contributions to our understanding of plant evolution and have brought about some long overdue changes. In fact, some of their methodology has contributed to a well-recognized revival in taxonomy/systematics. Some of the most evident examples of this are the incredible breakthroughs in knowledge of plant relationships resulting from molecular phylogenetics. It should also be noted that there is significant variation in the extent to which various "phylogenetic" systematists follow all of the implications of the cladistic approach—most, for example, still use binomial nomenclature even though they may disagree with it on theoretical grounds. At the same time, the system of nomenclature (binomial, etc.) and hierarchical classification that has developed over the past 250 years has served and continues to serve the botanical and broader communities well. There are thus positive aspects to both of these approaches.

Because of major differences in philosophy and methodology, the classification systems produced by proponents of evolutionary taxonomy and cladistics are often quite different. It is not unexpected then that the two conflicting viewpoints have produced a vigorous and heated debate (e.g., Nixon & Carpenter 2000), which has even been referred to as a "maelstrom" (Benton 2000). The proposed approach of phylogenetic classification has certainly not "mostly been politely accepted by the systematic community" as stated by Schander (1998). In fact, the tone of a few of the articles and discussions (on both sides of the argument) has been surprisingly impolite by the standards of modern scientific discourse, with Webster (2002) referring to the arguments as "an ideological cacophony of bombast and invective." There is voluminous literature on the subject, including numerous recent articles about the different taxonomic and nomenclatural approaches (e.g., Moore 1998; Stevens 1998; Diggs et al. 1999 (Appendix 6); Mishler 1999; Benton 2000; Cantino 2000; de Queiroz 2000; McNeill 2000; Nixon & Carpenter 2000; Sanders & Judd 2000; Stevens 2000; Stuessy 2000, 2001; Withgott 2000; de Queiroz & Cantino 2001; Grant 2001a, 2001b; Langer 2001; Lee 2001; Pennisi 2001; Berry 2002; Brummitt 2002; Forey 2002; Kress & DePriest 2002; Nicolson 2002; Stevens 2002; Webster 2002). Symposia and workshops have also been held (XVI International Botanical Congress—August 1999; Smithsonian's National Museum of Natural History—March 2001; Hunt Institute for Botanical Documentation—June 2002), and a new system of nomenclature has been proposed (PhyloCode 2002). However, few authors or discussions have specifically addressed the special problems faced by writers of floras (but see Stevens 1998, Sanders & Judd 2000, and Berry 2002). This controversy is actually multifaceted, with many quite different aspects (e.g., are taxon names defined?—Stuessy 2000, 2001, de Queiroz 2000, de Queiroz & Cantino 2001; which system will ultimately be more stable?—Forey 2002) that are beyond the scope of the discussion here. In this paper we are focusing on the implications for floristics.

IMPLICATIONS FOR FLORISTICS

As writers of a flora (the *Illustrated Flora of East Texas* project—Diggs et al.; www.easttexasflora.org), we and our co-authors are faced with the question of *what type of classification and nomenclatural concepts should be followed in a large regional flora* (ca. 3,300 species or roughly 1/6 the species in North America north of Mexico). We are acutely interested in this question, because as floristicians we must translate and synthesize a variety of types of botanical research, both practical and theoretical, into a form usable by a very diverse audience—one that ranges from professional taxonomists and other scientists to lay botanists, students, and interested amateurs, many of whom are unacquainted with taxonomic methods. In fact, we believe that addressing the needs of diverse users is one of the most important tasks of floristicians. Further, developing a "general-purpose system" that effectively addresses the needs of multiple users is often considered to be the "historical and continuing function" of taxonomy as a whole (Cronquist 1987). The answer to the question of what type of concepts should be followed varies greatly depending on whom one asks. The most conservative voices would say that the traditional system of nomenclature, a ranked hierarchical system of classification, traditional families, etc., should be used due to both theoretical and practical considerations. Some would even argue that clearly polyphyletic traditional families (e.g., Liliaceae in the broad sense) should continue to be used in floras since this is a very useful and practical approach. The most extreme voices on the other side (i.e. extreme cladists) would say that no set categories should be recognized (e.g., no families, no genera; instead, only supportable clades), only monophyletic groups (= a common ancestor and **all** its descendants; Fig. 176) should be given taxonomic recognition (i.e., no paraphyletic groups should be allowed—currently many genera and families are paraphyletic; paraphyletic groups are defined as those containing a common ancestor and some, but not all, of its descendants). Further, the extreme

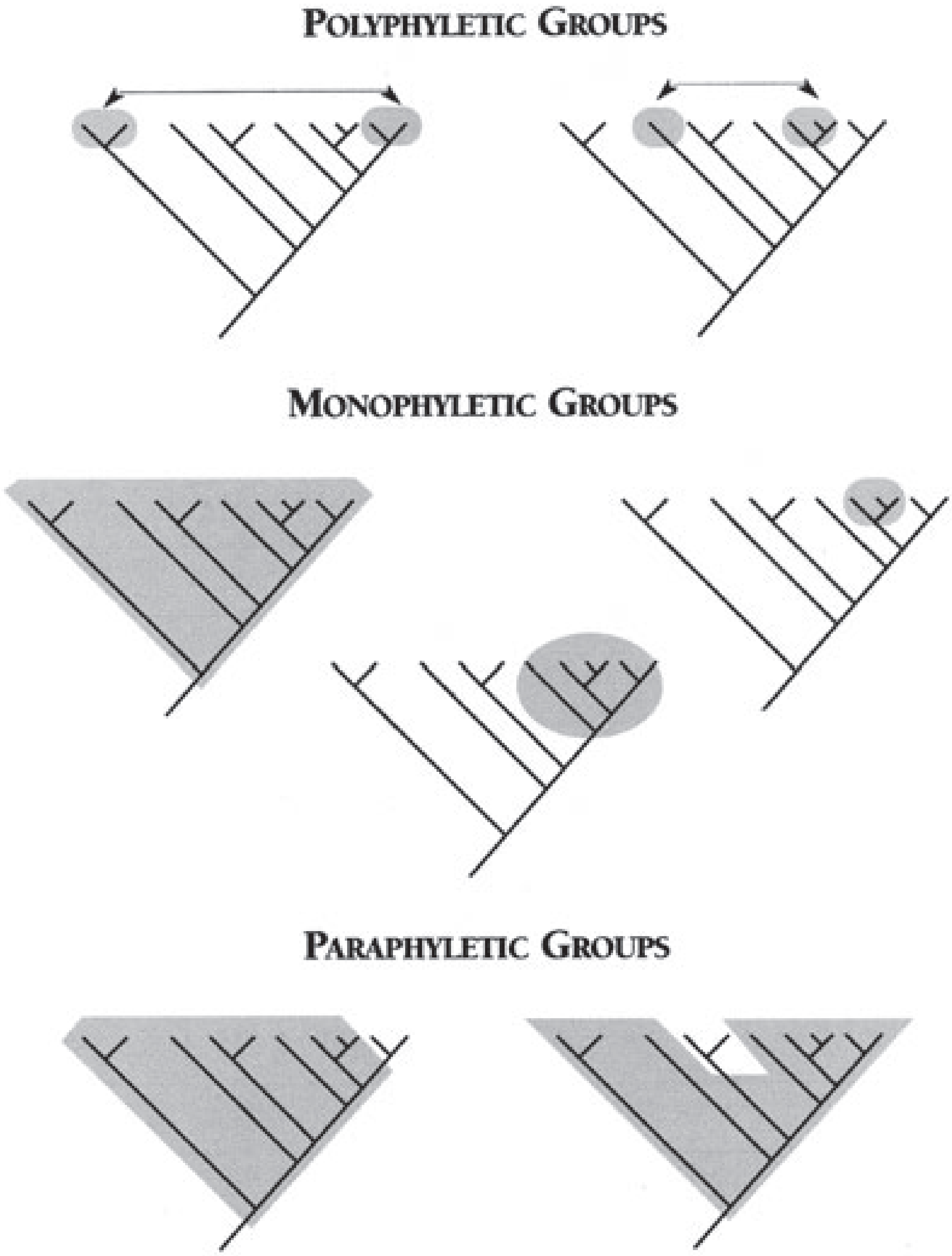

FIG. 176/DIAGRAMMATIC REPRESENTATION OF POLYPHYLETIC, MONOPHYLETIC, AND PARAPHYLETIC GROUPS. FIGURE PRODUCED BY BRIT/AUSTIN COLLEGE; REPRODUCTION OF THIS IMAGE DOES NOT REQUIRE COPYRIGHT PERMISSION.

cladists argue that binomial nomenclature should be replaced (since genera have no objective reality, there can be no generic names and hence no binomials; only clade-based names should be used). Interestingly, our previous flora (*Shinners & Mahler's Illustrated Flora of North Central Texas*—Diggs et al. 1999) was criticized by individuals from both extremes. Despite having more information on cladistics (lengthy appendix discussing the issue, discussions in numerous family synopses) than any other regional or state flora we know of (e.g., Hickman 1993; Yatskievych 1999; Rhodes & Block 2000; Wunderlin & Hansen 2000), we were criticized for not applying the cladistic approach throughout the flora. Likewise, some conservative botanists were disturbed by decisions such as lumping some groups (e.g., *Najas* into the Hydrocharitaceae), splitting others (e.g., *Senecio* into *Senecio* and *Packera*), and following an alphabetical rather than a traditional sequence (showing supposed relationships) of families and genera (a logical impossibility since a written flora is linear and evolution is a branching process). One thing to keep in mind when discussing this clash of viewpoints is the realization that any system of classification, nomenclature, and written presentation will be an imperfect reflection of the complexity represented by the evolutionary history of life on earth. In the words of Benton (2000), "phylogeny is real, classification is not." While we now have access to increasingly sophisticated and diverse sources of data, factors such as extinction, an incomplete fossil record, and the complexity of evolutionary processes (e.g., reticulate evolution—Wagner 1954; see discussion below) will prevent us from producing completely accurate phylogenetic reconstructions. Despite these limitations, as floristicians attempting to produce a useful flora, we have to use approaches to classification and nomenclature that best reflect a diverse and complex set of needs.

It is generally agreed that the primary goal of a flora is to allow identification of the plants treated. However, there are a number of secondary goals. According to Sanders and Judd (2000), these are: **1)** to provide entry into the systematic literature; **2)** to provide thumbnail summaries of the current state of our knowledge (including systematic, ecological, ethnobotanical, etc.); **3)** to serve as a reference for other professionals; and **4)** to fix the concepts of taxa, especially families and genera, in the minds of users. Generally we agree with these secondary goals, and expended considerable thought and effort in applying them in our previous floristic effort (Diggs et al. 1999). We also agree with Sanders and Judd (2000) that there is a critical need for the collaboration (and probably more importantly cross-training) of floristic, monographic, and phylogenetic researchers. However, we disagree with Sanders and Judd (2000) in *how* to accomplish the fourth of their stated goals. They argue that the methods of phylogenetic classification should be applied consistently in floras (e.g., only monophyletic groups allowed, hence precluding paraphyletic families). We believe that this approach, if inflexibly applied, would hinder the primary goal (of a flora) of allowing effective identification. Further, if all aspects of the cladistic approach are followed (e.g., elimination of ranks and binomial nomenclature) in a flora, we envision significant erosion of this primary goal. The loss of many morphologically coherent and easily recognizable paraphyletic families, the discontinuity in information retrieval due to a radical change in nomenclature, the lack of effective mnemonic devices to replace such widely recognized and practically important ranks as family and genus, and instability in nomenclature (and hence identification) associated with rapidly changing cladograms are a few of the reasons for this concern.

In some cases, floristicians, for practical or historical reasons, are unable to apply even the most important recent phylogenetic discoveries in their floras. For example, the critically important Flora of North America Project, because of the long time span necessary for such a massive multi-volume work, had to adopt a standard years ago (Cronquist system of families)—hence, the Liliaceae (in the broad sense), now known to be clearly polyphyletic, is still being recognized in a forthcoming volume (with an extensive discussion of phylogeny). While we strongly agree with cladists that polyphyletic groups should be eliminated (whenever possible), we disagree with the advisability of eliminating the numerous useful and meaningful paraphyletic groups, particularly at the levels of family and genus (see further discussion below). We would add three other goals to the four (Sanders & Judd 2000) enumerated above: **5)** to address specifically the needs of diverse users (discussed above); **6)** to connect the work of monographers and other researchers to the "consumers of botanical information" (T. Barkley, pers. comm.; Barkley 2000) who need to use these discoveries; and **7)** to use systems of classification and nomenclature that allow meaningful comparisons with other floristic works. In other words, for conservation, biogeographical, ecological, etc. purposes, it should be easy to compare data such as the total number of species, the number of endemics, or the number of introduced species from flora to flora (with the realization that the comparisons will be far from perfect, but useful nonetheless). Ultimately, we somehow hope to combine several important but not necessarily compatible approaches. We not only want to produce a useful, informative, and user-friendly flora, but also one that accurately reflects evolutionary history (i.e., is phylogenetically informative) and incorporates recent discoveries in botany.

APPROACH TAKEN IN THE *ILLUSTRATED FLORA OF EAST TEXAS*

After considerable thought, discussion with a variety of individuals, and a review of the pertinent literature, we are taking what we hope is an intermediate, albeit somewhat conservative, approach in the *Illustrated Flora of East Texas*. Our goal is to provide maximum information while retaining a practical and utilitarian framework.

Cladistic side

On the ***cladistic/phylogenetic systematics side*** of the argument, a number of our decisions have been influenced by the desire to increase information content and accuracy:

1) We are attempting to provide detailed information on the known evolutionary relationships of various plant groups. A tremendous amount of new information has become available recently (primarily, but not exclusively, as a result of the application of Hennigian principles to molecular data), and as much of this as possible is being included and references provided. For example, in the draft family synopsis of the Lemnaceae (duckweed family), we (Diggs et al., draft of this volume) have included the following statement.

Lemnaceae are tiny and extremely reduced morphologically, making it difficult in the past to determine the phylogenetic relationships of the family. Kvacek (1995) suggested that the fossil genus *Limnobiophyllum* is a fossil link between Araceae and Lemnaceae, and Stockey et al. (1997), using a cladistic approach and material of *Limnobiophyllum,* concluded that *Pistia* (a free-floating member of the Araceae) plus *Limnobiophylum* and Lemnaceae form a monophyletic group. Indeed, this linkage of Lemnaceae to Araceae goes back over 175 years (Hooker and Brown in Smith 1824; see discussion in Les et al. 2002). In addition, molecular studies have linked *Lemna* with *Pistia* (Araceae) (Duvall et al. 1993b) or more recently to Araceae subfamily Aroideae (French et al. 1995). In fact, the Lemnaceae is considered by many authorities to have evolved from within Araceae (JACK-IN-THE-PULPIT family) by extreme reduction, and it has been suggested that Lemnaceae be reduced to a subgroup within a more inclusive Araceae (Mayo et al. 1995, 1997, 1998; Stockey et al. 1997). From a cladistic standpoint, Araceae (without Lemnaceae) are paraphyletic and inappropriate for formal recognition.

Even where very preliminary information is available, we have included and referenced it in an attempt to foster a better understanding of evolutionary relationships.

2) Also on the cladistic side (and on that of most other plant taxonomists), we are rejecting all clearly polyphyletic groups, even when these are practical and of long-term or wide usage. The best example of this is the Liliaceae (lily family) sensu lato (in the broad sense). Extensive morphological and molecular data now clearly indicate that as broadly conceived, this family is a heterogeneous mixture based on superficial similarities in flower structure (e.g., Fay et al. 2000; Rudall et al. 2000b). In fact, recent molecular studies (e.g., Chase et al. 2000) have shown that species traditionally treated in the Liliaceae should be placed in at least four different *orders*. As a result, we are recognizing 14 separate families (all previously treated in the Liliaceae) for East Texas. However, from the standpoint of usability, we are incorporating a table in the Liliaceae (narrow sense) family treatment that clearly indicates in what family the genera formerly included in the Liliaceae (broad sense) are now placed. Furthermore, in the main key to families, as many as possible of the liliaceous (broad sense) families will be clustered together and clearly indicated. Likewise, the genus *Nolina* (bear-grass) and its relatives, which have often been included in the Agavaceae (agave family), are now known to not be closely related to that family and we are excluding them. In a draft family synopsis we (Diggs et al., draft of this volume) say,

In the past, taxa included here in the Nolinaceae were sometimes included in a broadly conceived Liliaceae (e.g., Kartez 1999) or often in the Agavaceae (e.g., Correll & Johnston 1970; Diggs et al. 1999; Verhoek & Hess 2002 following Cronquist 1988), based on certain morphological similarities. However, recent evidence suggests that the Agavaceae and Nolinaceae are not closely related and should be recognized separately (Dahlgren et al. 1985; Eguiarte et al. 1994; Bogler & Simpson 1995, 1996;

Kubitzki et al. 1998; Chase et al. 2000). Molecular evidence indicates that Nolinaceae is closely related to Convallariaceae and Ruscaceae, and some studies (e.g., Chase et al. 1995a; Chase et al. 2000; Fay et al. 2000) have suggested that the Nolinaceae should be included in the Convallariaceae. Following such preliminary studies, Judd et al. (1999), submerged the Nolinaceae into the Convallariaceae. On the other hand, Rudall et al. (2000a) and Judd et al. (2002) included the Nolinaceae in a broadly interpreted Ruscaceae. However, there has been disagreement in molecular analyses of the family and its presumed relatives (e.g., Rudall et al. 2000a; Yamashita & Tamura 2000). Since the Nolinaceae appears to be a well-defined monophyletic group (Bogler & Simpson 1995, 1996), and until the phylogeny of this complex is clarified and the nomenclature more stable, we are recognizing it as a distinct family.

Hopefully, such explanations will allow users to see that the understanding of plant relationships is still changing and improving. With such insights, we hope that non-taxonomists will be less resistant to *needed* nomenclatural changes.

3) Again on the cladistic side, when *established useful family concepts are not excessively distorted,* we are lumping small groups whose relationships have now become clear. For example, the monogeneric family Najadaceae (the genus *Najas)* is now known to be derived from within the Hydrocharitaceae (R. Haynes, pers. comm.; Shaffer-Fehre 1991; Les et al. 1993; Les & Haynes 1995; Haynes et al. 1998a; Haynes 2000d). Including *Najas* in the Hydrocharitaceae more accurately reflects evolutionary history yet does not substantially modify the concept of the Hydrocharitaceae nor distort it beyond the bounds of usability. We are therefore following several recent floristic treatments (e.g., Thorne 1993a; Diggs et al. 1999) in lumping *Najas* into the Hydrocharitaceae.

4) Our families, genera, and species are arranged alphabetically. Some very traditional taxonomists want "related" families placed together in the linear sequence physically required of a book. However, the complex branching pattern of evolution does not follow such a linear form and thus any linear sequence is highly arbitrary and distorts actual evolutionary relationships. An easy to use alphabetical sequence, while not reflecting relationships, at least does not distort them. In addition, an alphabetical arrangement allows quick and easy access to the material so arranged.

Evolutionary taxonomy side

On the ***evolutionary taxonomy*** side of the argument, a number of our decisions have been influenced by both practical and/or theoretical considerations:

1) We are continuing to use the system of nomenclature that has developed over the past 250 years (International Code of Botanical Nomenclature—Greuter et al. 2000). This (particularly the use of binomials) is an eminently useable system that addresses the needs of an audience far broader than the taxonomic community ("the consumers of botanical information"—T. Barkley, pers. comm.; Barkley 2000). We believe that eliminating it would cause great confusion among the many non-taxonomists who use plant names. In fact, it is likely that if plant taxonomy went to a specialized non-binomial, clade-based system, some separate static system of "accepted plant names" would be developed by the horticultural community or other user groups (e.g. agricultural, ecological, conservation). Such a move would both marginalize plant taxonomy and ultimately result in a nomenclatural system with much less information content than at present. This practical consideration may well be one of the most important reasons for maintaining our current system of classification and nomenclature. In fact, even those developing the PhyloCode (2002), the nomenclatural system being produced by phylogenetic systematists, have not yet come to grips with what to do regarding the naming of "species." It is interesting to note that Stevens (2002) has argued that binomials have been used so long and so widely (across many cultures and in many contexts) because they are inherent in human perception—in other words, having such a two word nomenclature system may be built into the organization of our nervous systems. Nixon and Carpenter (2000) in a similar vein suggested that, "Our natural form of communication (even as evidenced by the common human binomial system of naming ourselves) is clarified by the use of ranks and binomials." Likewise, anthropologist Brent Berlin (1992) noted that there are widespread cross-cultural regularities in the classification and naming of living organisms by people in traditional, nonliterate societies—these systems more closely approximate Linnaean binomials than clade-based nomenclature. Further, when the diverse users of a flora are considered, a radical shift in the system of nomenclature used seems particularly ill-advised, especially at a time when the public needs to be brought closer to, rather than pushed further away from, an appreciation and understanding of botany. Indeed, these ideas raise questions about a "dominant" code (T. Barkley, pers. comm.) of nomenclature. Undoubtedly, a P-code will be used, but it remains to be seen how widely such a system will be accepted by the diverse users of botanical information—the L-code may continue to be used as the primary or dominant code by the user community long after a functioning P-code (presumably the PhyloCode) is finalized.

2) While many taxonomists have long realized that the traditional ranked categories (e.g., family, genus) are not used consistently and are simply human constructs (unlike species which have some biological reality), they do, however, provide important mental pegboards or mnemonic devices to allow a practical way to arrange our thinking. As Stevens (2002) has said, "Hierarchical naming systems pervade our whole language and thought." We are thus retaining a traditional ranked hierarchical system of classification (in other words, groups of organisms arranged in a hierarchy of categories—genus, family, etc.). While there are evident problems with such a system, the "cornucopia of categories" (Colless 1977) resulting from a cladistic approach does not seem to be an overall improvement in communication, and in fact seems less suited to human mental abilities. In a clade-based system, a particular species is in dozens if not hundreds of successively larger clades—how does one choose which of these clades to use in real-world situations (e.g., floras, textbooks)? This point seems to be particularly crucial to writers of floras—unless all genera or even species are to be arranged alphabetically, which would be extremely user unfriendly, some higher level organization must be agreed upon. It seems clear that some *arbitrary convention* to replace the convenience of currently used families would have to be developed for use in a completely clade-based system—in other words, someone would arbitrarily have to decide which of the innumerable clades to recognize. Otherwise, there would be no practical way to group species in floras (now grouped in families and then genera) and no groups to refer consistently to when comparing different floras, etc. In fact, for practical reasons many cladists still use traditional ranks such as family and genus (e.g., Judd et al. 2002), despite stating that "one logical step would be to eliminate ranks altogether." Currently, only three words (e.g., Fagaceae, *Quercus alba*) are needed to communicate a great deal of information about a particular organism, and these are used consistently by botanists. In our flora for example, genera are being arranged alphabetically under alphabetically arranged families. Does this mean that these families are viewed as somehow being equivalent?—of course not. They are, however, effective means of conveying information. As stressed by Stevens (2002), if we are going to be able to effectively communicate, "... conventions will be needed. To paraphrase Linnaeus, without convention, all is chaos." As Stevens (2002) so clearly pointed out, even early botanists (e.g., Linnaeus, Bentham) were quite concerned about effective communication. What would be the system of organization under a system of unranked clades, and how could consistency (and thus communication, information retrieval, comparability, etc.) be assured in different floras, textbooks, etc.? Ultimately, some arbitrary convention (not unlike our current family system) would seem to be required. To be fair, it should be noted that the PhyloCode (2002) is not yet complete, and nomenclatural conventions will have to be worked out in the future. Whatever system is ultimately settled upon, the conventions used should take into consideration a variety of factors (e.g., accuracy of information conveyed, effectiveness of communication to a broad range of users, compatibility with the organization of the human nervous system, etc.).

3) Furthermore, we are *not* rejecting paraphyletic groups (e.g., families). For example, it now seems clear (as stated above) that the Lemnaceae (duckweed family) arose from within the Araceae (arum family), which is thus paraphyletic. It seems more reasonable to us to continue to recognize both easily distinguishable families and unambiguously state in discussions associated with both what the evolutionary relationships between the two are. Clearly the duckweeds have undergone extraordinary morphological and genetic divergence in adapting to an aquatic environment—so much so that the question of their ancestry was only recently resolved. To lump the two families and have their genera mingled in a taxonomic treatment accomplishes little and seems to result in a loss of clarity and evolutionary information. As currently recognized, both families have significant morphological coherence and thus recognition and predictive value—together, they are a mixture of two very different types of morphology. A similar example can be seen with the Cactaceae. That family has recently been shown to have evolved from within the Portulacaceae (Hershkovitz & Zimmer 1997; Applequist & Wallace 2001). Lumping the two families in a floristic treatment would only obscure the many differences between these useful and easily recognizable groups. This reflects the view of evolutionary taxonomists, who while attempting to have a classification system based on evolutionary relationships, also try to reflect the amount of evolutionary change undergone by groups (Fig. 178). Evolutionary taxonomists argue that classification is "... more than just branching patterns of evolution" (Stuessy 1997). Brummitt (2002) stressed Mayr's (1995) observation that Darwin indicated evolutionary classification depends on two factors, descent and modification, not descent alone. To use a well known animal example, because birds are so different from other vertebrates (e.g., fly, have feathers, etc.), they are treated as a different class of vertebrate, even though they are known to have evolved from within the paraphyletic class known as reptiles (Fig. 177). From the practical standpoint, there are numerous other useful and evolutionary meaningful paraphyletic groups. Examples include the Araceae, Capparaceae, Clusiaceae, Moraceae, Portulacaceae, etc. Radically changing their circumscription (e.g., adding Cactaceae to Portulacaceae, Podostemaceae to Clusiaceae, or Lemnaceae to Araceae) results in confusion and a loss of information. This risk of confusion is particularly problematic if the same name is variously used to include quite different sets of species (e.g., Portulacaceae in the narrow sense or in the broad sense including Cactaceae). The risk of a nomenclatural "train wreck" (Stevens 2002) is a troubling possibility. Very different uses of the same names "will be decidedly unsettling for society and perhaps damaging for our discipline" (Stevens 2002). Unfortunately, taxonomists have long had the reputation of changing names without regard for the implications, and great care needs to be taken to avoid non-essential changes. Grant (2001b) stressed that splitting up paraphyletic groups (e.g., genera such as *Gilia* or *Linanthus*) obscures relationships and multiplies generic names where one would be sufficient. Does the splitting up of recognizable and well known genera really best serve the broad constituency of users (keeping in mind that professional taxonomists are a small fraction of the users of scientific names)? Changes in classification at the generic level are particularly significant because of the resulting changes in scientific names.

Further, Brummitt (1997, 2002) has argued that paraphyletic groups are inevitable. He goes on to say that any genus "must have originated from a species in another genus, which is thus paraphyletic." The same logic applies at other levels in the hierarchy, including the species level. Species, unlike other categories in our hierarchical system of classification, have some objective biological reality (e.g., Rieseberg & Burke 2001). However, if a small subgroup of a species differentiates or specializes enough to become a distinct entity, the original species is thus rendered paraphyletic even though it may still be a reproductively isolated or otherwise distinct group. Species can be excluded by definition as not being paraphyletic (Sanders & Judd 2000) as done by some cladists, but in reality, by standard use of the term, they are often paraphyletic (see Mishler 1999, 2000). As Brummitt (2002) noted, the abandonment of species "seems to me to be a necessary logical extension to abandoning all other ranks" (Brummitt 2002). Further, Rieseberg and Brouillet (1994) argued that based on the modes of speciation known to occur in plants, paraphyletic species are common. In the words of Sosef (1997), "When a single diaspore [e.g., seed] accidentally reaches an isolated habitat and its offspring gradually changes (a linear process) and produces a new species, nothing 'happens' to the parent species." The new species thus renders the unchanged previous species paraphyletic. Ultimately, paraphyly thus seems unavoidable. An excellent example of this problem can be seen in the California tarweeds (genus *Raillardiopsis*) and the Hawaiian silverswords (genera *Argyroxiphium*, *Dubautia*, and *Wilkesia*) in the Asteraceae. It now appears (Baldwin et al. 1991) that *Raillardiopsis* (which had previously been considered a "phenotypically conservative genus of two nearly identical species") was the "ancestral genetic source" for the endemic and extremely morphologically divergent Hawaiian silversword alliance. *Raillardiopsis* is thus clearly paraphyletic, even though its two species are "nearly identical." When taken to its logical extreme, the failure to recognize paraphyletic groups would require the rejection of many useful groups (e.g. tarweeds). In animal taxonomy, this means the rejection not just of the group Reptilia (which gave rise to birds), but also Amphibia (which gave rise to reptiles), and Pices (which gave rise to Amphibia). Anyone understanding the basics of evolution realizes that fishes gave rise to amphibians. Does that make the class Pices any less useful a concept? Likewise, the capers

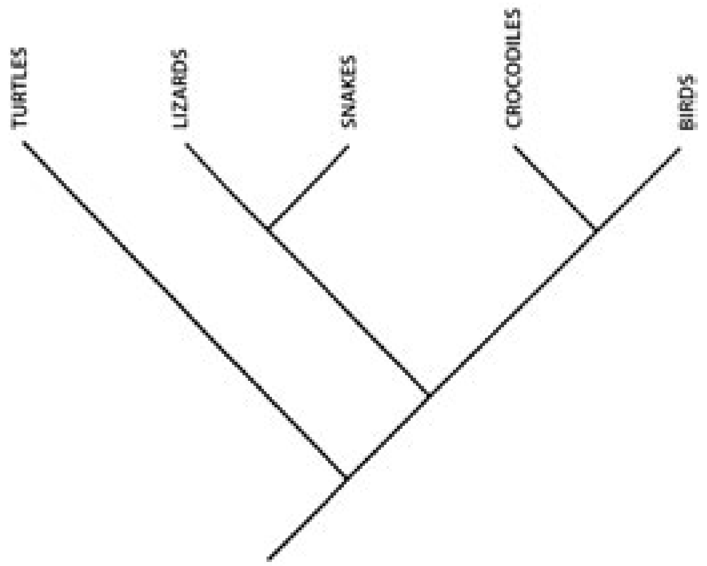

Fig. 177/Dendrogram showing relationships of some vertebrate groups. Note the paraphyletic nature of the "reptilia" (when considered to include turtles, lizards, snakes, and crocodiles, but not birds). Figure produced by BRIT/Austin College; reproduction of this image does not require copyright permission.

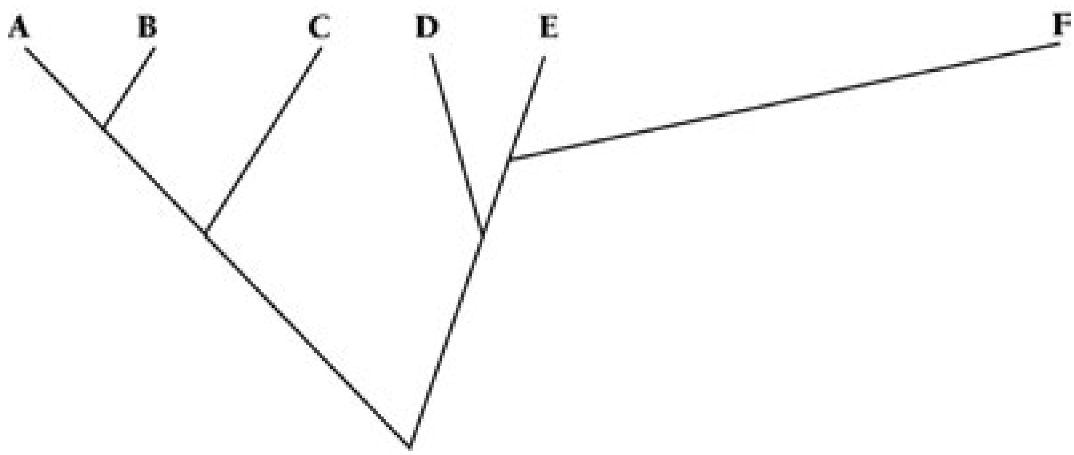

Fig. 178/Phenetic distance diagram; horizontal distance between species indicates phenetic difference. Note that species F, while most closely related phylogenetically to species E, is quite different in terms of phenetics. Figure produced by BRIT/Austin College; reproduction of this image does not require copyright permission.

(Capparaceae) gave rise to the mustards (Brassicaceae)—both families are still useful and meaningful concepts that can help us understand evolution and organize our thinking. Cronquist (1987) stressed the need for paraphyletic groups, indicating that both evolutionary relationships and the amount of evolutionary divergence among taxa is important. He said that "the reasons for this belief are rooted in the historical and continuing function of taxonomy as a general-purpose system of classification that can be used by all who are concerned with similarities and differences among organisms"—in other words, diverse users of botanical information. While we believe it is critically important for paraphyletic groups to be clearly distinguished from monophyletic groups, the usefulness of paraphyletic taxa (e.g., effective communication, recognition of divergence, morphological similarities, etc.) seems to be an important consideration.

4) Additionally, there are many cases where it is not yet clear what should be done cladistically. Thus in these cases we are retaining traditional usage until more information is available. For example, it is very likely that such families as the Lamiaceae (mint family), Verbenaceae (vervain family), and Scrophulariaceae (figwort family), as traditionally conceived, will have to be changed substantially. However, if we had to finalize treatments of these families today for our flora (which fortunately does not have to happen since these dicot groups will be treated in Vols. 2 and 3 of the *Illustrated Flora of East Texas* to be published at a later date), we would probably follow the traditional circumscriptions and accompany them with substantial explanations. The reason is that adequate research has not yet been done on these groups to provide answers that are definitive enough to warrant major changes in classification and nomenclature. In the words of Berry (2002), "it will be some time before our sampling of organisms at the molecular level will be good enough that we can get an adequate idea of relationships across the entire span of biological diversity." Further, it does not seem desirable that classification (and nomenclature) should change with every new cladistic discovery—do we really want nomenclature that "depend[s] rigidly on the particular cladogram favoured at the moment" (Benton 2000)? Indeed, Sanders and Judd (2000) discuss the criteria for accepting revised classifications. Before making major nomenclatural changes, there should be substantial taxonomic evidence, to avoid more of the numerous examples where initial cladistic hypotheses have proven to be wrong. For example, in the past, some authorities have suggested major changes in family circumscription based on preliminary information (e.g., lumping the Apiaceae (carrot) and Araliaceae (aralia) families—Judd et al. 1994; Zomlefer 1994), only to have more detailed work (Plunkett et al. 1996 [1997]) clarify the situation and indicate that the families should be maintained in nearly their traditional circumscriptions. According to Plunkett et al. (1996 [1997]), the approach taken by Judd et al. (1994) "hides rather than resolves the difficulties in Apiales." Likewise, Downie et al. (2001) did not lump the Araliaceae. Another example is the genus *Trillium*—it has often been treated in the Liliaceae in the broad sense (e.g., Correll & Johnston 1970) or based on early phylogenetic analyses in the Trilliaceae (e.g., Zomlefer 1996; Tamura 1998d; Judd et al. 1999). However, more recent phylogenetic analyses (e.g., Rudall et al. 2000b) indicate that it belongs in the Melanthiaceae. There are also instances where the best and most recent evidence conflicts. A number of molecular studies have suggested that Burmanniaceae (previously considered to be related to Orchidaceae) is in the Dioscoreales and thus more closely related to such families as Dioscoreaceae and Nartheciaceae than to Orchidaceae (which is in order Asparagales) (Chase et al. 1995b; Caddick et al. 2000, 2002b; Chase et al. 2000). In contrast, other recent molecular research including more genera than previously sampled indicates that the family (minus the superficially similar but unrelated genus *Corsia*) plus Thismiaceae is in a relatively isolated position "not closely aligned with either the Dioscoreales or the Orchidaceae" (Neyland 2002). Writers of floras are thus faced with having to judge which cladistic studies to accept and when there is enough evidence to use the new discoveries in floristic treatments. At the same time, writers of floras must avoid the instability and confusion that would result from changing classification and nomenclature with every new study published. Furthermore, recent tests (Grant 2001a) of the accuracy of cladograms when compared with known phylogenies (e.g., domesticated and experimental plant groups with known pedigrees), raises questions about basing classification and nomenclature solely on cladistic methodology. Grant (2001a) demonstrated that the "cladograms of the four plant groups [tested] all differ in significant details from the known pedigrees." Particularly important is his following point: "It is also recognized by all evolutionary systematists and most cladists that reconstructed phylogenies are unverified hypotheses. Some cladists, however, seem to regard their cladograms as real phylogenies." He (Grant 2001b) also indicated that "Molecular cladograms are very good indicators, but we should not lose sight of the fact that the groupings they indicate are molecular clades, not taxa." A recent paper by Rydin et al. (2002) on Gnetales is particularly telling in this regard. Depending on which molecular analysis was used, the phylogenetic position of Gnetales differed significantly. According to Rydin et al. (2002), "It is becoming increasingly clear that the understanding of molecular evolution and its impact on phylogenetic studies is poor. Nucleotide data alone might not be able to solve phylogeny and evolution of this ancient, once rapidly evolving group, and attempts to do so should include a comprehensive taxon sampling and several genes. Molecular data can definitely be misleading, and by ignoring that, science will not progress." From the standpoint of a floristician, while recognizing the obviously valuable contributions made by molecular systematists and cladists, careful thought must be given to avoid accepting major, sometimes disruptive (and occasionally incorrect) classification and nomenclature changes prematurely.

5) Finally, we are *not* accepting some aspects of phylogenetic classification (particularly strict monophyly—sometimes and perhaps better referred to as holophyly) since there are **serious *theoretical* problems** that make it at least partially incompatible with the reality of the natural world (however, see Freudenstein 1998 for an opposing viewpoint). Brummitt (2002, pers. comm.) has stressed the importance of these theoretical considerations, and in terms of the implications for floristics, these are perhaps as important as or even more important than the purely practical considerations. **One of the most serious problems** (referred to as a "fatal one" by Stuessy 1997) is that cladistics uses only branching information in phylogeny. In contrast, evolution is a complex process including such phenomena as asexual reproduction, progenitor-derivative species pairs, lateral gene transfer, polyploidy, and reticulate evolution (the latter resulting from hybridization between species and subsequent speciation in the offspring) (Rieseberg & Brouillet 1994; Sosef 1997; Stuessy 1997). These complexities cannot be accommodated in a classification system requiring only strict monophyletic groups and dichotomous branching. In the words of Stuessy (1997), "... simple dichotomous branching diagrams cannot do justice to the real world of higher plant phylogeny." An excellent example can be seen in the reticulate evolution of the fern genus *Asplenium* as discussed in the classic paper by Wagner (1954). In this case, the hybrids between two parental species become reproductively isolated (and thus constitute a separate new species). Another example can be seen in the Triticeae (*Elymus*, *Hordeum*, *Secale*, *Triticum*, and their relatives; Poaceae). This tribe has an extremely complex evolutionary history involving hybridization, polyploidy, and reticulate evolution (Barkworth 2000; Mason-Gamer & Kellogg 2000). Both of these examples emphasize that some evolutionary relationships are simply impossible to reflect accurately in a system requiring strict monophyly and only dichotomous branching. As Brummitt (1997) indicated, "No matter how much we may long for all our taxa to be monophyletic, if we are considering the whole evolutionary process, it is a logical impossibility." Another way of stating the problem is that simple branching patterns are unable to reveal all significant dimensions of phylogeny (Stuessy 1997).

A second theoretical problem with strict monophyly is that "only the tips of evolutionary branches can be classified" (Meacham & Duncan 1987) in such a system, and "Species at the interior nodes of the tree must remain unclassified." Not including ancestral species, some of which may well have survived to the present, seems untenable. However, including them leads cladists insisting on strict monophyly (holophyly) down the path of the "telescoping" or "snowball" effect (also known as the "taxonomic black hole") where more and more organisms have to be included in a futile attempt to reach the mythical (and impossible to reach) strictly monophyletic group (Sosef 1997; Brummitt 2002; but see Stevens 1998 and Sanders and Judd 2000 for a different viewpoint). Ultimately, the whole Tree of Life (2002) would have to be included in one giant monophyletic group. In the words of Brummitt (2002), "If we are classifying all the products of evolution, i.e., the whole evolutionary tree of life, every taxon we recognise must make another taxon paraphyletic. That is a simple logical fact. It is obvious to most people that if you cannot have paraphyletic taxa, you cannot have a classification showing anything beyond one original species, genus, family, etc." He points out that *if ranks are to be used* (which seems essential from the standpoint of practicality), paraphyly is unavoidable (Webster 2002 referred to this as "Brummitt's Paradox"). Thus, there is a "fundamental incompatibility between Linnaean classification and a system of monophyletic taxa, or clades" (Brummitt 2002). In other words, including all extinct species would mean that no monophyletic groups (or only one huge one) could be recognized. From this standpoint, "extinction [and our lack of knowledge about extinct species] is the saving grace of phylogenetic systematics" (T. Barkley, pers. comm.). *Importantly, "Brummitt's Paradox" means that simply converting cladograms into Linnaean nomenclature is impossible.* Ultimately, this means that in order to have strict monophyly, phylogenetic systematists must develop a rankless system such as the PhyloCode. While some modern phylogenetic systematists continue to recognize families for practical/pedagogical reasons (e.g., Judd et al. 2002), if carried to its logical conclusions, cladistics would mean that these families (particularly if extinct taxa are considered) would be telescoped into ever larger groups.

A third related theoretical problem demonstrates that a strictly monophyletic system *using Linnaean ranks* is incompatible with evolution (Brummitt, pers. comm.). As Brummitt (2002) indicated, "…I think we all understand that evolution has continually been throwing up greater and greater diversification of plants and animals, and yet the cladistic idea of classification requires that all successive descendant groups have to have lower and lower taxonomic rank. Something which has evolved from within one genus must have a rank lower than genus. Is this view of taxonomy really a sensible idea? How can we apply lower and lower ranks when evolution is producing wider and wider variation? In a clade-based classification you can go on extending your clades as evolution progresses *ad infinitum*, but if you are using a traditional taxon-based classification you can't keep on giving them lower ranks." Without paraphyly, the use of ranks in a monophyletic system therefore is simply not workable (hence the advocacy of a rankless PhyloCode by some cladists). This problem seems to clearly indicate the logical impossibility of a rank-based, strictly monophyletic system.

A fourth theoretical problem is that our current methodology of obtaining phylogenetic trees is based on a series of assumptions and indirect evidence (e.g., character polarity, choice of outgroups, etc.) (Stuessy 1997), as well as mathematical algorithms (e.g., parsimony) that result in trees that "are almost always inappropriate as phylogenetic hypotheses in any but the most general sense" (Zander 1998). Zander (1999) further indicated that, "Selecting one phylogenetic hypothesis of several or many reasonable alternatives as 'best' and presenting it as a reconstruction cannot provide a probabilistic or dependable basis for action." Is the pursuit of the shortest tree the ultimate goal of systematics? The answer seems clearly to be no, since there are well-documented non-parsimonious pathways of evolution (Stussey 1997). Thus, totally tying classification and nomenclature to such a system seems problematic. A final concern that follows from this is that the current classification and nomenclature system is independent of a particular approach. As stated by Jørgensen (2000), "A problem inherent with the system proposed by Cantino & de Queiroz (2000) [PhyloCode] is that their nomenclature depends upon a specific way of taxonomic thinking, i.e., nomenclature is ruled by the taxonomic system. This probably reflects that they are as convinced of their taxonomic system as Linnaeus was of his, but, please, at least consider the possibility that new taxonomies may evolve. Should we then change the nomenclatural system each time?"

FURTHER IDEAS AND DISCUSSION

The following ideas and quotes seem to provide substantial insight into the controversy. Because of both philosophical and practical implementation problems, Brummitt (1997) pointed out that while the controversy should be debated, it seems unlikely that "Linnaean classification" will soon be abandoned. Brummitt (1997) suggested that both a "Linnaean classification" system and a clade-based phylogeny are desirable because they have different functions. He argued that both be allowed to exist side by side and that the nomenclature of the two should be easily recognized as different (Brummitt 1997). In summarizing his ideas he stated, "… we should not follow traditional practices just because they are traditional, but neither should we adopt new ideas just because they are new. We need to understand the possibilities and appreciate the different objectives and functions of the different options. In the meantime, it seems to me and to many others that the compromise of maintaining Linnaean classification but trying to eliminate paraphyletic taxa is nonsensical and should be abandoned before any more damage is done to existing classifications and nomenclature." Lidén et al. (1997) indicated, "If applied consistently, Phyllis [= Lidén et al. term for nomenclatural application of cladistics] will cause confusion and loss of information content and mnemonic devices, without any substantial scientific or practical advantage. … any attempts to make Phyllis formal would be disastrous. We can find no conclusive, valid arguments against keeping the body of our current system intact." Sosef (1997) stressed the same idea saying, "The quest for monophyletic taxa and the splitting of former paraphyletic ones should halt immediately, as they unnecessarily deteriorate classifications which will often prove to be valid."

An interesting point was also made by Stuessy (1997) when he said, "… in this urgent climate of seeking to inventory the world's biota (Anonymous 1994), and requesting funds from the rest of society to do so, it would be highly counterproductive to simultaneously recommend whole-scale change of names of organisms for any reason." In the words of Paul Ehrlich (2002), who was stressing the need for taxonomists to focus on conservation activities, "Others spend their time trying to replace the functional Linnaean system for general communication about organisms with one based on estimates of times of phylogenetic divergence; a sillier enterprise is hard to imagine. ..."

While recognizing it is not perfect, Wheeler (2001, and quoted in Forey 2002) noted that Linnaean nomenclature "is stable enough to say what we know, flexible enough to accommodate what we learn; independent of specific theory, yet reflective of known empirical data; compatible with phylogenetic theory, but not a slave to it; particular enough for precise communication, general enough to reflect refuted hypotheses."

While strongly supporting a cladistic system, Welzen (1998) also noted that a compromise between the two types of classification is impossible. He also understood that because of practical reasons it is impossible to abandon Linnaean classification "... because too few cladograms are available to replace the existing system with a complete phylogenetic classification. Moreover, quite a few cladograms will not be that trustworthy due to the many homoplasies [result of convergent evolution] that have evolved; they will therefore, provide an unstable classification at best." Welzen (1997) went on to say, "I think, therefore, that the best solution is to choose the second option that Brummitt (1997) provides in his paper, namely, 'retaining Linnaean classification, with paraphyletic taxa, but developing alongside it an independent clade-based dichotomous system with its own separate nomenclature.' " Recently, Brummitt (2002) indicated that, "If people insist on monophyly, the clade-based PhyloCode will provide a logical solution. If they want to use the traditional ranks, the answer is very simple: recognise paraphyletic taxa." Brummitt (1997) made what seems to be a very reasonable suggestion: "Our task is to produce an optimally practical classification, and indicate which genera have evolved from which other genera, which families from which other families, and so on."

Indeed, recently it seems to have become clearer that two separate systems will be necessary (Cantino 2000; Brummitt 2002). Years ago, Woodger (1952, and quoted by Brummitt 2002) concluded that, "The taxonomic system and the evolutionary phylogenetic scheme are quite different things doing quite different jobs, and only confusion will arise from identifying or mixing them." Similarly, it has been argued more recently that to attempt to apply cladistic rules (e.g., elimination of all paraphyletic groups) on the traditional Linnaean system is a logical impossibility (Brummitt 2002) or at minimum highly detrimental (see discussion above). According to Brummitt (2002), "I believe there is no middle way which will combine universal monophyly with formal Linnaean ranks, and this is now increasingly being realized." However, while it is becoming more widely recognized that the two systems are incompatible (but see Stevens 2002), there is clearly value in having a strictly phylogenetic system of classification. It would thus seem that the most reasonable course for the near term would be to allow the concurrent existence of two separate systems—Linnaean and phylogenetic. The Linnaean system would retain hierarchical ranks, binomial nomenclature, and paraphyletic taxa, while the phylogenetic system (e.g., PhyloCode) would recognize monophyletic clades (but have neither ranks, binomial nomenclature, nor paraphyletic taxa, and possibly not even species). Because of practical considerations, the Linnaean system will probably continue to be the "dominant" system used (nearly exclusively) to communicate information about plants by scientists outside of systematics (e.g., ecologists, horticulturalists, conservationists, etc.) and by the general public. The phylogenetic system will make contributions among systematists and others attempting to further understand the evolutionary history of life on earth.

SUMMARY

Where does all this leave the writers of floras? We would argue that a modified traditional system (binomial nomenclature, ranked hierarchies—L-code) be used in floras (allowing paraphyletic groups but eliminating all polyphyletic groups despite some nomenclatural instability), and that these floras (and this is a critical point) should also incorporate newly discovered information on phylogenetic relationships. In order to facilitate as complete an understanding of plant evolution as possible, this new information should be briefly discussed/summarized in appropriate family and generic treatments even if too preliminary, tentative, or inappropriate for nomenclatural change (e.g., that would result in the loss of meaningful paraphyletic taxa).

In summary, in the *Illustrated Flora of East Texas*, we are thus attempting to reflect some of the many contributions and insights from "phylogenetic systematics," while retaining the practical benefits of an "evolutionary taxonomy" framework. As indicated above, no system will be a totally accurate representation of the complexity of the evolutionary history of life on earth. We believe, however, by reflecting both evolutionary relationships and the amount of evolutionary change, while maintaining a flexible approach punctuated with practicality, that a classification and nomenclature system useful to a broad audience, including non-taxonomists, can be achieved. We agree fully with Berry (2002) who said, "there are many users of scientific names—myself included—who are interested in both floristic inventories and evolutionary relationships, and nomenclatural stability as well." Ultimately, writers of floras need to present information accurately (i.e., reflect evolution) *and* in ways that can be used—that allow effective communication and identification, promote information retrieval, and are useful comparatively (e.g., in conservation assessments, to evaluate levels of endemism, to determine levels of introduced exotics, to form the basis of biogeographical studies, to do ecological surveys). All of these uses depend on having a unit (species) that can be meaningfully compared and classification and nomenclatural systems that allow effective communication. Taxonomic botanists are thus faced with the challenge of working toward systems that make such communication and comparisons possible (Berry 2002). Writers of floras, in particular, as the translators of botanical information to a wider audience, are uniquely faced with a difficult task—to apply the evolving concepts of modern systematic botany to floristics in a way that allows modern floras to be both accurate and useful. It is hoped that this article will stimulate discussion among those involved in or interested in the writing of floras.

ACKNOWLEDGMENTS

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Changes in the Scientific Names of Plants[1]

One of the most important goals of plant taxonomy is to develop a uniform, practical, and stable system of naming plants—one that can be used by both taxonomists and others needing a way to communicate information about plants. The internationally accepted system of giving scientific names to plants is set forth in the *International Code of Botanical Nomenclature* (Greuter et al. 1994), often referred to simply as the Code.

Why then do scientific names keep changing? Names of plants are changed for three main reasons:

- There are changes due to legalistic reasons involving the accepted rules of nomenclature as outlined in the Code. For example, the oldest validly published name for a species must be used. Thus, even though a plant is widely known by a particular scientific name, if an older, validly published name for the plant comes to light, the older name must be used unless a later name is officially conserved (this is referred to as the "rule of priority"). While such changes may be inconvenient, without strict application of nomenclatural rules, scientific names would become as inexact and useless for communication as common names. It should be kept in mind that a particular plant species can have numerous common names in a small geographic area (e.g., a state) and dozens of different common names in different languages and different countries.
- There are changes resulting from *shifts in taxonomic philosophies,* such as those exemplified by "splitters" and "lumpers," or the rejection of paraphyletic groups (for more details see Appendix 5 on Taxonomy, Classification, and the Debate about Cladistics).
- Most important, however, are those *changes resulting from an increased understanding of the plant species* themselves. Initial hypotheses on what species exist, and what their diagnostic characteristics are, are sometimes based on a limited number of specimens, little or no experience with the species in the field, and little additional information. These hypotheses are tested whenever more specimens become available for examination, when field work is carried out, or when additional studies are done (including molecular studies, electron microscopy, breeding studies, etc.). Sometimes the initial hypotheses are supported and no name changes are necessary. In other instances the hypotheses need to be modified to reflect the new evidence (e.g., a plant actually belongs in a different genus or species). This in turn can affect the scientific nomenclature. Ongoing name changes therefore do not indicate simple equivocation on the part of taxonomists, but rather are an accurate reflection of the dynamic nature of our scientific understanding of the plant kingdom.

In order to minimize the impact of nomenclatural changes on users of this book, we have typically given taxonomic synonyms (particularly commonly used ones) for those species whose names have changed in the recent past. Such synonyms can be found in brackets, [ ], near the end of the species treatments and can be reached using the index.

This write up was modified from one written by B. Ertter (pers. comm.).

[1]Reprinted from Diggs et al. (1999).

Collecting Herbarium Specimens[1]

What Is An Herbarium?

A collection of pressed and dried plant specimens is known by botanists as an herbarium (plural herbaria). The word herbarium, as originally used, referred to a book about medicinal plants. Pitton de Tournefort (early French botanist and physician) around 1700 used the term for a collection of dried plants, and his usage was taken up by Linnaeus (Arber 1938; Stearn 1957; Birdson & Forman 1992). Largely through Linnaeus' influence, the word herbarium thus replaced such earlier terms as *hortus siccus* (dry garden) or *hortus hyemalis* (winter garden) (Arber 1938; Stearn 1957; Shinners 1958). Luca Ghini (1490?–1556), a botany professor at the University of Bologna, Italy, is considered to have been the first person to dry plants under pressure, mount them on paper, and thus preserve them as a permanent record (Arber 1938; Birdson & Forman 1992). The usefulness of such specimens was soon apparent, and his technique was disseminated over Europe by his pupils (Arber 1938). By the time of Carl Linnaeus (1707–1778), this method was well known and widely used (Stearn 1957). The oldest surviving herbarium is that of Ghini's pupil Gherardo Cibo, who began to collect plants at least as early as 1532 (Arber 1938). Other early herbaria were developed in various countries, including England, France, Germany, and Switzerland and, in all, more than twenty 16th century collections survive in different European cities (Arber 1938; Valdés 1993). According to Stearn (1957), "The older herbaria consisted of specimens on sheets bound into [book-like] volumes. Linnaeus never adopted this inelastic and expensive procedure but mounted his specimens on loose sheets stored horizontally which could be easily re-arranged and to which other specimens could be added when necessary. Probably due to Linnaeus' example and teaching this method became general during the second half of the 18th century." Modern herbaria still utilize Linnaeus' basic system of mounting specimens individually on loose sheets. Today about 16,000 specimens that were at one time in Linnaeus' personal herbarium survive in England, Sweden, and France and can still be studied (Stearn 1957). From these beginnings, Holmgren et al. (1990) reported 2,639 herbaria worldwide with an estimated 272,800,926 specimens.

What Are Herbaria Used For?

Herbaria are among the most important tools in studying the plants of a given area, with the reasons for this importance being quite diverse (Benson 1979; Birdson & Forman 1992; Valdés 1993). Specific ways in which herbaria are used include: 1) Herbaria are invaluable *reference collections* used as means of identifying specimens of unknown plants. Even experienced botanists frequently need to refer to herbarium specimens in order to definitively identify a plant in question. In this way botanists are able to identify material for such organizations or individuals as poison centers, medical researchers, ranchers, law enforcement agencies, agricultural extension agents, or gardeners. 2) Herbarium specimens, which have an indefinite life if properly protected (the oldest in existence go back almost 500 years), also provide a valuable *historical record* of where plants occurred in the past in both space and time. A local example can be seen in Julien Reverchon's collections from the late 1800s and early 1900s made in the Dallas area. Because the natural vegetation of Dallas has been almost completely destroyed, without Reverchon's specimens we would have almost no knowledge of the previous richness of that flora. Also, herbarium specimens provide early documentation of the introduction of foreign weeds or the previous geographic limits of native plants (Shinners 1965). These examples demonstrate the importance of herbaria as a special type of museum, and as such they are important storehouses of irreplaceable data. In a real sense, herbaria serve as "... a source of primary information about man's explorations and observations of the earth's vegetation. ...." (Radford et al. 1974) and as "... the raw data underpinning our scientific knowledge of what kinds of plants exist, what their diagnostic features

[1]Reprinted from Diggs et al. (1999).

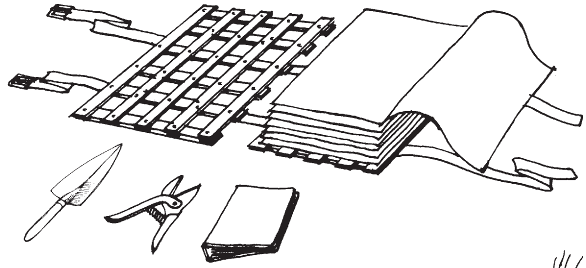
are, what range of variation exists within each, and where they occur" (B. Ertter, pers. comm.). To work with the actual specimens collected by Carl Linnaeus, Alexander von Humboldt, Asa Gray, or Charles Darwin not only provides us with valuable data but also links us in a tangible way with the origins of modern science and our own disciplines. 3) Further, because many plants are available for only a small part of the year and because it is impossible to have live specimens of thousands of species from different regions readily available for study, herbaria provide the only practical way to have material of numerous species to compare and study—they thus are important *research tools*. Without a major herbarium such as BRIT (the official abbreviation of the herbarium of the Botanical Research Institute of Texas), a book such as this would have been impossible to produce. In addition, herbaria serve as a record or repository of the voucher specimens upon which all taxonomic articles, books, and research are usually based (Boom 1996). In this way, other botanists can recheck and judge the validity of the work; these are critical steps in the scientific process. Also, because of the wealth of information contained in herbaria, they are essential research tools not only for taxonomists, but also for those in such diverse fields as ecology, endangered species research, entomology, environmental science, horticulture, medical botany, mycology, palynology, and even forensics. 4) Finally, herbaria serve important *educational purposes*. These range from their use by advanced undergraduates or graduate students learning taxonomic botany to grade school students learning about the importance of plants and the natural environment in their lives.

Collecting and Pressing Specimens

One of the most important considerations regarding plant collecting is to *secure appropriate permission*, whether on private or public land. This is critical in order to maintain a working relationship between landowners and botanists. It is particularly important to be sensitive to such landowner concerns as not damaging fences and properly closing gates. On public lands such as parks and wildlife refuges, there are often strict collecting regulations with legal sanctions for not following these rules.

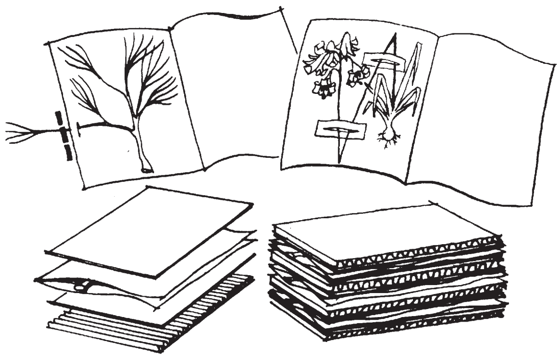
When selecting plants, collectors need to be sensitive to whether the plant to be collected is rare and whether the population will be adversely affected by having one or several individuals removed. Because populations of many native plants have been dramatically reduced by human activities, this concern is more important now than ever before. A rule of thumb sometimes given is the "1 to 20" rule—for every plant collected, there should be at least 20 others left in the population (Simpson 1997). Collectors should also bear in mind that certain plants (e.g., cacti, orchids) have special legal protection. Once it is ascertained that there is an adequate population for collecting, individuals representative of the range of variation in the population should be chosen. Individuals with herbivore or pathogen damage should not be ignored (Condon & Whalen 1983; McCain & Hennen 1986a, 1986b), and in fact they should often be purposefully selected because such specimens are "information-rich" (J. Hennen, pers. comm.)—that is, they often contain fungi, gall-inducing insects, or other pathogens and show characteristic plant responses to such organisms. Ideally, the entire plant, including roots or other underground structures, should be collected or, in the case of trees, shrubs, vines, or other large species, ample material representative of the plant should be obtained. Slender plants can be bent or folded to form a V, N, or even W shape on the sheet in order for them to fit (sometimes the point of the V can be stuck through a slit in the bottom of the newspaper to hold the plant in place). For tiny plants, it is appropriate to collect a number of individuals for each specimen needed. A general rule of thumb is that the folded half-sheet of newspaper used in the pressing process (a full sheet torn in half) should be reasonably well-covered by plant material without excessive overlap or crowding. The best specimens have both flowers and fruits—while this is often not possible, all specimens should have some reproductive structures (either spores, cones, flowers, or fruits). Because most taxonomic keys are based on reproductive characters, sterile specimens are often useless. In fact, many botanists collect extra flowers or fruits to use in identification. Seeds, fruits, or other parts that become easily detached and are in danger of being lost should be put in small paper envelopes or bags and kept with the specimen. Extremely large structures (e.g., pine cones, large fruits) cannot be pressed and have to be carefully numbered (to match the specimen from which they were detached) and stored separately.

The highest quality specimens are probably obtained by carrying a lightweight press into the field



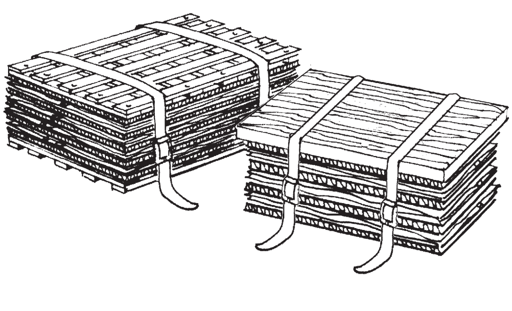
FIELD PRESS,
CUTTING OR DIGGING TOOLS,
AND FIELD BOOK

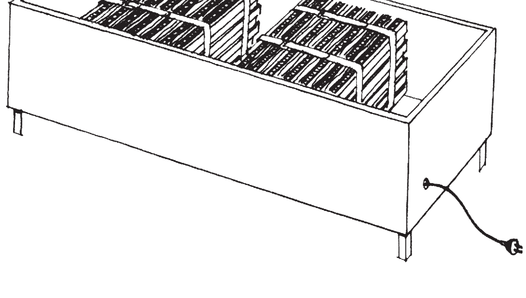
COLLECTING SPECIMENS
AND RECORDING DATA
IN THE FIELD



PRESS MATERIALS: FOLDS OF NEWSPAPER
(INTO WHICH SPECIMENS ARE PLACED),
BLOTTERS, AND CORRUGATED CARDBOARDS

PLANT PRESSES – THE PRESS AT THE LEFT
HAS END BOARDS MADE OF WOOD LATTICE;
THE ONE AT RIGHT HAS PLYWOOD END BOARDS





PLANT DRYER WITH LIGHT BULBS
AS HEAT SOURCE

Fig. 181. Plant pressing equipment (modified from Smith 1971).

and doing preliminary pressing there. Such a press is usually referred to as a "field press" and generally consists only of straps, lightweight end boards, two or three cardboards, and newspapers (Fig. 181). Because of the absence of blotters and most cardboards, a field press is much lighter than a regular press and is thus suitable for carrying some distance in the field. Specimens pressed in this way can later be rearranged (leaves flattened, etc.) before being put between blotters and cardboards for final pressing and drying. However, instead of using a field press, practicality sometimes dictates that plastic bags be used to transport the plants back to a car, kitchen table, laboratory, etc., for pressing. We have found that carrying a number of large zip-type bags (which can be reused) inside a plastic trash bag works well. Plants collected in this way and sprinkled with water can often be stored overnight in the plastic bag in a refrigerator with little loss of quality. In the past, botanists temporarily stored specimens in a metal container (called a vasculum) in folds of wet paper.

The pressing process begins by putting the plant in a single half-sheet of newspaper (22" × 14") folded crosswise (the folded half-sheet of newspaper should thus measure 11" × 14"). While this size may seem arbitrary, all subsequent steps in the collecting/herbarium process are tied to this size—these include plant dryers, cardboards and blotters for drying, specially designed herbarium storage cases, certain size shipping boxes, etc. The leaves, flowers, and other structures should be arranged in as natural a manner as possible on the newspaper, while at the same time trying to avoid excessive overlap. Folding or bending the plant is often necessary, as is the trimming off of excess material. When trimming is done (e.g., excess leaves removed), it should be carried out in a way that makes it clear that material was removed (e.g., a portion of the petiole of a removed leaf should be left). In order to insure the best possible results, delicate structures such as flowers can be given additional padding with small pieces of blotter or pads made of folded pieces of newspaper or paper towels. Another consideration is that leaves should be arranged so that both surfaces can be seen (hair characters of the lower surface are often important); likewise, all parts of the plant, especially reproductive structures, should be accessible for study. At least some flowers should be spread open so that the internal structures will be visible for examination. A number (corresponding to a number in a collecting notebook) is written on the lower corner of the half-sheet of newspaper on the left edge or bottom adjacent to the folds. Permanent, bold red felt-tip markers are very handy for marking newsprint. An absorbent felt or thick paper blotter is then placed on each side of the fold of newspaper containing the specimen, and this "sandwich" is placed between two pieces of corrugated cardboard. Additional plants are treated in the same fashion until all have been put in the press. The result is the following sequence: cardboard, blotter, fold of newspaper with plant, blotter, cardboard, blotter, fold of newspaper with plant, etc. (Fig. 181). While it may at first seem a waste of space, specimens of only one species should be placed in each fold of newspaper—this prevents getting "mixed collections" that are often confusing. It is also necessary to treat each species separately because, as discussed below, it is important to accurately record detailed written information about each one. After the plant material has been placed in newspaper between blotters and cardboards, wooden (or other stiff material) end boards are put on each side of the entire stack and straps are used to apply pressure, thus "pressing" the plants (Fig. 181). In this manner, as the plants dry they do not shrivel and high quality specimens can be obtained. The blotters wick moisture away from the plants and the corrugations in the cardboards allow water to easily escape the press. Some botanists use only cardboards (no blotters), with little loss of specimen quality; this is frequently done when the weight of the press is an important consideration or when a source of blotters is not available. In order to speed the drying process (a necessity in humid areas such as many places in the tropics), a heat or forced air source is often necessary. An easy way to heat a press is to leave it in the back seat or trunk of a car. A car roof rack is also an excellent place for a plant press. Plant dryers utilizing light bulbs as a heat source are easy and inexpensive to build and are often used by professional botanists; however, care should be taken to avoid the danger of fire (Fig. 181). Thick materials (e.g., fruits, very thick stems, material of plants such as cacti) may be sliced in order to allow appropriate drying and to prevent unwieldy structures in the press.

Plants should stay in the press until they are dry. The time necessary is quite variable, depending on whether a heat source or forced air source is used, the type of plant, the humidity of the ambient air, etc. If any part of the plant is moist to the touch, it needs additional drying. Removing plants too

quickly from the press will result in wrinkling or possibly molding. Likewise, leaving plants in a heated press for too long a period will cause damage (e.g., browning or fading of colors).
A good rule of thumb is that most plants are dry after one or two days in a forced-air, heated press while five to ten days is typical for plants in a press without any heat source. The press should be tightened daily to prevent wrinkling. Also, it is often good to change damp blotters daily.

Making a Label

Just as important as the plant specimen itself is a properly done label. All data needed to make the label should be written down in a small notebook or "field book" at the time the plant is collected (see e.g., Simpson 1997). Of crucial importance is accurate location data so that the site can be relocated by a stranger in the future. Most important are the state and county; detailed location information such as landmarks, accurate distances, nearby towns or cities, adjacent streams, rivers, and lakes, or any other data to help relocate the site also should be recorded. Other important information includes habitat (e.g., field, forest, weedy roadside, shallow water, soil type, whether the plant is growing in shade or sun), associated plants, collector, collection number, the date the plant was collected, and who was with the collector (these individuals could possibly help in the relocation of the site). The date should be given as, for example, 8 May 1996 because 08/05/96 usually means 5 August 1996 in the United States and 8 May 1996 in Europe. It is also very important to record information that will be not be obvious from the specimen (e.g., size or height of plant, in the case of trees diameter-at-breast-height—DBH, appearance of the bark, manner of growth—erect, climbing, prostrate, etc., were the flowers closed at a certain time of the day, pollinators observed, etc.) or that may be lost upon drying (flower color, odor, color of sap, presence of stinging hairs, sticky feel due to glandular hairs, etc.). Common names used locally or information on edibility or local uses are also valuable. Latitude and longitude and elevation are particularly valuable for researchers and should be recorded. These can be obtained from standard maps of most areas. However, recent technological advances have made getting such information much easier—inexpensive and accurate Global Positioning System (GPS) units are now readily available and give very accurate information. Specimens with such location data are especially valuable because they can be entered into databases with applications from the local to national levels—in Texas and elsewhere, major database projects are currently underway, and GPS locations on specimens are highly desirable. Because all of the other information discussed above is recorded in the field notebook, only the collection number needs to be put on the fold of newspaper in the press. A unique number should be given to each collection that a botanist makes and these numbers should increase sequentially throughout his or her lifetime. Thus, if *Lipscomb 3491* is a collection of *Quercus alba*, there will never be a different *Lipscomb 3491*. If two or more specimens of this *Quercus alba* are collected at the same time and same place by the same collector (such specimens are termed "duplicates"), they are given the same number. Such "duplicates" are often distributed to several herbaria so that there is more than one record of a particular collection. Because herbarium specimens are in essence museum collections that need to last hundreds of years, the labels should be printed on acid-free paper with permanent ink. Do not use "white-out" or other correction techniques that will be lost over time. There is no standard label size, but in general a 4" × 4" label should accommodate all necessary information without taking up excessive space on the mounting paper the specimen will ultimately be attached to (such a size will also allow 4 labels to be made from a single 8 1/2" × 11" sheet of paper). The examples of labels on the following page contain the appropriate information:

Putting Specimens in Permanent Collections

Once a specimen is dried and has an appropriate label, it can be studied or given to an herbarium for permanent storage and use in research and teaching. The proper method of donating specimens is to leave the specimen in the original half-sheet (fold) of newspaper in which it was pressed and insert the label; neither the specimen nor the label should be attached to the newspaper in any way—gluing, stapling, taping, or any other attachment method frequently damages the specimen and sometimes completely destroys its usefulness. Mounting the specimens and labels on museum quality paper for

Austin College Herbarium, Sherman, Texas
Plants of TEXAS

Cnidoscolus texanus (Müll.Arg.) Small Euphorbiaceae

GRAYSON County: Southwestern corner of county, ca. 4 km south of Tioga, just off (east of) Hwy 377, ca. 200 meters from southern edge of eastern arm of Lake Ray Roberts.

Open, sandy, weedy field with *Cenchrus spinifex* and *Monarda punctata*.

Plants herbaceous, ca. 1/2 to 1 m tall, common. Locally known as bull-nettle. Flowers white, sweet-scented; sap milky; foliage with glass-like hairs which break off in the skin and cause an intense burning sensation.

33° 26' 36.1" N 96° 55' 25.8" W (GPS)

Elevation: ca. 190 m 24 Sept. 1980

Coll.: Delzie Demaree with Robert Kral No.: 65,967
and Donna Ware

Austin College Herbarium, Sherman, Texas

Cnidoscolus texanus (Müll.Arg.) Small Euphorbiaceae

Texas, Grayson Co., southwestern corner of county, ca. 4 km south of Tioga, just east of Hwy 377, ca. 200 meters from southern edge of eastern arm of Lake Ray Roberts in open, sandy, weedy field with *Cenchrus spinifex* and *Monarda punctata*. Plants herbaceous, ca. 5–10 dm tall, common. Locally known as bull-nettle. Flowers white, sweet-scented; sap milky; foliage with glass-like hairs that break off in the skin and cause an intense burning sensation.

33° 26' 36.1" N 96° 55' 25.8" W (GPS); ca. 190 m

24 Sept. 1980

Coll.: Delzie Demaree 65,967
with Robert Kral and Donna Ware

permanent storage and use in the herbarium is done by herbarium personnel properly trained in these techniques—for example, special attachment procedures and long-life (archival) glues are used. There are a number of major herbaria in Texas with the largest including those at the University of Texas in Austin, the Botanical Research Institute of Texas (BRIT) in Fort Worth, and Texas A&M University in College Station. Many other schools or organizations have valuable collections; of particular note in East Texas are the herbaria at Stephen F. Austin State University in Nacogdoches, the Robert A. Vines Science Center in Houston, and Baylor University in Waco. BRIT welcomes the donation of herbarium specimens and botanists there can be contacted at (817) 332-4441 or info@brit.org or Botanical Research Institute of Texas, 509 Pecan Street, Fort Worth, TX 76102-4060. Such specimens will be scientific contributions, will have permanent protection, and will be important resources for the future.

GETTING STARTED COLLECTING PLANTS

How do you get started collecting plants? Unfortunately, pressing plants between the pages of books is usually not successful because the plants dry too slowly, loose their color, seldom dry flat, and tend to damage the book. Therefore one of the first steps is to make or buy a plant press (including two end boards, corrugated cardboards, blotters, and two straps). A simple press can be made by cutting two 12" × 18" pieces out of 3/8" or 1/2" plywood and then rounding the corners and sanding the surfaces to avoid injury from splinters. The 12" × 18" size is slightly larger than a folded half-sheet of newspaper and is thus ideal for making the correct size specimens. Other types of end boards can be made out of nearly any reasonably lightweight, sturdy material. Cardboards the same size as the press can be cut from boxes, paper towels can be substituted for blotters, and simple ropes at least 4 feet long can be used as straps. With such a simple system and proper care, excellent specimens can be made. Alternatively, ready-made, convenient presses can be purchased from the sources listed below. Probably the most important parts of the press are the straps—straps that can be easily tightened and thus ensure appropriate pressure increase both the quality of the specimens and the convenience of the process. We thus recommend that a pair of straps be purchased. Because herbaria are museums whose collections are intended to last hundreds of years, the other requirement is acid-free paper for the labels; this can either be special archival paper or 100% cotton rag bond. Such quality paper will last indefinitely, ensuring long-term use of the specimens. Appropriate paper can be obtained from the sources listed below or can often be purchased from or at least ordered through office supply stores. For reasons of clarity, if possible, labels should be typed on a typewriter, using a carbon film ribbon or printed using a computer and a laser printer (as is now done by most botanists because of speed and practicality). A hand lens (10 power) is another extremely useful tool in working with and identifying plant specimens. Many plant parts, including specialized hairs or scales, are quite small and moderate magnification is often essential for accurate identification; hand lenses can also be purchased from the sources below.

Herbarium Supply
2317 Birdie Dr.
Bozeman, MT 59715-8420
1-800-348-2338 or
FAX 406-994-9211
www.herbariumsupply.com

Carolina Biological Supply
2700 York Road
Burlington, NC 27215
1-800-334-5551
FAX 1-800-222-7112
www.carolina.com

Forestry Suppliers Inc.
205 W. Ranking St.
P.O. Box 8397
Jackson, MS 39284-8397
1-800-647-5368
www.forestry-suppliers.com

Pacific Papers
12006 154th Ave. NE
Redmond, WA 98052
1-800-676-1151
www.pacific-papers.com

Information for this appendix was obtained from Shinners (1958), Smith (1971), Radford et al. (1974), Benson (1979), Birdson and Forman (1992), MacFarlane (1994), and Simpson (1997). More detailed information about plant collecting techniques can be gained from these sources. Birdson and Forman (1992) in their *Herbarium Handbook* also provided an extensive treatment of herbarium techniques and management. Stuessy and Sohmer (1996), in a recent edited volume, gave a historical overview of the documentation of plant diversity, an analysis of societal and scientific needs from plant collections, and comprehensive information on collecting, documenting, storing, and preserving plant specimens.

Contact Information for Major East Texas Herbaria[1]

University of Texas at Austin
Herbarium Abbreviations: TEX, LL, and RUNYON
Number of Specimens: 1,006,000
Specialty: Texas; southwestern U.S.; Latin America, especially Mexico and northern Central America; worldwide Asteraceae, with emphasis on Latin America; Rhamnaceae, Fabaceae, Verbenaceae, Sapotaceae, and Fagaceae of Latin America; Myrsinaceae; Eriocaulaceae; Celastraceae.

Herbarium
University of Texas at Austin
1 University Station F0404
Austin, Texas 78712-0471
Contact: Tom Wendt
512/471-5904; FAX: 512/232-3402

Botanical Research Institute of Texas
Herbarium Abbreviations: BRIT, SMU, and VDB
Number of Specimens: 1,000,000
Specialty: Worldwide, especially Texas and southeastern U.S.; vascular plants, especially Cyperaceae, Poaceae, Fabaceae, and Asteraceae; bryophytes; lichens; weeds; cultivated plants.

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, Texas 76102-4060
Contact: Amada Neill
817/332-4441; FAX: 817/332-4112

Texas A&M University
Herbarium Abbreviation: TAES
Number of Specimens: 220,000
Specialty: Mainly southwestern U.S., Texas, and Mexico; Poaceae worldwide

S.M. Tracy Herbarium
Texas A&M University
2126 TAMU
College Station, Texas 77843-2126
Contact: Dale Kruse
979/845-4328; FAX: 979/845-6430

Stephen F. Austin State University
Herbarium Abbreviation: ASTC
Number of Specimens: 78,000
Specialty: Eastern Texas.

Herbarium
Stephen F. Austin State University
P.O. Box 13003
Nacogdoches, Texas 75962-3003
Contact: James Van Kley
409/468-2068

Baylor University
Herbarium Abbreviation: BAYLU
Number of Specimens: 52,500
Specialty: Texas

Herbarium
Baylor University
Waco, Texas 76798-7388
Contact: Walter Holmes
254/710-2911; FAX: 254/710-2969.

Robert A. Vines Environmental Science Center
Herbarium Abbreviation: SBSC
Number of Specimens: 37,000
Specialty: U.S., especially southeastern Texas; Mexico

Herbarium
Robert A. Vines Environmental Science Center
8856 Westview Drive
Houston, Texas 77055
Contact: Larry Brown
713/365-4175; FAX: 713/365-4178

Texas A&M University
Herbarium Abbreviation: TAMU
Number of Specimens: 35,000
Specialty: Vascular plants of Texas; domesticated and cultivated plants.

Herbarium
Texas A&M University
3258 TAMU
College Station, Texas 77845-3258
Contact: Monique Reed
979/845-8650; FAX: 979/845-2891

[1] Source: sciweb.nybg.org/science2/IndexHerbariorum.asp (accessed 8/26/04)

Texas State University
(formerly Southwest Texas State University)
Herbarium Abbreviation: SWT
Number of Specimens: 30,000
Specialty: Texas vascular plants

Herbarium
Southwest Texas State University
San Marcos, Texas 78666-4616
Contact: David Lemke
512/245-2178; FAX: 512/245-8713

Sam Houston State University
Herbarium Abbreviation: SHST
Number of Specimens: 16,000
Specialty: U.S. Gulf Coast; western U.S., especially eastern Texas

S.R. Warner Herbarium
Sam Houston State University
Huntsville, Texas 77341-2116
Contact: Justin Williams
936/294-1552; FAX: 936/ 294-3940

Botanical Research Center
Herbarium Abbreviation: BRCH
Number of Specimens: 9,000
Specialty: Texas, southern U.S., and northeastern Mexico; worldwide Poaceae, Cyperaceae, and Juncaceae.

Botanical Research Center
P.O. Box 6717
Bryan, Texas 77805-6717
Contact: Stanley Jones
979/731-8296; FAX: 979/260-9386

East Texas as a Unique Habitat[1]

George M. Diggs, Jr.

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ABSTRACT

East Texas is a botanically unique area with information from a variety of perspectives pointing to its distinctiveness. Some of these include: 1) high species diversity; 2) numerous habitats occurring within a small area; 3) similarities to the tropics; 4) influence of glaciation; 5) the modern vegetation as the result of a rich biogeographical heritage; and 6) unusual geological features.

East Texas is a botanically unique area from a variety of perspectives. The following six noteworthy aspects will be discussed: 1) high species diversity; 2) numerous habitats occurring within a small area; 3) similarities to the tropics; 4) influence of glaciation; 5) the modern vegetation as the result of a rich biogeographical heritage; and 6) unusual geological features.

1) Biological diversity—The approximately 3,230 vascular plant species found in East Texas (nearly 66% of the Texas flora) make it particularly rich in species for its size (ca. 60,000 square miles or ca. 23% of Texas; roughly the size of Georgia). This can be put in perspective when it is realized that the flora of the entire Great Plains, which make up one-fifth of the area of the conterminous United States, consists of 3,067 taxa of vascular plants (Great Plains Flora Association 1977, 1986; Thorne 1993d). When the entire flora of North America north of Mexico is considered (estimated at approximately 18,000 species—Thorne 1993d), East Texas includes about one out of every six plant species known in the continental United States and Canada. Likewise, when the number of species in three adjacent states Arkansas (2,356—Smith 1988), Louisiana (2,952—MacRoberts 1984), and Oklahoma (2,549 species—Taylor & Taylor 1994) is considered, East Texas again appears particularly diverse. This diversity is the result of a number of factors, including the region's geologic and climatic variation. Yet another factor is the habitat diversity present—large numbers of different habitats in a relatively small area (discussed below), each of these supporting a diverse assemblage of species. However, perhaps the most important factors contributing to the biological diversity in East Texas are the area's position on the ecotone or transition zone between the eastern deciduous forests and the central North American grasslands, and its proximity to the desert southwest and the nearly tropical area of south Texas. The result is a flora derived from several major, and quite different, floristic provinces (Thorne 1993d). Because of the resulting diverse floristic elements and its mid-continental position, the Big Thicket has been referred to by some as the "Biological Crossroads of North America" (e.g., Gunter 1993). The same description is perhaps even more fitting for East Texas as a whole. The intermingling of elements typical of the eastern deciduous forest, southeastern swamps, central North American grasslands, southwestern deserts, and even the tropics is striking, resulting is an extremely diverse flora.

2) Habitat richness—An unusual phenomenon seen in some portions of East Texas (particularly the Big Thicket area) is the close proximity of numerous radically different habitats (e.g., arid sandylands, beech-magnolia forest, baygall, cypress slough, palmetto hardwood flats, etc.). The complex vegetational pattern is controlled by slight variations in elevation, soil type, and available water (Parent 1993), but the result is that an extraordinary number of habitats can be found within a very small area. One of the best examples can be seen in the Big Thicket, where walking a transect over a few tens of meters can reveal the following—beginning in an arid sandylands upland with longleaf pine, shrubby bluejack oaks, bull-nettles, yuccas, prickly pear cacti, bracken fern, and roadrunners, proceeding down slope to a beech-magnolia forest with Carolina lily, crane-fly orchids and beech drops, and finally arriving at a baygall at the bottom of the slope with sweetbay magnolia, gallberry holly, titi, nodding-nixie, and

[1]Reprinted from Diggs (2002).

royal fern. In presettlement times, even small areas of prairie were probably close by—based on early explorer accounts (e.g., Lincecum 1835), there were numerous, scattered, small prairies at various places in the Pineywoods. Names given by early settlers to at least 46 places in the forested area of East Texas also confirm the presence of prairie—e.g., Mustang Prairie at Crockett, Tarrkington Prairie in Liberty County, and Shawnee Prairie in Angelina County (Truett & Lay 1984).

3) Similarities to the tropics—Another particularly striking aspect of East Texas, particularly the Big Thicket, is its resemblance in a number of respects to tropical rain forests. Similarities include the very tall trees well over 100 feet in height, the swollen buttressed bases on bald cypresses and water tupelos, the presence of epiphytes (e.g., Spanish moss, resurrection fern), numerous evergreen species (e.g., southern magnolia, sweetleaf, wax myrtle, red bay, cherry laurel, American and other holly species, smilax species, etc.), high species richness (discussed above), abundant individuals of the palm family (*Sabal minor*, dwarf palmetto, sometimes dominating the forest floor—e.g., palmetto-hardwood flats), abundant Orchidaceae (45 orchid species), numerous and often conspicuous ferns and fern allies (74 species) (Diggs et al. this volume), bamboo (*Arundinaria gigantea*, giant cane, historically forming large cane brakes), areas with standing water for long periods of time (e.g., Neuces River bottoms), abundant lianas (= large woody vines) extending high into the canopy, the presence of leaf-cutter ants, and even (until the early 1900s) jaguars (Bailey 1905). In addition, there are numerous representatives of many characteristically tropical families such as Annonaceae (including pawpaw), Araliaceae (hercules'-club), Bignoniaceae (crossvine), Lauraceae (red bay), Marantaceae (powdery thalia), Mayacaceae (bog-moss), Melastomataceae (meadow beauty), Menispermaceae (moonseed), and Symplocaceae (sweet-leaf).

4) Influence of glaciation—During the Quaternary Period (beginning ca. 1.8 million years ago and including the Pleistocene and Recent epochs), there have been profound changes in the vegetation of the southeastern U.S. including East Texas. During the Pleistocene Epoch ("ice ages"), there was significant climatic variability and at least 20 glacial-interglacial cycles. Not surprisingly, widespread changes in vegetation were associated with these climatic fluctuations (Delcourt & Delcourt 1993). During the last major period of full glaciation (80,000 to about 18,000 years ago), vegetation of the eastern U.S. was radically different than at present. Sea level was 100 to 120 meters lower than during modern times and the Laurentide Ice Sheet extended south to approximately 40° N latitude (near the junction of the Ohio and Mississippi rivers). Boreal forest could be found south to ca. 34° N latitude, and between 34° and 33° N latitude existed a narrow ecotone between "northern boreal and more southern temperate communities" (Delcourt & Delcourt 1993). In this regard, it should be noted that the zone between 34° and 33° latitude cuts across the northern several tiers of East Texas counties (e.g., Bowie, Grayson, Hunt, Red River). "South of latitude 33°, across the southern Atlantic and Gulf coastal plains, floristic elements of temperate deciduous forest occurred with plant taxa characteristic today of southeastern evergreen forests" (Delcourt & Delcourt 1993). Thus, it was in areas such as East Texas that some eastern deciduous forest species found refuge during full glacial times. Indeed, data from East Texas bogs (e.g., Boriack Bog, Lee Co.) in the Post Oak Savannah confirms the presence of such deciduous forest genera as *Acer*, *Alnus*, *Carya*, *Castanea*, *Cornus*, *Corylus*, *Fraxinus*, *Myrica*, *Quercus*, and *Tilia* more than 15,000 years ago, and suggests the region was heavily forested near the end of the last glaciation (Bryant 1977; Bryant & Holloway 1985b). While most of these genera can still be found in East Texas today (generally farther east), the profound climatic differences at that time are reflected in the presence of small amounts of *Picea glauca* (white spruce) pollen in late glacial deposits at Boriack Bog (radiocarbon dated as older than 15,000 years before the present) (Bryant 1977; Holloway & Bryant 1984; Bryant & Holloway 1985b). This cold loving species occurs today only much farther north. Bryant and Holloway (1985b) concluded that as post-glacial warming occurred in East Texas, the glacial age deciduous forest "lost certain key taxa such as *Picea* and *Corylus* yet the region remained forested with a wide variety of deciduous tree taxa." In other words, at 15,000 years before present, the mean annual air temperature was 5° C less than at present, conditions were moister, and there was a more widespread forest mosaic over most of Texas (Bryant 1977; Stahle & Cleaveland 1995). Subsequently, there has been in general a warming and drying trend in Texas (Bryant & Holloway 1985b) with consequent effects on the vegetation.

It is interesting to consider the impact of such profound climatic change on where plants occur today. Many otherwise difficult to explain plant distributions may be easily accounted for by considering them relicts of different climatic conditions of the past. A possible example is the occurrence of jack-in-the-pulpit (*Arisaema triphyllum*) in Parker County in the West Cross Timbers. This species is generally limited to mesic environments in the eastern part of the state. Nonetheless, a thriving population can be found in a mesic microhabitat, situated between sandstone rock walls in Parker County, well to the west of other known locations of this species. It seems likely that this population is a relict of a previously extensive forest that was largely lost as the climate warmed and dried. Other eastern species that have been found in surprising places much to the west include eastern hop-hornbeam (*Ostrya virginiana*) in Tarrant County and shag-bark hickory (*Carya ovata*) in Parker County, both disjunct by more than 120 miles (193 kilometers) from their current day locations in East Texas. Numerous other examples could be given, including many species and genera typical of East Texas showing up in isolated pockets on the Edwards Plateau (e.g., groundnut (*Apios americana*), cross-vine (*Bignonia capreolata*), witch-hazel, (*Hamamelis virginiana*), spice bush (*Lindera benzoin*), barbed rattlesnake-root (*Prenanthes barbata*), Carolina rose (*Rosa carolina*), dwarf palmetto (*Sabal minor*), American basswood (*Tilia americana*), and maple (*Acer*). An alternate explanation for these disjunctions, long distance dispersal, seems unlikely given the distance (up to 280 miles (450 km)), the number of species displaying the pattern, and the significant number of Edwards Plateau endemics, including many in genera typically found in more mesic habitats farther east (e.g, Texas snow-bell, *Styrax platanifolius* subsp. *texanus*). Further, dispersal by wind, water, or migratory birds seems unlikely since the prevailing winds and river drainage are from west to east, and there is virtually no migration from the east and almost no faunal overlap between the Edwards Plateau and East Texas (Palmer 1920). Likewise, many more typically eastern species extend west in the Red River valley (e.g., numerous species reach their western limits in Grayson County, including beaked groovebur (*Agrimonia rostellata*), black oak (*Quercus velutina*), may-apple (*Podophyllum peltatum*), and Solomon's-seal (*Polygonatum biflorum*). In addition, many herbaceous species, common farther north and east in the U.S., occur in Texas only rarely and erratically in the Pineywoods and have extremely limited distributions. Kral (1966c) and MacRoberts and MacRoberts (1997a) discussed a number of these "northern woodland elements" south of their normal range (e.g., *Erythronium rostratum*, *Lilium michauxii*, *Sanguinaria canadensis*, *Silene stellata*, *Trillium recurvatum*, *Uvularia sessilfolia*) and indicated that they appear to be relicts of glacial times surviving in areas with particularly favorable soil and moisture conditions (i.e., refugia). Kral (1966c) noted that he could walk for miles and then find a large colony of one of these species, apparently reproducing predominantly via vegetative means. These species may thus be "Ice Age holdovers hanging on precariously to the older geologic terraces in the coolest locations in the forest" (MacRoberts & MacRoberts 1997a). Even the presence of the drought intolerant American beech (*Fagus grandifolia*) in East Texas is surprising given its ecological requirements. This species reaches its southwestern limit in the U.S. in Montgomery Co. (not far north of Houston)—here beech appears to do best when protected from the intense Texas summer sun by a canopy of associated trees (McLeod 1975). All of these examples may be relicts of much more widespread distributions of deciduous forest species during glacial times when the climate in Texas was quite different and conditions much more mesic (Kral 1966c, Palmer 1920; O'Kennon 1991; Delcourt & Delcourt 1993). It is not surprising that isolated populations of once more widespread plant species are able to persist in small areas of special microclimate or unusual geology—in fact, such persistence would be expected.

5) Rich biogeographical heritage—The eastern deciduous forest, while covering only approximately 11 percent of the North American continent, "is the most diverse and species-rich component of the North American vegetation" (Graham 1999). This diverse forest extends as far west as East Texas, where a number of temperate genera reach the southwestern limit of their present distribution in the continental U.S. (Graham 1999)—in other words, numerous genera and hundreds of species occur all across the eastern U.S., in some cases only barely reaching East Texas (in a few instances only Jasper and Newton counties—e.g., *Magnolia pyramidata*, pyramid magnolia; or only Newton County—e.g., *Stewartia malacodendron*, silky-camellia or *Uvularia sessilifolia*, sessile-leaf bellwort). From the standpoint of biogeography, eastern deciduous forest elements are one of the most fascinating components of the East Texas flora. The fossil record shows that many plants once had distributions across much of the Northern Hemisphere—for example, temperate forests with tropical elements occurred very broadly and reached their maximum extension in the mid-Tertiary Period (the Tertiary extended from 65 million years ago (mya) to 5 mya). According to Graham (1999), "there was a belt of vegetation similar in structure and composition extending around much of the northern hemisphere." This widespread flora has been variously referred to as the Arcto-Tertiary flora, the Tertiaro-mesophytic flora, the boreotropical flora, or a mixed mesophytic forest. Geohistorical events from the mid-Tertiary to the present have included alterations in the shapes of the northern land masses, plate movements, fluctuations in sea levels, mountain building, and profound changes in the climate. Specific examples include land bridges across what are now the Bering Sea and the North Atlantic (due to lowering of sea level) and fossil evidence of periods of global climate much warmer than at present—e.g., broad-leaved deciduous forests in polar areas, and glaciation. As a result of these factors, there have been considerable changes in both the composition and the disposition of the flora, and the ranges of many plant groups have been greatly restricted (e.g., eliminated from Europe and w North America). A number of species of the once widespread Northern Hemisphere Tertiary flora have survived in one or more of four main Tertiary relict areas—1) eastern Asia; 2) eastern North America; 3) western North America; and 4) southeastern Europe—however, many survived in only two of these areas, eastern Asia and eastern North America. According to Wen (1999), ca. 65 genera of seed plants have this disjunct eastern Asia–eastern North America distribution. East Texas examples include, but are not limited to, *Aletris*, *Ampelopsis*, *Apios*, *Brachyelytrum*, *Campsis*, *Carya*, *Diarrhena*, *Halesia*, *Hamamelis*, *Lindera*, *Lyonia*, *Menispermum*, *Nyssa, Parthenocissus, Penthorum*, *Phryma*, *Podophyllum, Sassafras*, *Saururus*, *Stewartia*, *Tipularia*, *Trachelospermum*, *Triosteum*, and *Zizania*. In fact, representatives of 33 of the 65 genera (51%) cited by Wen (1999) as eastern Asia-eastern North America disjuncts occur in East Texas. In addition to present day disjuncts between the two areas, fossils of numerous present day Asian genera (e.g., *Ailanthus*, *Ginkgo*, *Metasequoia)* have been found in North America. This biogeographical pattern has sometimes been referred to as the "Asa Gray disjuction" in honor of the Harvard botanist who was one of the earliest to recognize its significance. It should be noted that this disjunct distribution pattern has complex and multiple origins (e.g., dispersal across both the Bering and North Atlantic land bridges), with similar present day distributions differing in time and manner of origin. However, the consensus is that the eastern Asia-eastern North America pattern is in general a relict of the maximum development of Northern Hemisphere temperate forests (with tropical elements) in the Tertiary, with greater survival in eastern Asia and eastern North America and higher rates of extinction in Europe and western North America due to such factors as glaciation and mountain building (Li 1952; Little 1970; Wood 1970, 1972, Graham 1972, 1993a, 1999; Wolfe 1975, 1987; Boufford & Spongberg 1983; Hamilton 1983; Hsü 1983; Wu 1983; Ying 1983; Tiffney 1985a, 1985b; Upchurch & Wolfe 1987; Cox & Moore 1993; Wendt 1993; Xiang et al. 1998; Wen 1999, 2001; Dilcher 2000; Xiang & Soltis 2001).

A related floristic relationship is the similarity between some isolated forests in the mountains of Mexico and those in the eastern United States. Numerous East Texas deciduous forest genera (e.g., *Acer*, *Alnus*, *Carpinus*, *Cercis*, *Crataegus*, *Cornus*, *Epifagus*, *Fagus*, *Fraxinus*, *Juglans*, *Liquidambar*, *Magnolia*, *Mitchella*, *Myrica*, *Nyssa*, *Ostrya*, *Pedicularis*, *Platanus*, *Prunus*, *Quercus*, *Rhus*, *Smilax*, *Tilia*, *Ulmus*, and *Vaccinium*) and even a few species (e.g., *Carpinus caroliniana*, *Epifagus virginiana*, *Fagus grandifolia*, *Nyssa sylvatica*, *Liquidambar styraciflua*, *Mitchella repens)* occur broadly across the eastern United States as far west as eastern Texas and then reappear in the Mexican highlands and in some cases even in Guatemala (Miranda & Sharp 1950; Martin & Harrell 1957; Thorne 1993d; Graham 1993a, 1999). Most of the deciduous forest "temperate" genera occur in "isolated patches of humid montane forest, typically in the Sierra Madre Oriental," usually above 1,000 m elevation (Martin & Harrall 1957). These occurrences in Mexico represent a disjunction, across a zone of arid grassland and thorn scrub, of at least 500 kilometers from the nearest East Texas locations, and in some cases much more (Martin & Harrall 1957). At one time, the similarities were thought to be the result of the migration of vegetation zones associated with Pleistocene glaciation (Dewey 1949). However, the fact that this relationship exists primarily at the generic level implies "a substantial period of isolation" of the Mexican components—a conclusion in line with recent paleobotanical evidence showing that the relationship was established long before the glacial cycles of the Pleistocene (Graham 1999). In actuality, this relationship represents a middle Miocene (Miocene epoch—24.6–5.1 million years ago) extension of deciduous forest and associated fauna (particularly amphibians) into Mexico during a period of widespread climatic cooling (Burnham & Graham 1999; Graham 1999). In the words of Graham (1999), a "major decline in temperature occurred in the middle Miocene" and "global temperatures reached new lows, allowing the deciduous forest to reach its southernmost extent." Subsequently, during the Pliocene (Pliocene epoch—5.1–1.8 million years ago) and later, the climate warmed and dried, and other types of vegetation (e.g., prairie or thorn scrub communities) spread replacing deciduous forest. As a result, the once continuous deciduous forests became disjunct, surviving only in the eastern U.S. and eastern Mexico. During the following millions of years, evolution resulted in the differentiation of some of the disjunct populations into separate species, while others remained similar enough to be considered one species. Ultimately, with continued climatic change, this forest type has been further reduced in Mexico until at present it survives in only limited isolated pockets of appropriate microclimate in the highlands (Miranda & Sharp 1950; Graham 1993a, 1993b, 1999).

The influence of the eastern deciduous forest on the flora of East Texas is thus an extremely complex and interesting story written across tens of millions of years, untold upheavals in geology and climate, and profound evolutionary change. And yet, it is a story that can be deciphered using modern concepts and techniques in geology, paleobotany, paleoclimatology, and evolutionary biology.

6) Unique geology—While there are many aspects of the geology of East Texas that are interesting and important biologically, several unusual phenomena deserve special mention. First, the salt domes scattered in East Texas are an interesting geologic feature, though very limited in total area. Millions of years ago in the area we now call East Texas, the forces of plate tectonics pulled a continent apart and the earth's crust began to sag. During the Jurassic Period (208–145 million years ago) huge shallow seas, eventually retreating to become the present-day Gulf of Mexico, began to form in this sagged area. This water was shallow, the area was not well connected to the ocean, and it sometimes virtually dried up leaving vast salt flats—the result over long periods of time was the deposition of tremendously thick layers of salt (known now as Louann salt). These deposits are the source of the salt domes of modern day East Texas. Eventually, as sedimentation continued and more and more material was laid down over the salt, the tremendous pressure of the overlying younger sediments (Cretaceous and Tertiary in age) caused the salt layers to become distorted. Acting under pressure almost like toothpaste being squeezed out of a tube, the salt formed upward thrusting columns and spires, which in some areas broke through the covering sediments to reach to or near the surface in the form of isolated domes of salt (e.g., near Palestine or Grand Saline—in the latter case, the salt is mined) (Spearing 1991). Ecologically, these salt domes are significant because of the effect they have on plant and animal life—coastal salt marsh plants, for example, can be found hundreds of miles inland (e.g., *Bulboschoenus robustus*, salt-marsh bulrush, at an inland salt marsh near Grand Saline in Van Zandt Co.). Economically, they are also very important because rich deposits of oil often collected around them from nearby oil-bearing layers—e.g., Spindletop, the first gusher that in 1901 ushered in the Texas oil boom.

Evidence for an extraterrestrial object hitting East Texas is a second fascinating and unusual geologic phenomenon. Local farmers and ranchers (e.g., family of J.A. (Jack) Lincecum, J.B. Lincecum, pers. comm.) in Leon county near Marquez have long known that there was something strange about the geology of the area. Limestone rocks, unlike those anywhere nearby, occur at the surface. In fact, there is a roughly circular 1.2 km diameter surface outcrop of disturbed Upper Cretaceous limestone rocks in an area otherwise characterized by much younger Paleocene sandstone. Some geologists thought the structure, known as the Marquez Dome, was another example of the relatively common salt domes found widely in East Texas (e.g., Spearing 1991). Recently, however, geologists have more accurately explained this unusual geologic feature as an impact crater, based on a variety of evidence including core samples (petroleum industry well-log data), gravity anomaly data, seismic reflection data, surface geology, faults, and steeply sloping strata. It is thus one of fewer than 200 such craters known world-wide (Perkins 2002b). Approximately 58 ± 3.1 million years ago near the Paleocene-Eocene boundary, when the region was a near shore environment, an extraterrestrial object (e.g., meteorite) impacted into soft, unconsolidated sediments, producing a 13 km diameter impact crater. Subsequently buried by sediments, and later partially uncovered by erosion, the only present day surface exposure of the crater is an uplifted area at the crater's center—a 1.2 km diameter outcrop of blocks of Cretaceous Pecan Gap limestone (Taylor group) in a matrix of sand and clay. The presence of this anomalous limestone at the surface represents a vertical uplift of the Cretaceous rocks at least 1120 m (more than half a mile), and is an indication of the tremendous energy released when an object moving at incredible speed impacted the area (Gibson & Sharpton 1989; Gibson 1990; McHone & Sorkhabi 1994; Buchanan et al. 1998; Wong et al. 2001). The unusual surface outcrop of limestone rocks is potentially interesting botanically—e.g., the presence of unexpected calciophilic species.

East Texas is thus a unique habitat from numerous perspectives. When it is considered that within the last 150 years virtually all of the Pineywoods was cut for timber and virtually all of the Blackland Prairie was destroyed for cotton production and other uses, many questions, both practical and philosophical, come to mind regarding the use of natural resources. Is it not our responsibility to preserve a minute fraction of this wonderful and unique natural heritage? How can we justify destroying absolutely everything in the name of progress and economic prosperity? What will future generations of Texans say about the actions of those alive today? Are we the stewards of the natural world or merely its exploiters?

List of Texas Endemics Occurring in East Texas

Except where noted, endemic information is from W. Carr (2002b), *No Place But Texas: An Annotated List of Plant Taxa Endemic to the Lone Star State* (Unpublished February 2002 draft), The Nature Conservancy of Texas.

This list contains 163 Texas endemics and 26 East Texas endemics. Additional information about the following endemics can be found with the species descriptions in the taxonomic treatments.

Indicates taxa endemic to East Texas

Monocots

Agavaceae Agave Family
- *Hesperaloe engelmannii* Krauskopf, possibly endemic to Texas (see Turner & Turner 2002)
- *Yucca cernua* E. Keith, based on Keith (2003)
- *Yucca constricta* Buckley, endemic to Texas (Kartesz 1999) or nearly so (recently reported for ne Mexico—Hess & Robbins 2002)
- *Yucca necopina* Shinners
- *Yucca pallida* McKelvey
- *Yucca rupicola* Scheele

Alliaceae Onion Family
- *Allium canadense* L. var. *ecristatum* (M.E. Jones) Ownbey
- *Allium elmendorfii* M.E. Jones ex Ownbey
- *Allium runyonii* Ownbey

Amaryllidaceae Amaryllis Family
- *Cooperia traubii* Hayw.
- *Crinum americanum* L. var. *traubii* (Moldenke) L.S. Hannibal, (Holmes 2002)
- *Zephyranthes pulchella* J.G. Sm.

Commelinaceae Spiderwort Family
- *Allium canadense* L. var. *ecristatum* (M.E. Jones) Ownbey
- *Tinantia anomala* (Torr.) C.B. Clarke, endemic to Texas or nearly so (1 record from Durango, Mexico—R. Faden, pers. comm.)
- *Tradescantia edwardsiana* Tharp
- *Tradescantia gigantea* Rose, probably endemic to Texas—Faden (2000b) mapped the species as occurring in Louisiana, but noted that "Plants of *Tradescantia gigantea* growing around Ruston, Louisiana, may have originated from cultivated plants."
- *Tradescantia humilis* Rose
- *Tradescantia subacaulis* Bush

Cyperaceae Sedge Family
- *Carex edwardsiana* E.L. Bridges & Orzell
- *Eleocharis reverchonii* Sevenson, based on Smith et al. (2002)
- *Rhynchospora indianolensis* Small, based on Kartesz (1999) and Kral (2002c)

Juncaceae Rush Family
- *Juncus texanus* (Engelm.) Coville, endemic to Texas (Brooks & Clements 2000) or nearly so (possibly present in adjacent Oklahoma—Kartesz 1999; Carr 2002b)
- *Juncus validus* Coville var. *fascinatus* M.C. Johnst., based on Kartesz (1999), Brooks & Clements (2000), and Carr (2002c)

Nolinaceae Bear-grass Family
- *Nolina lindheimeriana* (Scheele) S. Watson

Orchidaceae Orchid Family
- *Spiranthes parksii* Correll

Poaceae Grass Family
- *Bromus texensis* (Shear) Hitchc.
- *Chloris texensis* Nash
- *Dichanthelium nodatum* (Hitchc. & Chase) Gould [*Panicum nodatum* Hitchc. & Chase]
- *Digitaria texana* Hitchc. [including *Digitaria runyonii* Hitchc.], endemic to Texas (Carr 2002b, 2002c) or possibly also in FL (Wipff 2003f)
- *Muhlenbergia* ×*involuta* Swallen
- *Tridens buckleyanus* (L.H. Dewey) Nash [*Triodia buckleyana* (L.H. Dewey) Vasey ex Hitchc.]
- *Tridens congestus* (L.H. Dewey) Nash [*Triodia congesta* L.H. Dewey]

Willkommia texana Hitchc. var. *texana*
Zizania texana Hitchc.

Dicots

Acanthaceae Acanthus Family
Ruellia drummondiana (Nees) A. Gray

Apiaceae Carrot Family
Daucosma laciniatum Engelm. & A. Gray
Tauschia texana A. Gray

Asclepiadaceae Milkweed family
Asclepias linearis Scheele
Matelea edwardsensis Correll

Asteraceae Sunflower Family
Brickellia dentata (DC.) Sch. Bip.
Brickellia eupatorioides (L.) Shinners var. *gracillima* (A. Gray) B.L. Turner
Chaetopappa bellidifolia (A. Gray & Engelm.) Shinners
Chaetopappa effusa (A. Gray) Shinners
Chaetopappa imberbis (A. Gray) G.L. Nesom [*Chaetopappa asteroides* (Nutt.) DC. var. *imberbis* A. Gray]
Chaptalia texana Greene [*Chaptalia nutans* (L.) Polák. var. *texana* (Greene) Burkart]
Chrysopsis texana G.L. Nesom [*Bradburia hirtella* Torr. & A. Gray]
Coreopsis nuecensoides E. B. Sm.
Gaillardia aestivalis (Walter) H. Rock. var. *winkleri* (Cory) B.L. Turner [*Gaillardia lutea* Greene var. *winkleri* Cory]
Gutierrezia amoena (Shinners) Diggs, Lipscomb & O'Kennon [*Amphiachyris amoena* (Shinners) Solbrig; *Xanthocephalum amoenum* Shinners]
Helianthus debilis Nutt. subsp. *silvestris* Heiser
Hymenopappus carrizoanus B. L. Turner
Liatris bracteata Gaiser
Liatris cymosa (Ness) K. Schum. [*Laciniaria cymosa* Ness]
Liatris glandulosa G.L. Nesom & O'Kennon, based on Nesom and O'Kennon (2001)
Palafoxia hookeriana Torr. & A. Gray [including var. *minor* Shinners]
Palafoxia reverchonii (Bush) Cory
Pectis angustifolia Torr. var. *fastigiata* (A. Gray) D. J. Keil
Silphium albiflorum A. Gray
Symphyotrichum eulae (Shinners) G.L. Nesom [*Aster eulae* Shinners], based on G. Nesom (pers. comm.)
Thelesperma flavodiscum (Shinners) B. L. Turner
Thurovia triflora Rose [*Gutierrezia triflora* (Rose) M. A. Lane]
Thymophylla tenuiloba (DC.) Small var. *wrightii* (A. Gray) Strother [*Dyssodia tenuiloba* (DC.) B.L. Rob. var. *wrightii* (A. Gray) Strother]
Verbesina lindheimeri B.L. Rob. & Greenm.
Xanthisma texanum DC. var. *texanum*

Berberidaceae Barberry Family
Berberis swaseyi Buckley ex M.J. Young [*Mahonia swaseyi* (Buckley) Fedde]

Boraginaceae Borage Family
Cryptantha texana (A. DC.) Greene
Onosmodium helleri Small

Brassicaceae Mustard Family
Arabis petiolaris (A. Gray) A. Gray
Leavenworthia aurea Torr. var. *texana* (Mahler) Rollins [*Leavenworthia texana* Mahler]
Lesquerella densiflora (A. Gray) S. Watson
Lesquerella engelmannii (A. Gray) S. Watson subsp. *engelmannii*
Lesquerella grandiflora (Hook.) S. Watson
Lesquerella pallida (Torr. & A. Gray) S. Watson
Lesquerella recurvata (Engelm. Ex A. Gray) S. Watson
Lesquerella sessilis (S. Watson) Small
Streptanthus bracteatus A. Gray

Buddlejaceae Buddleja Family
Buddleja racemosa Torr. subsp. *incana* (Torr.) E.M. Norman [*Buddleja racemosa* Torr. var. *incana* Torr.]
Buddleja racemosa Torr. subsp. *racemosa*

Campanulaceae Bellflower Family
Campanula reverchonii A. Gray
Triodanis texana McVaugh

Caryophyllaceae Pink Family
Paronychia setacea Torr. & A. Gray

Cistaceae Rockrose Family
Lechea san-sabeana (Buckley) Hodgdon

Convolvulaceae Morning-glory Family
Dichondra recurvata Tharp & M. C. Johnst.

Euphorbiaceae Spurge Family
Ditaxis aphoroides (Müll. Arg.) Pax [*Argythamnia aphoroides* Müll. Arg.]

Ditaxis simulans (J.W. Ingram) Radcl.-Sm. & Govaerts [*Argythamnia simulans* J.W. Ingram]
Croton alabamensis E.A. Sm. Ex Chapm. var. *texensis* Ginzbarg
Euphorbia peplidion Engelm. [*Tithymalus peplidion* (Engelm.) Small]
Euphorbia roemeriana Scheele [*Tithymalus roemerianus* (Scheele) Small]
Tragia nigricans Bush

Fabaceae LEGUME FAMILY
Amorpha roemerana Scheele [*Amorpha texana* Buckley]
Astragalus crassicarpus Nutt. var. *berlandieri* Barneby
Astragalus nuttallianus DC. var. *pleianthus* (Shinners) Barneby
Astragalus reflexus Torr. & A. Gray
Astragalus wrightii A. Gray
Dalea hallii A. Gray
Dalea obovata (Torr. & A. Gray) Shinners [*Petalostemum obovatum* Torr. & A. Gray]
Dalea tenuis (J.M. Coult.) Shinners [*Petalostemum tenue* J.M. Coult.; *Petalostemum stanfieldii* Small]
Desmanthus reticulatus Benth.
Galactia canescens Benth.
Galactia texana (Scheele) A. Gray
Pediomelum cyphocalyx (A. Gray) Rydb.
Pediomelum hypogaeum (Nutt. ex Torr. & A. Gray) Rydb. var. *scaposum* (A. Gray) Mahler [*Psoralea hypogaea* Nutt. ex Torr. & A. Gray var. *scaposa* A. Gray; *Psoralea scaposa* (A. Gray) J.F. Macbr.]
Pediomelum latestipulatum (Shinners) Mahler var. *appressum* (Ockendon) Gandhi & L. E. Br. [*Psoralea latestipulata* Shinners var. *appressa* Ockendon]
Tephrosia lindheimeri A. Gray
Trifolium bejariense Moric.

Fumariaceae FUMITORY FAMILY
Corydalis curvisiliqua Engelm. subsp. *curvisiliqua*.
Corydalis micrantha (Engelm. ex A. Gray) A. Gray subsp. *texensis* G.B. Ownbey [*Corydalis micrantha* (Engelm. ex A. Gray) A. Gray var. *texensis* (G.B. Ownbey) Shinners]

Gentianaceae GENTIAN FAMILY
Bartonia texana Correll

Hydrangeaceae HYDRANGEA FAMILY
Philadelphus ernestii S.Y. Hu

Hydrophyllaceae WATERLEAF FAMILY
Phacelia laxa Small
Phacelia patuliflora (Engelm. & A. Gray) A. Gray var. *patuliflora*
Phacelia strictiflora (Engelm. & A. Gray) A. Gray var. *strictiflora*

Lamiaceae MINT FAMILY
Brazoria truncata (Benth.) Engelm. & A. Gray var. *truncata*.
Brazoria truncata (Benth.) Engelm. & A. Gray var. *pulcherrima* (Lundell) M.W. Turner [*Brazoria pulcherrima* Lundell]
Monarda punctata L. var. *intermedia* (E.M. McClint. & Epling) Waterf.
Monarda stanfieldii Small [*Monarda punctata* L. var. *stanfieldii* (Small) Cory; *Monarda punctata* L. subsp. *stanfieldii* (Small) Epling]
Monarda viridissima Correll
Rhododon ciliatus (Benth.) Epling [*Hedeoma ciliata* Benth.; *Hedeoma texanum* Cory]
Salvia engelmannii A. Gray
Salvia penstemonoides Kunth & Bouché
Teucrium cubense Jacq. var. *laevigatum* (Vahl) Shinners [*Teucrium cubense* Jacq. subsp. *laevigatum* (Vahl) E. M. McClint. & Epling]

Loganiaceae LOGANIA FAMILY
Spigelia texana (Torr. & A. Gray.) A. DC.

Malvaceae MALLOW FAMILY
Hibiscus dasycalyx S.F. Blake & Shiller
Malvastrum aurantiacum (Scheele) Walp.
Sphaeralcea lindheimeri A. Gray

Nyctaginaceae FOUR O'CLOCK FAMILY
Abronia macrocarpa L.A. Galloway
Mirabilis gigantea (Standl.) Shinners

Onagraceae EVENING-PRIMROSE FAMILY
Gaura villosa Torr. subsp. *parksii* (Munz) P.H. Raven & D.P. Greg.
Oenothera mexicana Spach.

Papaveraceae POPPY FAMILY
Argemone aurantiaca G.B. Ownbey

Polemoniaceae PHLOX FAMILY
Phlox drummondii Hook. subsp. *wilcoxiana* (Bogusch) Wherry
Phlox nivalis Lodd. subsp. *texensis* Lundell

Phlox pilosa L. subsp. *latisepala* Wherry [*Phlox pilosa* L. var. *asper* (E.E. Nelson) Wherry]
Phlox pilosa L. subsp. *riparia* Wherry
Phlox roemeriana Scheele

Polygonaceae BUCKWHEAT FAMILY
Polygonella parksii Cory
Polygonum texense M.C. Johnst.
Rumex spiralis Small

Ranunculaceae CROWFOOT FAMILY
Anemone edwardsiana Tharp [including var. *petraea* Correll]
Clematis texensis Buckley
Thalictrum texanum (A. Gray) Small

Rosaceae ROSE FAMILY
Crataegus anamesa Sarg.
Crataegus brazoria Sarg.
Crataegus dallasiana Sarg.
Crataegus nananixonii J.B. Phipps & O'Kennon, (Phipps & O'Kennon 1997)
Crataegus stenosepala Sarg.
Crataegus texana Buckley
Crataegus viburnifolia Sarg.
Crataegus warneri Sarg.
Prunus minutiflora Engelm.
Prunus texana D. Dietr. [*Prunus glandulosa* (Hook.) Torr. & A. Gray]
Rubus riograndis L.H. Bailey [*Rubus duplaris* Shinners; *Rubus trivialis Michx.* var. *duplaris* (Shinners) Mahler]

Rubiaceae MADDER FAMILY
Houstonia parviflora Holz. ex Greenm. [*Hedyotis greenmanii* Fosberg]
Houstonia subviscosa (C. Wright ex A. Gray) A. Gray [*Hedyotis subviscosa* (C. Wright ex A. Gray) Shinners]

Scrophulariaceae Figwort Family
Agalinis edwardsiana Pennell
Agalinis navasotensis Dubrule & Canne-Hilliker
Castilleja purpurea (Nutt.) G. Don var. *lindheimeri* (A. Gray) Shinners [*Castilleja lindheimeri* A. Gray]
Seymeria texana (A. Gray) Pennell

Solanaceae POTATO FAMILY
Physalis virginiana Mill. var. *texana* (Rydb.) Waterf. [*Physalis texana* Rydb.]

Styracaceae STORAX FAMILY
Styrax platanifolius Engelm. ex Torr. subsp. *platanifolius*

Valerianaceae VALERIAN FAMILY
Valerianella florifera Shinners
Valerianella stenocarpa (Engelm. ex A. Gray) Krok.

Vitaceae GRAPE FAMILY
Parthenocissus heptaphylla (Buckley) Britton ex Small
Vitis monticola Buckley

Species of Pteridophytes, Gymnosperms, and Monocots of Conservation Concern Occurring in East Texas

The following list contains 99 species (115 total taxa—species, subspecies, and varieties) of pteridophytes, gymnosperms, and monocots that we consider to be of conservation concern in East Texas. These represent 9.3% of the total 1,060 species and 10.2% of the total 1,131 taxa treated in Volume 1. Dicots of conservation concern will be listed in Vols. 2 & 3.

A taxon (species, subspecies, or variety) is included in this list if:

1) It is cited in the botanical literature as being rare, threatened, endangered, or of conservation concern. In these cases, the reference is given. References of particular importance include Poole et al. (2002) and Carr (2002d). In order to stress the rarity of the plants under discussion, these two key references are cited in the taxonomic treatments and in the list below as RARE 2002a and RARE 2002b respectively.

2) Its distribution in Texas is so limited that we consider it to be of conservation concern in the state. This is indicated in the text by the abbreviation IFET (*Illustrated Flora of East Texas*). In general, our criterion is that if a native species, subspecies, or variety is known to us in Texas from three or fewer counties, it is included in this list. In a few cases, as noted in the text, additional species are included for various reasons. We realize that a "three county" guideline is somewhat arbitrary and not always the best criterion. In some cases a taxon, though present in only three counties, may be locally abundant. In other instances, a taxon occurring in four or more counties may be quite rare throughout its range. However, given the paucity of collections and lack of distributional data about many plants in Texas, this is at least a first attempt at pointing out taxa not previously recognized as of possible conservation concern in the state. Hopefully, the material presented here will stimulate collectors to provide additional collections and information.

Taxa are listed in alphabetical order within three categories: ferns and related plants, gymnosperms, and monocots.

Taxa whose scientific names occur in italics are known immediately adjacent to the flora area but not from it. They are mentioned in the treatments and here as "notes" to provide as much information as possible.

Conservation concern designations (e.g., G2S2SOC), if available, are given. A key to these designations can be found on pages 20 and 21 of introduction to this volume.

Additional information about the following species of conservation concern can be found with the species descriptions in the taxonomic treatments.

Indicates taxa endemic to Texas; Indicates taxa endemic to East Texas

Pteridophytes

Cheilanthes aemula Maxon, TEXAS LIP FERN, RIVAL LIP FERN. IFET.

Cystopteris protrusa (Weatherby) Blasdell, SOUTHERN BLADDER FERN, LOWLAND BLADDER FERN, LOWLAND BRITTLE FERN. IFET.

Dryopteris celsa (W. Palmer) Knowlton, W. Palmer & Pollard, LOG FERN. IFET.

Isoetes butleri Engelm., BUTLER'S QUILLWORT. IFET.

Isoetes lithophila N. Pfeiff., ROCK QUILLWORT. (TOES 1993: V; RARE 2002a: G2S2SOC)

Lycopodiella prostrata (R.M. Harper) Cranfill, CREEPING CLUB-MOSS, PROSTRATE BOG CLUB-MOSS, SOUTHERN CLUB-MOSS, FEATHER-STEM CLUB-MOSS. IFET.

Palhinhaea cernua (L.) Vasc. & Franco, NODDING CLUB-MOSS, STAG-HORN CLUB-MOSS. IFET.

Psilotum nudum (L.) P. Beauv., WHISK-FERN. IFET.

Tectaria heracleifolia (Willd.) Underw., BROAD HALBERD FERN. IFET.

Gymnosperms

No East Texas gymnosperms are of conservation concern.

Angiosperms

Monocots

Alisma subcordatum Raf., SOUTHERN WATER-PLANTAIN, AMERICAN WATER-PLANTAIN, WATER-PLANTAIN, SMALL-FLOWER WATER-PLANTAIN, MUD-PLANTAIN. IFET.

Allium canadense L. var. **ecristatum** (M.E. Jones) Ownbey, CRESTLESS WILD ONION. This variety is of conservation concern. (RARE 2001, 2002b**:** G5T3S3)

Allium elmendorfii M.E. Jones ex Ownbey, ELMENDORF WILD ONION, MARION'S WILD ONION, WILD ONION. (TOES 1993: V; RARE 2002a: G2S2)

Anthenantia villosa (Michx.) P. Beauv., GREEN SILKYSCALE. IFET.

Aristida basiramea Engelm. ex Vasey, FORK-TIP THREEAWN, FORKED THREEAWN. IFET.

Aristida ramosissima Engelm. ex A. Gray, S-CURVE THREEAWN. IFET.

Bulbostylis ciliatifolia (Elliott) Fernald var. **ciliatifolia**, CAPILLARY HAIR SEDGE. IFET.

Carex amphibola Steud., NARROW-LEAF CARIC SEDGE, EASTERN NARROW-LEAF SEDGE. IFET.

Carex decomposita Muhl,. CYPRESS-KNEE SEDGE. (RARE 2002b: G3S1).

Carex hyalina Boott, FEW-FLOWERED CARIC SEDGE, TISSUE CARIC-SEDGE. Though rated by TOES (1993), as can be seen from the county distribution map, this species is now known from a large number of counties. (TOES 1993: V)

Carex kraliana Naczi & Bryson, KRAL'S CARIC SEDGE. IFET.

Carex lupuliformis Sartw., FALSE HOP SEDGE. (RARE 2002b: G3G4S1).

Chloris texensis Nash, TEXAS WINDMILL GRASS. Gould (1975b) indicated "Few specimens have been collected and most of these were collected over 30 years ago." (TOES 1993: V; RARE 2002a: G2S2SOC)

Cinna arundinacea L., STOUT WOOD REED, WOOD REED, WOOD REED GRASS, SWEET WOOD GRASS. Given its limited and disjunct distribution in the state, we consider this species to be of conservation concern in Texas. IFET.

Cladium mariscoides (Muhl.) Torr., SMOOTH SAW-GRASS, TWIG-RUSH, SWAMP SAW-GRASS. IFET.

Cooperia jonesii Cory, JONES' RAIN-LILY. Flagg et al. (2002b) indicated that this species is of conservation concern. (RARE 2001 and RARE 2002b: G3QS3)

Cooperia traubii Hayw., TRAUB'S RAIN-LILY. (RARE 2001 and RARE 2002b: G3QS3)

Corallorhiza odontorhiza (Willd.) Poir., AUTUMN CORALROOT, LATE CORALROOT, LATE SOUTHERN CORALROOT, FALL CORALROOT, SMALL-FLOWER CORALROOT. IFET.

Crinum americanum L. var. **traubii** (Moldenke) L.S. Hannibal. IFET.

Ctenium aromaticum (Walter) A.W. Wood, TOOTHACHE GRASS, ORANGE GRASS. Only recently discovered (2003) in the state (Newton Co.; *Singhurst 11,740*, BAYLU) at the e margin of East Texas. IFET.

Cyperus bipartitus Torr., SHINING FLAT SEDGE. IFET.

Cyperus drummondii Torr. & Hook., DRUMMOND'S FLAT SEDGE. IFET.

Cyperus grayoides Mohlenbr., MOHLENBROCK'S SEDGE, MIDWESTERN GRAY'S FLAT SEDGE. This species is considered to be of conservation concern by Tucker et al. (2002). Though widespread in East Texas (e.g., numerous counties cited by Turner et al. 2003), it is apparently quite limited in habitat and rare. (RARE 2002b:G3S3)

Cyperus lanceolatus Poir., EPIPHYTIC FLAT SEDGE. IFET.

Cypripedium kentuckiense C.F. Reed, SOUTHERN LADY'S-SLIPPER, YELLOW LADY'S-SLIPPER, RAFINESQUE'S LADY'S-SLIPPER, KENTUCKY LADY'S-SLIPPER, IVORY LADY'S-SLIPPER, PURLOINED-SLIPPER. (TOES 1993: IV; RARE 2002a: G3S1SOC)

Danthonia sericea Nutt., DOWNY DANTHONIA, SILKY WILD OAT GRASS, DOWNY OAT GRASS. IFET.

Diarrhena obovata (Gleason) Brandenburg, HAIRY BEAKGRAIN. IFET.

Dichanthelium aciculare (Desv. ex Poir.) Gould & C.A. Clark var. **aciculare**, NEEDLE-LEAF ROSETTE GRASS, NARROW-LEAF PANIC GRASS. IFET.

Dichanthelium acuminatum (Sw.) Gould & C.A. Clark var. **longiligulatum** (Nash) Gould & C.A. Clark, COASTAL PLAIN ROSETTE GRASS. IFET.

Dichanthelium clandestinum (L.) Gould, DEER-TONGUE, DEER-TONGUE ROSETTE GRASS. IFET.

Dichanthelium dichotomum (L.) Gould subsp. **roanokense** (Ashe) Freckmann & Lelong. IFET.

Dichanthelium latifolium (L.) Gould & C.A. Clark, BROAD-LEAF ROSETTE GRASS, BROAD-LEAF PANIC GRASS. IFET.

Dichanthelium strigosum (Muhl.) Freckmann var. **leucoblepharis** (Trin.) Freckmann. IFET.

Dichanthelium strigosum (Muhl.) Freckmann var. **strigosum**, ROUGH-HAIR ROSETTE GRASS, CUSHION-TUFTED PANIC GRASS. IFET.

Eleocharis elongata Chapm., SLIM SPIKE-RUSH. IFET.

Eleocharis melanocarpa Torr., BLACK-FRUIT SPIKE-RUSH. IFET.

Eleocharis ravenelii Britton in Small, RIO GRANDE SPIKE-RUSH, SOUTH TEXAS SPIKE SEDGE. Carr (2001) and Poole et al. (2002) recognized *E. austrotexana* and considered it a Texas endemic and of conservation concern (G3, S3). While we are lumping *E. austrotexana* with *E. ravenelii*, because of its rareness in the state, we still consider the taxon to be of conservation concern in Texas. IFET.

Eleocharis reverchonii Svenson, REVERCHON'S SPIKE-RUSH. This species is sometimes synonymized with *E. acicularis*. However, we are following the recent treatment in Smith et al. (2002) who recognize it as a distinct species; they also indicate that it is of conservation concern.

Eleocharis wolfii (A. Gray) A. Gray ex Britton, WOLF'S SPIKE-RUSH. *Eleocharis wolfii* is considered rare in a number of states (Kartesz 1999), and is possibly of conservation concern.

Epipactis gigantea Douglas ex Hook., GIANT HELLEBORINE, STREAM ORCHIS, STREAM EPIPACTIS, CHATTERBOX. (RARE 2002b: G3S3)

Eriocaulon kornickianum Van Heurck & Müll. Arg., SMALL-HEAD PIPEWORT, GULF PIPEWORT. This species is cited by Kral (2000b) as being of conservation concern. (TOES 1993: V; RARE 2002a: G2S1SOC)

Erythronium rostratum W. Wolf, YELLOW TROUT-LILY, BEAKED TROUT-LILY. IFET.

Festuca versuta Beal, TEXAS FESCUE. Darbyshire and Pavlik (ined.) indicated that this species is "rare." (RARE 2001, 2002b: G3S2S3)

Hesperaloe engelmannii Krauskopf, (no common name known, but could reasonably be called ENGELMANN'S RED-FLOWERED YUCCA). IFET. ?

Hesperaloe parviflora (Torr.) J.M. Coult., RED-FLOWERED-YUCCA, RED-YUCCA, RED HESPERALOE, RED-FLOWER FALSE YUCCA. (RARE 2001, 2002b: G3S3)

Hexalectris nitida L.O. Williams, SHINING HEXALECTRIS, GLASS MOUNTAIN-CORALROOT, GLASS MOUNTAIN CRESTED-CORALROOT, SHINING COCK'S-COMB, SHINING-CORALROOT. (RARE 2001, 2002b: G3S3)

Hexalectris warnockii Ames & Correll, TEXAS PURPLE-SPIKE, TEXAS CRESTED-CORALROOT. Goldman et al. (2002b) considered this species to be of conservation concern. (RARE 2002a: G2S2SOC)

Hypoxis rigida Chapm., CHAPMAN'S YELLOW STAR-GRASS. IFET.

Iris fulva Ker Gawl., RED FLAG, COPPER IRIS, RED IRIS. IFET.

Isolepis cernua (Vahl) Roem. & Schult., LOW LATERAL BULRUSH. IFET.

Lachnocaulon digynum Körn., PINELAND BOGBUTTON, TINY BOGBUTTONS, TINY BUG-BOTTOMS. Kartesz (1999) considered this species to be rare throughout its range. (RARE 2002a: G3S1SOC)

Leersia monandra Sw., BUNCH CUT GRASS. Pyrah (ined.) noted that there are few recent collections of this species; it could thus possibly be of conservation concern. Larry Brown (pers. comm.) noted that there are Brazoria Co. collections (SBSC) made in 2000 and 2002.

Lemma perpusilla Torr., DUCKWEED, MINUTE DUCKWEED. IFET.

Maianthemum racemosum (L.) Link, LARGE FALSE SOLOMON'S SEAL, FALSE SPIKENARD, SOLOMON'S-PLUME. If present in Texas, the species is extremely rare and of conservation concern.

Manfreda sileri Verhoek, SILER'S TUBE-ROSE, MAJOR SILER'S HUACO, HUACO. (RARE 2002a: G3S3)

Manfreda virginica (L.) Rose subsp. **lata** (Shinners) O'Kennon, Diggs, and Lipscomb, WIDE-LEAF FALSE ALOE. (RARE 2001, 2002b: G5T2QS2)

Muhlenbergia frondosa (Poir.) Fernald, WIRE-STEM MUHLY, NIMBLE-WILL, SATIN GRASS. IFET.

Muhlenbergia glabriflora Scribn., INLAND MUHLY, SMOOTH MUHLY. IFET.

Muhlenbergia sylvatica Torr. ex A. Gray, FOREST MUHLY, WOODLAND MUHLY. IFET.

Orontium aquaticum L., GOLDEN-CLUB. IFET.

Panicum flexile (Gatt.) Scribn, WIRY WITCH GRASS. IFET.

Paspalum boscianum Flüggé, BULL PASPALUM. IFET.

Paspalum conjugatum P.J. Bergius, SOUR PASPALUM, SOUR CROWN GRASS. IFET.

Platanthera blephariglottis (Willd.) Lindl., LARGE WHITE FRINGED ORCHID, WHITE FRINGED ORCHID, WHITE FINGER ORCHID, PLUME OF NAVARRE. IFET.

Platanthera chapmanii (Small) Luer, CHAPMAN'S FINGER ORCHID, CHAPMAN'S ORCHID, CHAPMAN'S FRINGED ORCHID. Because of its decreased abundance (Liggio & Liggio 1999; J. Liggio, pers. comm.) and limited occurrence we consider the species to be of conservation concern in Texas. IFET.

Platanthera integra A. Gray ex L.C. Beck, YELLOW FRINGELESS ORCHID, SMALL SOUTHERN YELLOW ORCHIS, GOLDEN FROG-ARROW, FROG-ARROW, GOLDEN FRET-LIP, ORANGE REIN ORCHID. IFET.

Platanthera lacera (Michx.) G. Don, GREEN FRINGED ORCHID, RAGGED FRINGED ORCHID, RAGGED ORCHID. IFET.

Ponthieva racemosa (Walter) C. Mohr, SHADOW-WITCH, HAIRY SHADOW-WITCH, PONTHIEU'S ORCHID, GLANDULAR NEOTTIA. IFET.

Potamogeton pusillus L. subsp. **tenuissimus** (Mert. & W.D.J. Koch) R.R. Haynes & Hellq. IFET.

Rhynchospora debilis Gale, SAVANNAH BEAK SEDGE. IFET.

Rhynchospora globularis (Chapm.) Small var. **pinetorum** (Britton & Small ex Small) Gale. IFET.

Rhynchospora indianolensis Small, INDIANOLA BEAK SEDGE, INDIANOLA BEAK-RUSH. (RARE 2001, 2002b: G3S3)

Rhynchospora macra (C.B. Clarke ex Britton) Small, LARGE BEAK SEDGE, LARGE BEAK-RUSH. (RARE 2001, 2002b:G3S1)

Saccharum coarctatum (Fernald) R.D. Webster, BUNCHED PLUME GRASS. IFET.

Schoenolirion wrightii Sherman, TEXAS SUNNY-BELL. (RARE 2001 and RARE 2002b: G3S2)

Schoenoplectus etuberculatus (Steud.) Soják, CANBY'S CLUB-RUSH, CANBY'S BULRUSH. IFET.

Schoenoplectus hallii (A. Gray) S.G. Sm., HALL'S BULRUSH, HALL'S CLUB-RUSH. The only confirmed reports of this species from the state are from Wise Co. to the west of East Texas. However, it should be looked for in other parts of the state. Smith (2002c) indicated that *S. hallii* is of conservation concern. (G2S1—J. Poole, pers. comm.)

Scleria baldwinii (Torr.) Steud., BALDWIN'S NUT-RUSH. IFET.

Scleria ciliata Michx. var. **elliottii** (Chapm.) Fernald. IFET.

Scleria ciliata Michx. var. **glabra (**Chapm.) Fairey, BRITTON'S NUT-RUSH. IFET.

Scleria distans Sw., RIVER-SWAMP NUT-RUSH. IFET.

Scleria reticularis Michx., NETTED NUT-RUSH. IFET.

Spiranthes brevilabris Lindl., TEXAS LADIES'-TRESSES. According to Sheviak and Brown (2002), *S. brevilabris* "has dramatically declined, with only a single extant population known in 1998–2000." The species is thus obviously of conservation concern. IFET.

Spiranthes eatonii Ames ex P.M. Brown, EATON'S LADIES'-TRESSES. IFET.

Spiranthes floridana (Wherry) Cory, FLORIDA LADIES'-TRESSES. Sheviak and Brown (2002) reported that "This species has become very uncommon, with only a single extant population known in 1998–2000." However, J. Liggio (pers. comm.) is aware of populations in two units of the Big Thicket National Preserve. IFET.

Spiranthes longilabris Lindl., GIANT SPIRAL ORCHID, LONG-LIP LADIES'-TRESSES, GIANT SPIRAL LADIES'-TRESSES. IFET.

Spiranthes parksii Correll, NAVASOTA LADIES'-TRESSES, PARKS' LADIES'-TRESSES. MacRoberts et al. (1997) discussed the status of this **federally endangered** East Texas endemic. (TOES 1993: I; RARE 2002a: G3S3LEE)

Spiranthes sylvatica P.M. Brown, WOODLAND LADIES'-TRESSES. IFET.

Sporobolus neglectus Nash, PUFF-SHEATH DROPSEED, SMALL DROPSEED, POVERTY GRASS. IFET.

Sporobolus ozarkanus Fernald, OZARK DROPSEED, OZARK POVERTY GRASS. IFET.

Stenanthium densum (Desr.) Zomlefer & Judd, BLACK DEATH-CAMASS, CROW-POISON, BLACK-SNAKE-ROOT, PINE BARREN DEATH-CAMASS, COASTAL DEATH-CAMAS, OSCEOLA'S-PLUME. IFET.

Tradescantia buckleyi (I.M. Johnston) D.R. Hunt, BUCKLEY'S SPIDERWORT. (RARE 2001, 2002b: G3S3)

Tradescantia leiandra Torr., CANYON SPIDERWORT, SETCREASEA. (RARE 2001, 2002b: G3S2)

Triantha racemosa (Walter) Small, COASTAL FALSE ASPHODEL, STICKY TOFIELDIA. IFET.

Tridens buckleyanus (L.H. Dewey) Nash, BUCKLEY'S TRIDENS, BUCKLEY'S FLUFF GRASS. (RARE 2001, 2002b: G3G4S3S4)

Trillium ludovicianum Harb., LOUISIANA TRILLIUM. IFET.

Trillium pusillum Michx. var. **texanum** (Buckl.) Reveal & C.R. Broome, TEXAS TRILLIUM. (TOES 1993: V; RARE 2002a: G3T2T3S2S3SOC)

Trillium viridescens Nutt., LONG-PETALED TRILLIUM, OZARK GREEN TRILLIUM, OZARK TRILLIUM. This species is cited by Case (2002) as being of conservation concern.

Uvularia sessilifolia L., SESSILE-LEAF BELLWORT, SMALL BELLWORT, WILD-OATS, STRAW-LILY. IFET.

Willkommia texana Hitchc. var. **texana**, TEXAS WILLKOMMIA. (RARE 2001, 2002b: G3G4T3S3)

Wolffiella oblonga (Phil.) Hegelm., SABER BOG-MAT. IFET.

Xyris drummondii Malme, DRUMMOND'S YELLOW-EYED-GRASS. This species is cited by Kral (2000a) as being of conservation concern. (TOES 1993: V; RARE 2002a: G3S2SOC)

Xyris difformis Chapm. var. **curtissii** (Malme) Kral, BOG YELLOW-EYED-GRASS. IFET.

Xyris fimbriata Elliott, FIMBRIATE YELLOW-EYED GRASS, FRINGED YELLOW-EYED GRASS. This species is known from only four Texas counties and is disjunct from eastern Louisiana. IFET.

Xyris scabrifolia R.M. Harper, ROUGH YELLOW-EYED-GRASS, HARPER'S YELLOW-EYED-GRASS, ROUGH-LEAF YELLOW-EYED-GRASS. (TOES 1993: V; RARE 2002a: G3S2SOC)

Xyris smalliana Nash, SMALL'S YELLOW-EYED-GRASS. IFET.

Yucca cernua Keith, WEEPING YUCCA. While not officially designated as such (because of the recentness of its discovery), we consider this East Texas endemic species to be of conservation concern; it is currently known from only 7 populations (Keith 2003; E. Keith, pers. comm.). IFET.

Yucca necopina Shinners, GLEN ROSE YUCCA, BRAZOS RIVER YUCCA. (TOES 1993: V; RARE 2002a, 20002b: G1G2S1S2; however, a lower rank may be appropriate since the species is apparently more common than previously known—Carr 2001)

Zephyranthes refugiensis F.B. Jones, REFUGIO ZEPHYR-LILY, REFUGIO RAIN-LILY. Flagg et al. (2002b) indicated that this species is of conservation concern. (RARE 2001 and RARE 2002b: G2G3S2S3)

Zizania texana Hitchc., TEXAS WILD RICE. This **federally endangered** species is known only from the upper 4 km of the spring-fed San Marcos River in Hays Co. (TOES 1993; Horne & Kahn 1997; Terrell et al. 1997) (TOES 1993: I; RARE 2002a: G1S1LEE)

List of Conservation & Environmental Organizations in East Texas

Federal

Army Corps of Engineers (Environmental Division)
P.O. Box 17300
819 Taylor St.
Fort Worth, TX 76102-0300
817/978-2201
INTERNET: www.swf.usace.army.mil

Environmental Protection Agency (Region 6-EN-XP)
1445 Ross Ave.
Suite 1200
Dallas, TX 75202
214/665-6444
INTERNET MAIN SITE: www.epa.gov
INTERNET REGION 6 SITE: www.epa.gov/earth1r6/index.htm

EPA Ecosystems Protection Branch
EPA Region 6-WQ-E
214/665-7135
INTERNET: www.epa.gov/earth1r6/6wq/ecopro/

EPA Marine and Wetlands Section
Contact: Troy Hill, Acting Chief 214/665-6680
or Richard Prather, Wetlands Coordinator 214/665-8333
INTERNET: www.epa.gov/earth1r6/6wq/ecopro/em/names.htm

EPA Office of Planning and Coordination
Contact: Bonnie Braganza, Acting Chief
214/665-8150
INTERNET: www.epa.gov/earth1r6/6en/xp/enxp1.htm

EPA Watershed Management Section
Contact: Sharon Parrish, Chief 214/665-7145
E-MAIL: Parrish sharon@epa.gov

Fish and Wildlife Service; National Wildlife Refuge System
INTERNET: www.fws.gov/refuges/

Attwater Prairie Chicken NWR (Austin and Colorado cos.)
P.O. Box 519
Eagle Lake, TX 77434
979/234-3021; FAX: 979/234-3278
E-MAIL: FW2_RW_AttwaterPrairieChicken@fws.gov
INTERNET: www.fws.gov/southwest/refuges/texas/attwater/

Balcones Canyonlands NWR (Burnet, Travis, and Williamson cos.)
10711 Burnet Rd., Suite 201
Austin, TX 78758
512/339-9432
INTERNET: www.fws.gov/southwest/refuges/texas/balcones/index.htm

Hagerman NWR (Grayson County)
6465 Refuge Road
Sherman, Texas 75092-5817
903/786-2826
E-MAIL: fw2_rw_hagerman@fws.gov
INTERNET: www.fws.gov/southwest/refuges/texas/hagerman/index.html

Little Sandy NWR (Wood Co.)
c/o Little River NWR
P.O. Box 340
Broken Bow, OK 74728
580/584-6211; FAX: 580/584-2034

Trinity River NWR (Liberty Co.)
P.O. Box 10015
Liberty, TX 77575
409/336-9786
E-MAIL: fw2_rw_trinityriver@fws.gov
INTERNET: www.fws.gov/southwest/refuges/texas/trinityriver/

Forest Service/National Forests and Grasslands of Texas
415 S. First Street, Ste. 110
Lufkin, TX 75901
936/639-8501

Angelina National Forest (Angelina, Jasper, Nacogdoches, and San Augustine cos.)
Davy Crockett National Forest (Houston and Trinity cos.)
Sabine National Forest (Jasper, Newton, Sabine, San Augustine, and Shellby cos.)
Sam Houston National Forest (Montgomery, San Jacinto, and Walker cos.)

Caddo and Lyndon B. Johnson National Grasslands (Fannin and Wise cos.)
P.O. Box 507
1400 N. US 81/287
Decatur, TX 76234
940/627-5475
INTERNET: www.fs.fed.us/r8/texas/recreation/caddo_lbj/caddo-lbj_gen_info.shtml

or Caddo Work Center (Field Office)
U.S. Forest Service
Rt. 2
Honey Grove, TX 75446
903/378-2103

Fort Hood Center for Cooperative Ecological Research (Bell and Coryell cos.)
(Cooperative agreement between Department of Defense and The Nature Conservancy of Texas)
The Nature Conservancy of Texas
P.O. Box 1440
711 Navarro
San Antonio, TX 78295-1440
210/224-8774; FAX: 210/228-9805
E-MAIL: lmcbride@tnc.org
INTERNET: nature.org/wherewework/northamerica/states/texas/science/art6072.html

National Park Service

Big Thicket National Preserve
Headquarters
3785 Milan Street
Beaumont, TX 77701-4724
409/951-6700

Visitor Center
6102 FM 420
Kountze, TX 77625-7842
409/951-6725

State

Texas Agricultural Experiment Station
113 Jack K. Williams Administration Bldg.
College Station, TX 77843-2142
INTERNET: agresearch.tamu.edu/r&ECenters.htm

State-wide research centers in East Texas

Dallas Research and Extension Center
17360 Coit Road
Dallas, TX 75252
972/231-5362
INTERNET: dallas.tamu.edu/

Overton Research and Extension Center
1710 N. Hwy. 3053
Overton, TX 75684
903/834-6191
INTERNET: overton.tamu.edu/

Stephenville Research and Extension Center
1229 North US Hwy 281
Stephenville, TX 76401
254/968-4144
INTERNET: stephenville.tamu.edu

Texas Cooperative Extension (formerly the Texas Agricultural Extension Service): (county offices in each county)
INTERNET: county-tx.tamu.edu/

Texas Department of Parks and Wildlife
4200 Smith School Road
Austin, TX 78744
1-800/792-1112 - General Information Line
INTERNET MAIN SITE: www.tpwd.state.tx.us/
INTERNET LIST OF TEXAS STATE PARKS: www.tpwd.state.tx.us/park/parklist.htm

STATE PARKS IN EAST TEXAS:
Atlanta State Park (Cass Co.), 927 Park Rd. 32, Atlanta, TX 75551 903/796-6476
Bastrop State Park (Bastrop Co.), P.O. Box 518, Bastrop, TX 78602-0518 512/321-2101
Bonham State Park (Fannin Co), 1363 State Park 24, Bonham, TX 75418 903/583-5022
Caddo Lake State Park (Harrison Co.), 245 Park Rd 2, Karnack, TX 75661 903/679-3351
Cedar Hill State Park (Dallas Co.), 1570 FM 1382, Cedar Hill, TX 75104 972/291-3900

Cooper Lake State Park (Delta and Hopkins cos.), 1664 Farm Rd 1529 South, Cooper, TX 75432 903/395-3100
Daingerfield State Park (Morris Co.), 455 Park Rd 17, Daingerfield, TX 75638 903/645-2921
Eisenhower State Park (Grayson Co.), 50 Park Rd 20, Denison, TX 75020 903/465-1956,
E-MAIL: espc@texoma.net
Fairfield Lake State Park (Freestone Co.), 123 State Park Rd 64, Fairfield, TX 75840 903/389-4514
Fort Parker State Park (Limestone Co.), 194 Park Rd. 28, Mexia, TX 76667 254/562-5751,
E-MAIL: fortparker@glade.net
Huntsville State Park (Walker Co.), P.O. Box 508, Huntsville, TX 77342-0508 936/295-5644
Lake Bob Sandlin State Park (Titus Co.), 341 Park Rd. 2117, Pittsburg, TX 75686 903/572-5531
Lake Livingston State Park (Polk Co.), 300 Park Rd. 65, Livingston, TX 77351 936/365-2201
Lake Somerville State Park Complex (Lee and Burleson cos.), 6280 FM 180 Ledbetter, TX 78946-7036 979/289-2392
Lake Tawakoni State Park (Hunt Co.), 10822 FM 2475, Wills Point, TX 75169 903/560-7123
Lake Whitney State Park (Hill Co.), Box 1175, Whitney, TX 76692 254/694-3793
Martin Creek Lake State Park (Rusk Co.), 9515 County Rd. 2181D, Tatum, TX 75691 903/836-4336
Martin Dies, Jr. State Park (Jasper and Tyler cos.), RR 4, Box 274, Jasper, TX 75951 409/384-5231
Purtis Creek State Park (Henderson and Van Zandt cos.), 14225 FM 316, Eustace, TX 75124 903/425-2332
Ray Roberts Lake State Park (Cooke and Denton cos.), 100 PW 4137, Pilot Point, TX 76258-8944 940/686-2148
Rusk and Palestine State Parks (Cherokee and Anderson cos.), RR 4, Box 431, Rusk, TX 75785 903/683-5126
Texas State Railroad State Park (Anderson and Cherokee cos.), P.O. Box 39, Rusk, TX 75785 800/442-8951, 903/683-2561
Tyler State Park (Smith Co.), 789 Park Road 16, Tyler, TX 75706-9141 903/597-5338
Village Creek State Park (Hardin Co.), PO Box 8565, Lumberton, TX 77657 409/755-7322

WILDLIFE MANAGEMENT AREAS IN EAST TEXAS

Alabama Creek WMA (Trinity Co.) In Davy Crockett National Forest, Contact Shawn Willis, 1805 E. Lufkin, Lufkin, TX 75901, 936/639-1879
Alazan Bayou WMA (Nacogdoches Co.) Contact Joel Casto, 1805 E. Lufkin, Lufkin, TX 75901, 936/639-1879
Angelina-Neches/Dam "B" WMA (Jasper and Tyler cos.) Contact Gary Calkinds, 1342 S. Wheeler, Jasper, TX 75951, 409/384-6894
Bannister WMA (San Augustine Co.) Contact Bob Baker, 1342 S. Wheeler, Jasper, TX 75951, 409/384-6894
Caddo Grasslands WMA (Fannin Co.) Contact Jack Jernigan, 4998 CR 2131, Detroit, TX 75436, 903/674-3027
Caddo Lake WMA (Harrison and Marion cos.) Contact Jack Jernigan, 700 Senic Loop, Marshall, TX 75672, 903/927-2633
Cooper WMA (Delta and Hopkins cos.) Contact Aron Flanders, 829 CR 4795, Sulphur Springs, TX 75482-0402, 903/945-3132
Granger WMA (Williamson Co.) Contact Trey Carpenter, 3100 Granger Dam Rd., Granger, TX 76530, 512/859-2668
Moore Plantation WMA (Jasper and Sabine cos.) Contact Bob Baker, 1342 S. Wheeler, Jasper, TX 75951, 409/384-6894
North Toledo Bend WMA (Shelby Co.) Contact Joel Casto, 1805 E. Lufkin, Lufkin, TX 75901, 936/639-1879
Old Sabine Bottom WMA (Smith Co.) Contact Larry LeBeau, 21187 CR 4106, Lindale, TX 75771, 903/881-8233
Pat Mayse WMA (Lamar Co.) Contact Jack Jernigan, 4998 CR 2131, Detroit, TX 75436, 903/674-3027
Sam Houston National Forest WMA (Montgomery, San Jacinto and Walker cos.) Contact Chris Gregory, P.O. Box 868, Livingston, TX 77351, 936/327-8487
Tawakoni WMA (Hunt and Van Zandt cos.) Contact Larry LeBeau, 21187 CR 4106, Lindale, TX 75771, 903/881-8233
White Oak Creek WMA (Bowie, Cass, Morris, and Titus cos.) Contact John C. Jones, 33948 Hwy 77, Omaha, TX 75571, 903/884-3800

Texas Commission on Environmental Quality
P.O. Box 13087
Austin, TX 78711
512/239-1000
INTERNET: www.tceq.state.tx.us/index.html

EAST TEXAS TCEQ REGIONAL OFFICES

Region 5
TCEQ
2916 Teague Dr.
Tyler, TX 75701-3756
903/535-5100

Region 9
TCEQ
6801 Sanger Ave., Ste. 2500
Waco, TX 76710-7826
254/751-0335

Region 10
TCEQ
3870 Eastex Fwy.
Beaumont, TX 77703-1892
409/898-3838

Region 11
TCEQ
1921 Cedar Bend Dr., Ste. 150
Austin, TX 78758-5336
512/339-2929

Region 12
TCEQ
5425 Polk Ave., Ste. H
Houston, TX 77023-1486
713/767-3500

PUBLIC

Dallas County Park and Open Space Program
411 Elm Street, 3rd Floor
Dallas, TX 75202-3301
214/653-6653
INTERNET: www.dallascounty.org/html/citizen-serv/open-spaces/intro.html

(Additional preserves listed on the website above)

Cedar Ridge Preserve (Formerly the Dallas Nature Center)
7171 Mountain Creek Parkway
Dallas, TX 75249
972/293-5150
INTERNET: www.audubondallas.org/cedarridge.html

Harry S. Moss Park (City of Dallas)
7914 Greenville Ave.
Dallas, TX 75231

Parkhill Prairie Preserve
Collin County Parks and Open Space Program
825 N. McDonald St., Ste. 145
McKinney, TX 75069
972/424-1460 ext. 3744 (Metro)

River Legacy Living Science Center
703 N.W. Green Oaks Blvd.
Arlington, TX 76006
817/860-6752; FAX 817/860-1595
E-MAIL: parksdepartment@ci.arlington.tx.us
INTERNET: www.ci.arlington.tx.us/park/riverlegacy.html

PRIVATE

Audubon Texas
901 S. Mopac, Bldg. II, Ste. 410
Austin, TX 78746
512/306-0225
INTERNET: www.tx.audubon.org

Austin College: Center for Environmental Studies
900 North Grand Avenue
Sherman, TX 75090
903/817-2000 general number
903/817-2342 Science Area Secretary
General *INTERNET*: www.austincollege.edu
Biology Dept. *INTERNET*: www.austincollege.edu/Category.asp?669
Center for Environmental Studies *INTERNET*: www.austincollege.edu/Category.asp?1450

Big Thicket Association
P.O. Box 198
Saratoga, TX 77585
INTERNET: www.btatx.org

Botanical Research Institute of Texas
509 Pecan Street
Fort Worth, TX 76102-4060
817/332-4441; FAX 817/332-4112
E-MAIL: info@brit.org
INTERNET: www.brit.org

Caddo Lake Institute
Route 2 Box 24 B
Karnack, TX 75661
INTERNET: www.clidata/cliinfo.htm

Heard Natural Science Museum and Wildlife Sanctuary
One Nature Place
McKinney, TX 75069-8840
972/562-5566; FAX: (972) 548-9119
E-MAIL: info@heardmuseum.org
INTERNET: www.heardmuseum.org

Lady Bird Johnson Wildflower Center
(previously National Wildflower Research Center)
4801 La Crosse Ave.
Austin, TX 78739
512/292-4100
E-MAIL: wildflower@wildflower.org
INTERNET: www.wildflower.org/

Native Plant Society of Texas (NPSOT)
State Office
Coordinator: Dar Richardson
P.O. Box 3017
Fredericksburg, TX 78624
830/997-9272
E-MAIL: coordinator@npsot.org
INTERNET: www.npsot.org

(See www.npsot.org internet site for NPSOT chapters in East Texas)

Native Prairies Association of Texas
P.O. Box 210
Georgetown, TX 78627-0210
INTERNET: www.texasprairie.org

Natural Area Preservation Association
(a land trust; accepts land to preserve in perpetuity)
P.O. Box 162481
Austin, TX 78716-2481
512/804-1981
INTERNET: www.napa-texas.org/

The Nature Conservancy of Texas
State Office
P.O. Box 1440
San Antonio, Texas 78295-1440
210/224-8774
E-MAIL: lmcbride@tnc.org
INTERNET: nature.org/wherewework/northamerica/states/texas/

The Nature Conservancy of Texas
North Texas/Blackland Prairies Regional Office
Contact: James Eidson
E-MAIL: jeidson@tnc.org
Clymer Meadow Preserve
P.O. Box 26
Celeste, TX 75423
Phone/FAX: 903/568-4139

The Nature Conservancy of Texas
Roy E. Larsen Sandyland Sanctuary
P.O. Box 909
Silsbee, TX 77656-0909
409/385-0445; FAX: 409/385-4745

The Nature Conservancy of Texas
Nacogdoches Office
c/o USFS Experiment Station
506 Hayter Street, Room 111
Nacogdoches, TX 75961
963/559-1516; FAX 963/559-1518

Texas Committee on Natural Resources
3532 Bee Caves Rd., Ste. 110
Austin, TX 78746
512/441-1122
E-MAIL: tconr@texas.net
INTERNET: tconr.home.texas.net

Thompson Foundation
2801 Turtle Creek—2W
Dallas, TX 75219
214/522-6142

Books for the Study of Texas Native Plants

Modified from a list provided by the **Native Plant Society of Texas**
P.O. Box 3017, Fredericksburg, TX 78624
830/997-9272
E-mail: coordinator@npsot.org
many of the books listed can be purchased from the Native Plant Society of Texas

Sources of General Botanical Information

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Grasses, Range Plants

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Texas Botany, Landscaping, Miscellany

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A Suggested List of Ornamental Native Plants: Trees, Shrubs, Vines, Grasses, Wildflowers, and Ground Covers For East Texas

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There are three reasons that native plants of East Texas are used in the landscapes of the region.

1. Many native plants are popular simply because they offer significant ornamental value: eye-catching and colorful flowers, unique foliage, edible or interesting fruit, distinctive seeds, bark, plant form or some other character that is found attractive and appealing by the public.

2. Many native plants are selected to maintain cohesion with the "natural" landscape of the area. Native plants have proven adaptation to the climate and soils of East Texas and are recognized as easy to establish and durable. Many native plants are used for their ecological appeal with a recognized history as wildlife food (see appendix 19), use by migratory birds, or as an attractant to butterflies (see appendix 20).

3. Many native plants are selected by nurseries and landscapers because they embrace a philosophy favoring greater native plant use or they intend to satisfy the wishes of the consumer. The client with a strong penchant for natives often directs the ultimate mix of plant materials planted in a site.

There are other reasons often offered by garden writers and horticulturists to encourage greater use of native plants, some of which deserve elaboration.

1. Natives are more disease and insect resistant. This is not always true. Some native plants used in landscapes are quite easily attacked, disfigured, and even killed outright by indigenous pests. Dogwood, *Cornus florida*, is often recommended or requested in the East Texas region, yet it is often difficult to establish and susceptible to stress and disease-related short life problems. A midge often disfigures yaupon, *Ilex vomitoria* foliage. Tent caterpillars often wreak havoc on oaks, *Quercus* spp., and pecan, *Carya illinoinenisis*. There are many other examples. It's more prudent to educate by saying, "Many natives are insect and disease tolerant."

2. Natives are more drought resistant. This depends on the species and site selection. A native plant that normally finds its home in a swamp or stream-side spot may perform admirably in a drier site, but that's not always the case. It's probably better to say, "Many natives are drought resistant."

3. Natives are less invasive. This is not always true. There are many natives that seed out heavily and create landscape maintenance issues. In East Texas, seedlings of oaks, elm, sweetgum, redbuds and others often emerge and proliferate, making for a ubiquitous maintenance problem in the landscape. Some natives sucker and spread thicket-like into garden areas where they are not desired. It's probably better to say, "Many natives are not invasive in the landscape."

This list of suggested natives includes native plants commonly used in the landscapes of the region and also includes plants that are rarely available, offer landscape appeal, and should be considered for greater usage. The list also includes native plants from nearby regions of Texas that may not be present in the natural vegetation of the East Texas region. This list does not describe the many cultivars available, many of which may have been selected from regions of the South far distant from the East Texas region. This list is offered only as a starting point, and readers needing more detailed information are encouraged to consult horticultural websites in the area.

Suggested List of Ornamental Native Plants

Trees

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Acer barbatum Aceraceae	Florida maple	Sun, well-drained to moist soil	Deciduous woody perennial to 50'
Acer leucoderme Aceraceae	Chalk maple	Sun, well-drained soil	Deciduous woody perennial to 30'
Acer rubrum Aceraceae	Red maple	Sun, well-drained to moist soil	Deciduous woody perennial to 60'
Betula nigra Betulaceae	River birch	Sun, well-drained moist soil	Deciduous woody perennial to 60'
Carpinus caroliniana Betulaceae	Hornbeam	Part-shade, well-drained soil	Deciduous woody perennial to 60'
Carya illinoinensis Juglandaceae	Pecan	Sun, well-drained soil	Deciduous woody perennial to 60'
Cercis canadensis Fabaceae	Redbud	Sun, well-drained soil	Deciduous woody perennial to 20'
Chilopsis linearis Bignoniaceae	Desert -willow	Sun, well-drained soil	Deciduous woody perennial to 20'
Chionanthus virginicus Oleaceae	Fringe tree, Granny gray beard	Sun, well-drained soil	Deciduous woody perennial to 20'
Cornus florida Cornaceae	Flowering dogwood	Part-shade, well-drained soil, mulch	Deciduous woody perennial to 20'
Crataegus brachyacantha Rosaceae	Blueberry hawthorn	Sun to part-shade, well-drained soil	Deciduous woody perennial to 20'
Crataegus marshallii Rosaceae	Parsley hawthorn	Sun to part-shade, well-drained soil	Deciduous woody perennial to 20'
Crataegus viburnifolia Rosaceae	Viburnum hawthorn	Part-shade to sun, well-drained soil	Deciduous woody perennial to 20'
Eysenhardtia texana Fabaceae	Eisenhardtia	Sun, well-drained soil	Deciduous woody perennial to 20'
Fagus grandifolia Fabaceae	American beech	Part-shade, well-drained soil	Deciduous woody perennial to 20'
Forestiera acuminata Oleaceae	Swamp-privet	Sun, well-drained soil	Deciduous woody perennial to 20'
Gleditsia triacanthos Fabaceae	Common honey-locust	Sun, well-drained soil	Deciduous woody perennial to 20'
Halesia diptera Styracaceae	Silverbell	Part-shade, well-drained soil	Deciduous woody perennial to 20'
Hamamelis vernalis Hamamelidaceae	Witch-hazel cultivars	Part-shade, well-drained soil	Deciduous woody perennial to 12'
Ilex cassine Aquifoliaceae	Dahoon holly	Part-shade, well-drained soil	Evergreen woody perennial to 20'
Ilex decidua Aquifoliaceae	Deciduous holly, possumhaw	Sun, well-drained soil	Evergreen woody perennial to 20'
Ilex opaca Aquifoliaceae	American holly	Sun to part-shade, well-drained soil	Evergreen woody perennial to 30'
Juniperus virginiana Cupressaceae	Eastern red-cedar	Sun, well-drained soil	Evergreen woody perennial to 30'
Liriodendron tulipifera Magnoliaceae	Tulip tree	Sun, well-drained moist soil	Deciduous woody perennial to 100'

TREES (CONTINUED)

PLANT (CONTINUED)	CONCERNS	ORNAMENTAL FEATURES	NOTES
Acer barbatum	None	Fall color	Underutilized, specimen with good form and fall color
Acer leucoderme	None	Fall color	Specimen with good form and fall color
Acer rubrum	None	Fall color, form	Many cultivars with good form and fall color
Betula nigra	None	bark, form	Several improved cultivars
Carpinus caroliniana	Establishment	Bark, form	Underutilized, rarely available
Carya illinoinensis	Establishment	Form, nuts	Large shade tree, park specimen
Cercis canadensis	Short tree life	Flowers, form	Many cultivars, popular, short life in some locations
Chilopsis linearis	Short tree life, limb dieback	Flowers, form	Many cultivars, showy in bloom, needs excellent drainage
Chionanthus virginicus	None	Flowers, fall color	Underutilized, very drought resistant
Cornus florida	Establishment, short tree life	Flowers, form, fall color	Many cultivars, needs proper siting
Crataegus brachyacantha	Training in early years	Flowers, form, foliage	Rust and other foliar diseases may be a problem
Crataegus marshallii	Training in early years, webworms	Flowers, form, foliage	Rust and other foliar diseases may be a problem
Crataegus viburnifolia	Rarely available	Flowers, form	Rust and other foliar diseases may be a problem
Eysenhardtia texana	Rarely available	Flowers, foliage	Western species
Fagus grandifolia	Slow growth	Foliage, form	Patriarch of the forest
Forestiera acuminata	None	Foliage, form, flowers	Rarely encountered in landscapes
Gleditsia triacanthos	Thorns, short life	Foliage, form	Improved thornless cultivars
Halesia diptera	Establishment	Flowers, form	Outstanding woodland tree
Hamamelis vernalis	Establishment	Flowers, form	Winter flower interest
Ilex cassine	Establishment	Foliage, form, screen, berries	Some cultivars available
Ilex decidua	Suckering in early years	Berries, form	Many cultivars, easy-to-establish
Ilex opaca	Being replaced by hybrids	Evergreen, berries, form	Many cultivars, durable tree
Juniperus virginiana	None	Foliage, form, screen	Improved cultivars, durable, underutilized
Liriodendron tulipifera	Establishment, weedy seedlings	Form, flowers, foliage,	Improved cultivars, underutilized, park specimen

Trees (*continued*)

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Magnolia grandiflora Magnoliaceae	Southern magnolia	Sun, well-drained moist soil	Evergreen woody perennial to 50'
Magnolia macrophylla Magnoliaceae	Bigleaf magnolia	Part-shade, well-drained moist soil	Deciduous woody perennial to 20'
Magnolia virginiana Magnoliaceae	Sweetbay magnolia	Sun, well-drained moist soil	Deciduous woody perennial to 20'
Nyssa aquatica Nyssaceae	Tupelo	Sun, well-drained soil to moist	Deciduous woody perennial to 20'
Pinus echinata Pinaceae	Shortleaf pine	Sun, well-drained soils	Evergreen woody perennial to 80'
Pinus palustris Pinaceae	Longleaf pine	Sun, well-drained soil	Evergreen woody perennial to 30'
Poncirus trifoliata Rutaceae	Bitter orange, trifoliate-orange	Sun, well-drained soil	Evergreen woody perennial to 30'
Prunus mexicana Rosaceae	Wild plum, Mexican plum	Sun, well-drained soil	Deciduous woody perennial to 20'
Quercus michauxii Fagaceae	Swamp chestnut oak	Sun, well-drained soil	Deciduous woody perennial to 60'
Quercus texana Fagaceae	Nuttall oak, Texas red oak	Sun, wide range of soil types	Deciduous woody perennial to 60'
Quercus virginiana Fagaceae	Live Oak	Sun, well-drained soil	Evergreen woody perennial to 50'
Sophora affinis Fabaceae	Eve's-necklace	Sun, well-drained soil	Deciduous woody perennial to 20'
Taxodium distichum Cupressaceae	Bald cypress	Sun, wet to well-drained soils	Deciduous woody perennial to 100'

Shrubs

Callicarpa americana Verbenaceae	American beauty-berry	Sun to shade, well-drained soil	Deciduous woody perennial
Cliftonia monophylla Cyrillaceae	Buckewheat tree	Sun to part-shade, moist soil	Evergreen woody perennial to 10'
Cyrilla racemiflora Cyrillaceae	TiTi	Sun, moist soil	Evergreen woody perennial to 15'
Euonymus americanus Celastraceae	Hearts-a-burstin	Part-shade, well-drained soil	Deciduous woody perennial
Hypericum galioides Clusiaceae	St. John's-wort	Sun, well-drained soil	Deciduous woody perennial
Ilex verticillata Aquifoliaceae	Winterberry	Part-shade, moist soil	Deciduous woody perennial to 10'
Ilex vomitoria Aquifoliaceae	Yaupon *'Pride of Houston'*	Sun to shade, well-drained soil	Evergreen woody to 15'
Itea virginica Saxifragaceae	Sweet-spires	Sun to part-shade, moist soil	Deciduous woody perennial to 8'
Lindera benzoin Lauraceae	Spicebush	Sun, well-drained soil	Deciduous woody perennial to 12'
Myrica cerifera Myricaceae	Southern wax myrtle	Sun to part-shade, moist to well-drained soil	Evergreen woody perennial to 10'
Ptelea trifoliata Rutaceae	Hoptree	Sun to part-shade, well-drained soil	Deciduous woody perennial to 20'
Sabal minor Arecaceae	Dwarf palmetto	Sun to part-shade, moist soil	Evergreen perennial to 8'

Trees (continued)

PLANT (continued)	CONCERNS	ORNAMENTAL FEATURES	NOTES
Magnolia grandiflora	Establishment	Flowers, form, screen, foliage	Many cultivars, mulch when young
Magnolia macrophylla	leaf litter	Foliage, flowers, form	Underutilized, protect from wind, mulch
Magnolia virginiana	None	Flowers, form, screen, foliage	Underutilized
Nyssa aquatica	Establishment	Foliage, fall color, form	Underutilized
Pinus echinata	None	Foliage, form	Durable
Pinus palustris	Establishment	Foliage, form, specimen	Underutilized, durable, beetle resistant
Poncirus trifoliata	Thorns	Foliage, flowers, fruit, screen	Improved cultivars
Prunus mexicana	Short-lived	Flowers, form, specimen	Durable, easy to establish, edible fruit
Quercus michauxii	None	Fall color, form, foliage	Underutilized
Quercus texana	None	Specimen, form	Fast-growing, durable and popular
Quercus virginiana	None	Form, foliage	Durable, common
Sophora affinis	None	Flowers, seed pods, form, foliage	Underutilized, premier small tree for sun
Taxodium distichum	Knees	Fall color, form	Long-lived, durable, improved cultivars

Shrubs (continued)

Callicarpa americana	None	Rose-pink to violet or red-purple fruits	Drought tolerant
Cliftonia monophylla	Establishment	White or pink flower forms	Underutilized
Cyrilla racemiflora	Suckers	White flowers	Very showy in bloom, pruning challenge
Euonymus americanus	Suckers	Showy fruit in Fall	Becomes a thicket under good horticulture
Hypericum galioides	None	Yellow flowers, form	Showy border plant
Ilex verticillata	Establishment	Berries, form	Many cultivars
Ilex vomitoria	Leaf midge	Berries, foliage, form	A mainstay in the trade, many cultivars
Itea virginica	Suckers wildly	Flowers, foliage, fall in good spots	Durable, underutilized
Lindera benzoin	Establishment	Fragrant flowers, fall color, form	Underutilized
Myrica cerifera	None	Foliage, form	Good screen, durable
Ptelea trifoliata	None	Aromatic flowers, seed pods, foliage	Excellent for small gardens
Sabal minor	None	Foliage, form	Durable, long-lived, underutilized

Shrubs (continued)

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Salvia greggii Lamiaceae	Autumn or Gregg's sage	Sun, well-drained soil	Deciduous woody perennial to 4'
Styrax americanus Styracaceae	American snowbell	Sun to part-shade, well-drained soil	Deciduous woody perennial to 10'
Viburnum dentatum Caprifoliaceae	Arrow-wood viburnum	Sun to part-shade, well-drained soil	Deciduous woody perennial to 10'
Viburnum rufidulum Caprifoliaceae	Southern blackhaw, rusty blackhaw	Sun to part-shade, well-drained soil	Deciduous woody perennial to 20'

Vines

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Bignonia capreolata Bignoniaceae	Crossvine	Sun to part-shade, well-drained soil	Evergreen woody perennial
Campsis radicans Bignoniaceae	Common trumpet-creeper	Sun, well-drained soil	Evergreen woody perennial
Gelsemium sempervirens Loganiaceae	Carolina jessamine	Sun to part-shade, well-drained soil	Evergreen woody perennial
Lonicera sempervirens Caprifoliaceae	Coral honeysuckle	Sun, well-drained soil	Deciduous woody perennial
Wisteria frutescens Fabaceae	American wisteria	Sun, well-drained soil	Deciduous woody perennial

Grasses

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Chasmanthium latifolium Poaceae	Wild oats	Part-shade to sun, well-drained soil	Clumping grass, perennial
Muhlenbergia capillaris Poaceae	Hairy-awn muhly, Gulf muhly	Sun, well-drained soil	Clumping grass, perennial
Panicum virgatum Poaceae	Switch grass	Sun, well-drained to moist soil	Clumping grass, perennial
Schizachyrium scoparium Poaceae	Little bluestem	Sun, well-drained to moist soil	Clumping grass, perennial

Wildflowers

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Aquilegia chrysantha Ranunculaceae	Yellow columbine	Part-shade to shade, well-drained soil	Hardy Perennial
Arisaema triphyllum Araceae	Jack-in-the-pulpit	Shade, well-drained soil	Corm
Asclepias tuberosa Asclepiadaceae	Butterfly-weed	Sun, well-drained soil	Herbaceous perennial
Baptisia alba Fabaceae	White wild indigo	Sun, well-drained soil	Herbaceous perennial
Callirhoe papaver Malvaceae	Wine-cup	Sun, well-drained soil	Herbaceous perennial
Coreopsis lanceolata Asteraceae	Lance coreopsis	Sun, well-drained soil	Herbaceous perennial
Crinum americanum Amaryllidaceae	Swamp lily	Sun, well-drained soil	Bulb
Echinacea pallida Asteraceae	Pale echincacea Purple cone flower	Sun, well-drained soil	Hardy perennial

SHRUBS (*CONTINUED*)

PLANT (*CONTINUED*)	**CONCERNS**	**ORNAMENTAL FEATURES**	**NOTES**
Salvia greggii	None	Flowers, form	Showy, common, can be heavily pruned
Styrax americanus	None	Flowers, form	Showy, underutilized, good woodland plant
Viburnum dentatum	None	Foliage, flowers, form	Durable, screening, berries
Viburnum rufidulum	None	Foliage, fall color, form	Durable, underutilized, showy flowers

VINES (*CONTINUED*)

Bignonia capreolata	Not utilized enough, aggressive	Flowers, foliage	Highly recommended
Campsis radicans	Overly aggressive in the landscape	Flowers	Many cultivars
Gelsemium sempervirens	None	Flowers, foliage, form	Many cultivars
Lonicera sempervirens	Vigor	Flowers, foliage	Many cultivars, attracts hummingbirds
Wisteria frutescens	Suckers	Flowers, foliage	Underutilized

GRASSES (*CONTINUED*)

Chasmanthium latifolium	None	Form, seed	Underutilized
Muhlenbergia capillaris	None	Form, seed, pink fall color	Showy, durable
Panicum virgatum	None	Form, seed	Many cultivars
Schizachyrium scoparium	None	Form, seed	Many cultivars

WILDFLOWERS (*CONTINUED*)

Aquilegia chrysantha	Leaf Miner	Spurred yellow flowers	Flowers and seed pods used as cut flowers
Arisaema triphyllum	Corms possess a skin irritant	Large leaves consist of three leaflets. Pitcher-shaped flowers are striped and give way to clusters of red fruit	This spring ephemeral usually disappears by early summer
Asclepias tuberosa	Aphids	Large, flat heads of bright orange flowers	Larval host plant for monarch
Baptisia alba	None	Long spikes of white, pea-like flowers	Flowers and seed pods are good cut flowers
Callirhoe papaver	None	Low growing plant with glowing purple flowers	Use as a groundcover or in a rock garden
Coreopsis lanceolata	None	Large, bright yellow flowers	Nectar source for pollinators
Crinum americanum	None	Succulent foliage with fragrant white flowers	Prefers wet soils, excellent margin plant
Echinacea pallida	None	Thin lavender petals hang from bright orange "seed cones"	Exceptional butterfly nectar source

Wildflowers (continued)

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Erythrina herbacea Fabaceae	Coral-bean	Sun, well-drained soil	Herbaceous perennial
Eupatorium fistulosum Asteraceae	Joe-pye-weed	Sun, well-drained soil	Herbaceous perennial
Gaillardia aestivalis var. **winkleri** Asteraceae	Winkler's white firewheel	Sun, well-drained soil	Hardy perennial
Gaillardia pulchella Asteraceae	Indian-blanket	Sun, well-drained soil	Tender annual
Gaura lindheimeri Onagraceae	White gaura	Sun, well-drained soil	Hardy perennial
Glandularia canadensis Verbenaceae	Rose vervain	Sun, well-drained soil	Hardy perennial
Glandularia tenuisecta Verbenaceae	Moss verbena	Sun, well-drained soil	Herbaceous perennial
Helianthus angustifolius Asteraceae	Swamp-sunflower	Sun, well-drained to moist soil	Rhizome
Helianthus maximiliani Asteraceae	Maximilian sunflower	Sun, well-drained soil	Rhizome
Helianthus mollis Asteraceae	Ashy sunflower	Sun, well-drained to moist soil	Rhizome
Hibiscus coccineus Malvaceae	Texas star hibiscus, scarlet hibiscus	Sun, well-drained to moist soil	Herbaceous perennial
Hibiscus moscheutos Malvaceae	Common rose-mallow	Sun, well-drained soil	Herbaceous perennial
Hymenocallis liriosme Amaryllidaceae	Western spider-lily	Sun, well-drained to wet soil	Bulb
Iris ×fulva Iridaceae	Louisiana iris	Sun, well-drained soil, prefers wet soil	Hardy perennial
Liatris elegans Asteraceae	Pink-scale gayfeather	Sun, well-drained soil	Corm
Liatris pycnostachya Asteraceae	Kansas gayfeather	Sun, well-drained soil	Corm
Lilium michauxii Liliaceae	Carolina lily	Part-shade, well-drained soil	Bulb
Lobelia cardinalis Campanulaceae	Cardinal-flower	Sun to part-shade, moist soil	Hardy perennial
Lupinus texensis Fabaceae	Texas bluebonnet	Sun, well-drained soil	Biennial
Malvaviscus arboreus var. **drummondii** Malvaceae	Drummond's wax-mallow	Sun to part-shade, well-drained soil	Herbaceous perennial
Monarda fistulosa Lamiaceae	Wild bergamot	Sun, well-drained soil	Hardy perennial
Nelumbo lutea Nelumbonaceae	Yellow lotus	Sun, aquatic	Rhizome
Nymphaea odorata Nymphaeaceae	White water-lily	Sun, aquatic	Rhizome

WILDFLOWERS (*CONTINUED*)

PLANT (*CONTINUED*)	**CONCERNS**	**ORNAMENTAL FEATURES**	**NOTES**
Erythrina herbacea	All parts, especially seeds are poisonous	Spikes of brilliant red flowers	Attracts hummingbirds
Eupatorium fistulosum	None	Tall plants with large clusters of pink flowers	Attracts butterflies
Gaillardia aestivalis var. *winkleri*	Endangered	Yellow centers surrounded by white rays	Seeds produce plants with a variety of color combinations
Gaillardia pulchella	None	Red flowers tipped in yellow	Attracts butterflies
Gaura lindheimeri	Aphids	Airy stems with numerous white or pink flowers	Several cultivars available
Glandularia canadensis	None	Compact plants with magenta-purple flower	Attracts butterflies, very heat tolerant
Glandularia tenuisecta	Summer die out	Fern-like foliage, flowers clusters	Purple flowers, low-growing
Helianthus angustifolius	None	Smothered in bright yellow flowers in the fall	Tolerates wet soils, attracts butterflies
Helianthus maximiliani	Can spread aggressively	Bright yellow flowers on tall plants	Food source for birds, attracts butterflies
Helianthus mollis	None	Bright yellow flowers	Tolerates poor soils
Hibiscus coccineus	None	Large, vibrant red flowers	Can tolerate wet soils
Hibiscus moscheutos	None	Large white flowers with dark red centers	Widely used in perennial hibiscus breeding
Hymenocallis liriosme	None	Clusters of large white flowers	Can tolerate extremely wet soils
Iris ×*fulva*	None	Cultivars of nearly every color available	Will tolerate wet to average garden soils
Liatris elegans	None	Tall spikes of light purple to pink flowers	Attracts butterflies
Liatris pycnostachya	None	Tall spikes of purple flowers	Attracts butterflies, used in prairie restoration
Lilium michauxii	None	Flowers consist of recurved, spotted yellow petals tipped in orange	Seeds need cold stratification to germinate, rare in trade
Lobelia cardinalis	Spider mites	Spikes of vivid red flowers	Will naturalize in damp, shady areas
Lupinus texensis	None	Clusters of blue, pea-like flowers	Scarify seeds for better germination
Malvaviscus arboreus var. *drummondii*	None	Bright red flowers resembling a small turban	Outstanding hummingbird attractor
Monarda fistulosa	Powdery mildew; plants can be invasive	Whorled light purple flowers	Nectar source for bees and butterflies, good cut flower
Nelumbo lutea	Aggressive	Large yellow flowers with darker yellow centers	Seed pods are used in dried flower arrangements
Nymphaea odorata	Aggressive	Floating white flowers with prominent yellow centers	Requires still water from 2 to 6 feet in depth

WILDFLOWERS (*CONTINUED*)

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Penstemon digitalis Scrophulariaceae	Smooth penstemon	Sun to part-shade, well-drained soil	Hardy perennial
Penstemon tenuis Scrophulariaceae	Gulf Coast penstemon	Sun to part-shade, well-drained soil	Hardy perennial
Phlox drummondii Polemoniaceae	Drummond's phlox	Sun, well-drained soil	Half hardy annual
Phlox nivalis ssp. **texensis** Polemoniaceae	Texas trailing phlox	Sun, well-drained soil	Hardy perennial
Phlox pilosa Polemoniaceae	Downy phlox	Sun to part-shade, well-drained soil	Herbaceous perennial
Physostegia virginiana Lamiaceae	Obedient plant	Sun to part-shade, well-drained to moist soil	Hardy perennial
Polygonatum biflorum Convallariaceae	Great Solomon's seal	Shade, well-drained soil	Rhizome
Rudbeckia hirta Asteraceae	Black-eyed-susan	Sun, well-drained soil	Tender annual
Rudbeckia maxima Asteraceae	Giant coneflower	Sun, well-drained soil	Hardy perennial
Rudbeckia subtomentosa Asteraceae	Sweet coneflower	Sun, well-drained soil	Herbaceous perennial
Salvia azurea Lamiaceae	Blue sage, pitcher sage	Sun, well-drained soil	Hardy perennial
Salvia coccinea Lamiaceae	Tropical sage	Sun, well-drained soil	Tender perennial
Salvia farinacea Lamiaceae	Mealy sage	Sun, well-drained soil	Tender perennial
Salvia greggii Lamiaceae	Autumn sage	Sun, well-drained soil	Hardy perennial
Salvia lyrata Lamiaceae	Cancerweed, lyre-leaf sage	Sun to part-shade, well-drained soil	Herbaceous perennial
Sarracenia alata Sarraceniaceae	Pitcher plant	Sun, wet soil	Rhizome
Spigelia marilandica Loganiaceae	Indian-pink	Part-shade, moist well-drained soil	Herbaceous perennial
Thalia dealbata Marantaceae	Powdery thalia, powdered thalia	Sun, wet soil	Rhizome

GROUND COVERS

Symphoricarpos orbiculatus Caprifoliaceae	Indian-currant, Coral-berry	Part-shade, well-drained soil	Deciduous woody perennial to 3'

Wildflowers *(continued)*

PLANT *(continued)*	CONCERNS	ORNAMENTAL FEATURES	NOTES
Penstemon digitalis	None	Airy spikes of white flowers	The cultivar 'Husker Red' has attractive burgundy foliage
Penstemon tenuis	None	Airy spikes of light purple flowers	Good cut flower and nectar source
Phlox drummondii	None	Clusters of bright pink, red or white flowers	Attracts butterflies
Phlox nivalis ssp. *texensis*	Endangered	A carpet of bright pink flowers	Early spring color
Phlox pilosa	None	Large, flat heads of pinkish purple flowers	Flowers are lightly fragrant and attract butterflies
Physostegia virginiana	Can spread aggressively	Spikes of pink or white flowers on tall stems	Very good cut flower
Polygonatum biflorum	None	Pendant, greenish-white flowers appear in pairs at each leaf axil	Young shoots can be eaten raw or cooked
Rudbeckia hirta	None	Large yellow flowers with dark brown centers	Choose named cultivars for better garden performance
Rudbeckia maxima	None	Silvery foliage with tall spikes of yellow flowers	Will tolerate wet soils
Rudbeckia subtomentosa	None	Masses of yellow flowers on tall stems	Useful in prairie restoration
Salvia azurea	None	Tall spikes of sky blue flowers	Useful in prairie restoration
Salvia coccinea	None	Spikes of glowing red flowers	Attracts hummingbirds
Salvia farinacea	None	Dense spikes of dark blue flowers	Excellent cut flower, and nectar source
Salvia greggii	None	Flowers come in many shades of red, white, and pink	Many good cultivars and hybrids available
Salvia lyrata	None	Short spikes of light lavender flowers	Cultivar 'Purple Knockout' has attractive, dark purple foliage
Sarracenia alata	Rare, habitat threatened	Hooded tubular leaves with red veins	Needs boggy, acidic soils
Spigelia marilandica	Rare in the wild	Vivid red flowers with bright yellow throats	Stunning color for shady gardens
Thalia dealbata	None	Broad leaves with dark purple flowers on	Grown as a submersible plant in aquatic gardens

Ground Covers *(continued)*

Symphoricarpos orbiculatus	Suckering	Flowers, berries, form	Durable, easy to establish

A Suggested List of Ornamental Non-native Plants: Trees, Shrubs, Vines, Grasses, Wildflowers, and Ground Covers For East Texas

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East Texas, horticultural landscapes are dominated by non-native plants. These plants are often characterized as "exotic plants," and they are popular because of aesthetic appeal and durability in the landscape. Plants from China, Japan, and Korea comprise a large sector of the nursery industry's offerings in East Texas, particularly in the small tree, shrub, groundcover, herbaceous perennials, and annuals categories. Hardiness zones and climactic conditions in parts of Asia often closely imitate many locations in the Southern U.S. In addition, there are many previously untested exotic plant species under evaluation in the Southern U.S. that show great promise as potential landscape plants.

There are many popular non-invasive exotic plants in the trade that have aesthetic appeal, consumer recognition, and a history of proven performance. For example, crape-myrtles, *Lagerstroemia indica* and hybrids of *L. indica* × *L. faurei*, are popular because of bright, colorful bloom, superior form, interesting bark, ease of landscape establishment, and a reputation for tolerating challenging landscape conditions. In addition, with crape-myrtle and other exotic species, breeders and nurserymen have developed a wide palette of cultivars that offer a variety of flower color and form.

The popularity and use of exotic ornamental plants (particularly those new to the industry) is often driven by nurserymen, landscapers, and gardening experts who promote the plants. In Texas, the land grant university, Texas A&M University, evaluates and promotes new or underutilized species and varieties for more state wide use through a Texas SuperStar™ program.

For many years, there has been controversy associated with exotics that invade the natural environment. Whether by seed, suckers, or other propagules, some exotic plants move in the landscape from where they are desired to places where they aren't. In some states, legislation has been enacted to prevent commerce in invasive species. This list does not include plants with known invasive characteristics, even though they may be readily available in Texas (i.e., *Pistacia chinensis, Ligustrum japonicum, Lonicera japonica*).

Suggested List of Non-native Ornamental Plants

Trees

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Acer buergerianum Aceraceae	Trident maple	Sun, well-drained soil	Deciduous woody perennial to 30'
Acer ginnala Aceraceae	Amur maple	Sun, well-drained soil	Deciduous woody perennial to 30'
Acer palmatum Aceraceae	Japanese maple	Part shade, well-drained soil	Deciduous woody perennial to 15'
Castanea mollissima Fagaceae	Chinese chestnut	Sun, well-drained soil	Deciduous woody perennial to 20'
Cedrus atlantica Pinaceae	Atlas cedar	Sun, well-drained soil	Evergreen woody perennial to 30'
Cedrus deodara Pinaceae	Deodar cedar	Sun, well-drained soil	Evergreen woody perennial to 30'
Chionanthus retusus Oleaceae	Chinese fringetree	Sun, well-drained soil	Deciduous woody perennial to 15'
Cornus kousa var. **angustata** Cornaceae	Japan dogwood	Sun, well-drained soil	Evergreen woody perennial to 15'
Cunninghammia lanceolata Cupressaceae	China fir	Sun, well-drained soil	Evergreen woody perennial to 40'
Cupressus glabra Cupressaceae	Arizona cypress	Sun, well-drained soil	Evergreen woody perennial to 40'
Firmiana simplex Sterculiaceae	Chinese parasol-tree	Sun, well-drained soil	Deciduous woody perennial to 20'
Eisenhardtia texana Fabaceae	Eisenhardtia	Sun, well-drained soil	Deciduous woody perennial to 20'
Gordonia lasianthus Theaceae	Gordonia	Part shade, well-drained soil	Evergreen woody perennial to 20'
Hamamelis × intermedia Hamamelidaceae	Witchhazel cultivars	Part shade, well-drained soil	Deciduous woody perennial 10'–15'
Hibiscus syriacus Malvaceae	Rose-of-Sharon	Sun, well-drained soil	Deciduous woody perennial to 15'
Ilex latifolia Aquifoliaceae	Lusterleaf holly	Sun, well-drained soil	Evergreen woody perennial to 20'
Ilex × Aquifoliaceae	Numerous hybrids	Sun, well-drained soil	Evergreen woody perennial, height varies by variety
Juglans microcarpa Juglandaceae	Texas walnut	Sun, well-drained soil	Deciduous woody perennial to 20'
Juniperus chinensis Cupressaceae	Chinese juniper	Sun, well-drained soil	Evergreen woody perennial to 20'
Koelreuteria bipinnata Sapindaceae	Goldenrain-tree	Sun, well-drained soil	Deciduous woody perennial to 20'
Lagerstroemia indica Lythraceae	Common crape-myrtle	Sun, well-drained soil	Deciduous woody perennial to 20'
Magnolia × Magnoliaceae	Magnolias, numerous varieties	Sun to part shade, well-drained soil	Deciduous woody perennial, height varies by variety
Malus 'Flame' Rosaceae	Flowering crabapple	Sun, well-drained soil	Deciduous woody perennial to 20'

TREES (CONTINUED)

PLANT (CONTINUED)	CONCERNS	ORNAMENTAL FEATURES	NOTES
Acer buergeranum	None	Form, foliage cultivars	Durable, popular, several cultivars
Acer ginnala	None	Fall color, form, foliage	Brilliant red foliage in late fall
Acer palmatum	Establishment	foliage, fall and/or spring color, form	Many cultivars, aristocrat of small trees
Castanea mollisima	Establishment, chestnut litter	Foliage, form, fruit	Underutilized, durable, showy chestnuts
Cedrus atlantica	Establishment, growth rate	Foliage, form, specimen	Many cultivars, attractive
Cedrus deodara	Establishment, spring frosts	Foliage, form, specimen	Many cultivars, underutilized
Chionanthus retusus	Needs pruning and training first four years	White flowers, foliage, fall color, seed	A great small flowering tree, underutilized, good for harsh sites
Cornus kousa	Establishment	White flowers, foliage, form	Underutilized, worth seeking
Cunninghammia lanceolata	Dead foliage, form in early years	Foliage, form, specimen	Durable, *C. unicanaliculata* has soft needles
Cupressus glabra	Short tree life, browning of foliage	Foliage, form, fast growth rate, screen	Many superior cultivars, short tree life remains a problem
Firmiana simplex	Litter, seedlings	Foliage, form, tropical look	Easy to establish, fast growing
Eisenhardtia texana	Rarely available	Flowers, foliage	Western species showy in bloom, attracts bees
Gordonia lasianthus	Underutilized, proper site	Flowers, foliage, form	Needs elevation slightly above a permanently moist run
Hamamelis × intermedia	Underutilized, establishment	Flowers, foliage, fall color, form	Many superior cultivars, great winter interest
Hibiscus syriacus	None	Flowers, foliage, form	Many superior cultivars, showy summer flowers
Ilex latifolia	Establishment	Foliage, form, durability	Underutilized, great specimen or screen
Ilex ×	Spiny foliage on some varieties	Berries, foliage, form	Numerous superior cultivars, specimen or screen
Juglans microcarpa	Not usually available	Form, bark, foliage, nuts	Underutilized, dramatic specimen when properly sited
Juniperus chinensis	Bagworms, short life	Foliage, form	Numerous cultivars and related species
Koelreuteria bipinnata	Seedlings	Yellow flowers, salmon fruit, foliage, form	Durable, showy in bloom or fruit
Lagerstroemia indica	Powdery mildew	Flowers, form, bark	Durable, highly popular with many cultivars
Magnolia ×	Establishment	Flowers, foliage, form	Outstanding varieties of varied breeding lines in trade
Malus 'Flame'	Foliage diseases, short life problems	Flowers, form, bark	Many cultivars, durable

TREES (CONTINUED)

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Parrotia persica Hamamelidaceae	Persian witch hazel	Sun, well-drained soil	Deciduous woody perennial to 20'
Pistacia texana Anacardiaceae	Texas pistache	Sun, well-drained soil	Deciduous woody perennial to 15'
Prunus campanulata Rosaceae	Taiwan cherry	Sun, well-drained soil	Deciduous woody perennial to 20'
Prunus mume Rosaceae	Japanese apricot	Sun, well-drained soil	Deciduous woody perennial to 20'
Quercus acutissima Fagaceae	Sawtooth oak	Sun, well-drained soil	Deciduous woody perennial to 60'
Quercus canbyi Fagaceae	Canbyi oak	Sun, well-drained soil	Deciduous woody perennial to 40'
Quercus glauca Fagaceae	Japanese evergreen oak	Sun, well-drained soil	Evergreen woody perennial to 30'
Quercus polymorpha Fagaceae	Polymorpha oak	Sun, well-drained soil	Deciduous woody perennial to 60'
Quercus rysophylla Fagaceae	Risophylla oak	Sun, well-drained soil	Deciduous woody perennial to 60'
Sinojackia rehderiana Styracaceae	Jack tree	Part shade, well-drained soil	Deciduous woody perennial to 20'
Sophora secundiflora Fabaceae	Mountain-laurel, Texas mountain laurel	Sun, well-drained soil	Evergreen woody perennial to 15'
Styrax japonica Styracaceae	Japanese snowbell	Part shade, well-drained soil	Deciduous woody perennial to 20'
Taxodium mucronatum Cuppressaceae	Mexican or Montezuma bald cypress	Sun, well-drained soil	Deciduous woody perennial to 80'
Taxus chinensis Taxaceae	Chinese yew	Part shade, well-drained soil	Evergreen woody perennial to 15'
Ulmus parvifolia Ulmaceae	Chinese elm, lace-bark elm	Sun, well-drained soil	Deciduous woody perennial to 80'
Ungnadia speciosa Sapindaceae	Mexican-buckeye	Sun, well-drained soil	Deciduous woody perennial to 20'
Vitex agnus-castus Verbenaceae	Common chastetree	Sun, well-drained soil	Deciduous woody perennial to 15'
Zelkova serrata Ulmaceae	Japanese zelkova	Sun, well-drained soil	Deciduous woody perennial to 40'

SHRUBS

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Abelia chinensis Caprifoliaceae	Chinese abelia	Sun, well-drained soil	Deciduous woody perennial to 8'
Abelia × grandiflora Caprifoliaceae	Glossy abelia	Sun, well-drained soil	Semi-evergreen woody perennial to 8'
Adina rubella Rubiaceae	Chinese buttonbush	Sun, moist soils	Deciduous woody perennial to 8'
Aucuba japonica Cornaceae	Aucuba	Shade, well-drained soil	Evergreen herbaceous perennial to 3'

Trees (*continued*)

PLANT (*continued*)	**CONCERNS**	**ORNAMENTAL FEATURES**	**NOTES**
Parrotia persica	Establishment, sun scald in early years	Form, foliage, bark, fall color, form	Underutilized durable tree, specimen
Pistacia texana	Establishment, availability	Form, bark, foliage, flowers	Underutilized western species, durable, showy
Prunus campanulata	short tree life	Flower, form, foliage	Many cultivars and related species offer good spring show
Prunus mume	None	Flower, form, foliage	Underutilized, many cultivars, hardy flowers
Quercus acutissima	None	Form, foliage, winter interest	Durable, fast-growing stately oak
Quercus canbyi	None	Form, foliage, winter interest	Underutilized Mexican semi-evergreen, durable
Quercus glauca	None	Blue foliage, small stature	Underutilized, durable
Quercus polymorpha	None	Form, foliage, winter interest	Underutilized Mexican semi-evergreen, durable
Quercus rysophylla	None	Form, foliage, winter interest	Underutilized Mexican semi-evergreen, durable
Sinojackia rehderiana	Difficult to shape in early years	Flowers, foliage, seed	Fast growing snowbell, showy, worthy of more use
Sophora secundiflora	None	Flowers, foliage, seed, form	Underutilized, needs sharp drainage and attention in establishment years
Styrax japonica	Chilling requirement issues in southeast Texas	Flowers, form	Many cultivars, underutilized
Taxodium mucronatum	Shape	Foliage, form	Underutilized, no knees, form remains a problem
Taxus chinensis	Rarely available slow growth rate	Foliage, form	Underutilized, performs well in deep shade to part shade
Ulmus parvifolia	None	Form, foliage, bark	Many cultivars, dwarf to full size, popular
Ungnadia speciosa	None	Flowers, form, foliage, fall color	Underutilized, good for dry gardens
Vitex agnus-castus	None	Flowers, form	Durable, gaining in popularity, showy cultivars in trade
Zelkova serrata	None	Form, foliage	Durable, street tree, specimen

Shrubs (*continued*)

Abelia chinensis	None	Flowers, form	Durable, larger flowers than *A.* ×*grandiflora* and fragrant
Abelia × *grandiflora*	None	Flowers, form	Durable, many cultivars, flowers, can be pruned back to ground to resupply vigor
Adina rubella	None	Flowers, form,	Non-suckering, semi-evergreen in some years
Aucuba japonica	Freeze damage	Foliage	Several cultivars, durable, needs protection from hard freeze events

SHRUBS (*CONTINUED*)

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Berberis thunbergii Berberidaceae	Japanese barberry	Sun, well-drained soil	Semi-evergreen woody perennial to 5'
Buxus sempervirens Buxaceae	Boxwood	Shade, well-drained soil	Evergreen woody perennial to 10'
Callistemon citrinus Myrtaceae	Bottlebrush	Sun, well-drained soil	Evergreen woody perennial to 10'
Calycanthus floridus Calycanthaceae	Sweet shrub	Part shade, well-drained soil	Deciduous woody perennial to 10'
Camellia japonica Theaceae	Camellia	Part shade, well-drained soil	Evergreen woody perennial to 15'
Camellia oleifera Theaceae	Camellia	Part shade, well-drained soil	Evergreen woody perennial to 15'
Camellia sasanqua Theaceae	Sasanqua camellia	Part shade, well-drained soil	Evergreen woody perennial to 15'
Cephalotaxus harringtonia Cephalotaxaceae	Japanese plum yew	Part shade, well-drained soil	Evergreen woody perennial to 15'
Cercis chinensis Fabaceae	Chinese redbud	Sun, well-drained soil	Deciduous woody perennial to 10'
Chaenomeles speciosa Rosaceae	Common flowering quince	Sun, well-drained soil	Deciduous woody perennial to 8'
Chamaecyparis pisifera Cupressaceae	Sawara cypress	Sun, well-drained soil	Evergreen woody perennial to 15'
Chamaecyparis thyoides Cupressaceae	Atlantic white cedar	Sun, well-drained to moist soil	Evergreen woody perennial to 15'
Chimonanthus praecox Calycanthaceae	Fragrant wintersweet	Sun, well-drained soil	Deciduous woody perennial to 8'
Clethra pringlei Clethraceae	Mexico pepperbush	Sun, well-drained soil	Evergreen woody perennial to 15'
Cleyera japonica Theaceae	Cleyera	Sun to part shade, well-drained soil	Evergreen woody perennial to 10'
Daphniphyllum macropodum Daphniphyllaceae	False daphne	Part shade, well-drained soil	Evergreen woody perennial to 15'
Deutzia scabra Hydrangeaceae	Deutzia	Sun, well-drained soil	Deciduous woody perennial to 10'
Distylium racemosum Hamamelidaceae	Distylum	Sun, well-drained soil	Evergreen woody perennial to 15'
Elaeagnus pungens Elaeagnaceae	Thorny elaeagnus	Sun, well-drained soil	Evergreen woody perennial to 15'
Eriobotrya japonica Rosaceae	Loquat	Sun, well-drained soil	Evergreen woody perennial to 20'
Euonymus japonicus Celastaceae	Japanese euonymus	Sun to part shade, well-drained soil	Evergreen woody perennial to 10'
Eurya emarginata Theaceae	Eurya	Sun to part shade, well-drained soil	Evergreen woody perennial to 5'
Fatsia japonica Araliaceae	Japanese fatsia	Part shade, well-drained soil	Evergreen woody perennial to 10'
Gardenia jasminoides Rubiaceae	Cape jasmine or gardenia	Part shade, well-drained soil	Evergreen woody perennial to 10'

SHRUBS (*CONTINUED*)

PLANT (*CONTINUED*)	**CONCERNS**	**ORNAMENTAL FEATURES**	**NOTES**
Berberis thunbergii	Establishment, thorns a minor aggravation	Foliage, form	Many cultivars, showy foliage
Buxus sempervirens	Short life, limb die-out	Foliage, form	Many cultivars, needs proper siting
Callistemon citrinus	Freeze damage	Flowers, foliage, form	Hardiness and nomenclature issues
Calycanthus floridus	None	Fragrant flowers, foliage, form	Underutilized, several cultivars
Camellia japonica	Scale, foliar insects	Flowers, foliage, form	Many cultivars, popular
Camellia oleifera	Scale, foliar insects	Flowers, foliage, form	A few cultivars, very hardy species
Camellia sasanqua	Scale, foliar insects	Flowers, foliage, form	Many cultivars, popular
Cephalotaxus harringtonia	Growth rate	Foliage, form	Underutilized, slow growth rate in early years a problem
Cercis chinensis	Short life	Flowers, form	Underutilized, very showy
Chaenomeles speciosa	Leaf drop, form	Flowers	Very durable, bloom is a harbinger of spring
Chamaecyparis pisifera	Foliage diseases	Foliage, form	Siting important
Chamaecyparis thyoides	Foliage diseases	Foliage, form	Siting important
Chimonanthus praecox	None	Flowers in winter, fragrance	Uncommon, winter fragrance can be strong
Clethra pringlei	Freeze damage	Flowers, foliage	Underutilized, hardiness issues remain undetermined
Cleyera japonica	None	Foliage, form	Many cultivars, durable
Daphniphyllum macropodum	Establishment	Foliage, form	Underutilized, dense foliage appears tropical
Deutzia scabra	None	Flowers	Many cultivars, showy bloom
Distylium racemosum	Freeze damage	Form, foliage	Underutilized, siting important
Elaeagnus pungens	Frequent pruning	Form, foliage	Common, dwarf forms in market show promise
Eriobotrya japonicus	Freeze damage	Foliage, form, fruit	Tropical look, fast growing, fruit in some years if plant is sheltered
Euonymus japonica	Scale, foliar insects	Foliage, form	Common, leaf insects and diseases in harsh sites
Eurya emarginata	Slow growth rate	Foliage, form	Underutilized shade plant
Fatsia japonica	Freeze damage	Foliage, form	Common, freeze damage in some years
Gardenia jasminoides	Scale, foliar insects	Flowers, foliage, form	Durable, several cultivars, popular, problems only on poor sites

SHRUBS (*CONTINUED*)

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Hydrangea macrophylla Hydrangeaceae	Bigleaf hydrangea	Part shade, well-drained soil	Deciduous woody perennial to 5'
Hydrangea paniculata Hydrangeaceae	Panicle hydrangea	Part shade, well-drained soil	Deciduous woody perennial to 10'
Hydrangea quercifolia Hydrangeaceae	Oak-leaf hydrangea	Part shade, well-drained soil	Deciduous woody perennial to 10'
Ilex cornuta Aquifoliaceae	Chinese holly	Sun, well-drained soil	Evergreen woody perennial to 8'
Ilex crenata Aquifoliaceae	Japanese holly	Sun to part shade, well-drained soil	Evergreen woody perennial to 8'
Ilex myrtifolia Aquifoliaceae	Myrtle holly	Sun to part shade, well-drained soil	Evergreen woody perennial to 8'
Illicium floridanum Illiaceae	Florida anise-tree	Part shade, well-drained soil	Evergreen woody perennial to 15''
Illicium henryi Illiciaceae	Henry anise-tree	Part shade, well-drained soil	Evergreen woody perennial to 15''
Jasminum humile Oleaceae	Italian yellow jasmine	Sun, well-drained soil	Evergreen woody perennial to 15''
Kerria japonica Rosaceae	Kerria	Sun, well-drained soil	Deciduous woody perennial to 5'
Leucophyllum frutescens Scrophulariaceae	Texas purple sage, cenizo	Sun, very well-drained soil	Deciduous woody perennial to 5'
Leucothoe populifolia Ericaceae	Florida leucothoe	Part shade, well-drained soil	Evergreen woody perennial to 10'
Lindera aggregata Lauraceae	Lindera	Sun to part shade, well-drained soil	Evergreen woody perennial to 10'
Lindera glauca Lauraceae	Japanese spicebush	Part shade, well-drained soil	Deciduous woody perennial to 10'
Lonicera fragrantissima Caprifoliaceae	Sweet-breath-of-spring	Sun to part shade, well-drained soil	Deciduous woody perennial to 10'
Loropetalum chinense Hamamelidaceae	Chinese witch hazel	Sun to part shade, well-drained soil	Evergreen woody perennial to 15' or more
Mahonia bealei Berberidaceae	Leatherleaf mahonia	Part shade, well-drained soil	Evergreen woody perennial to 8'
Mahonia fortunei Berberidaceae	Fortune's mahonia	Part shade, well-drained soil	Evergreen woody perennial to 5'
Mahonia gracilis Berberidaceae	Graceful mahonia	Part shade, well-drained soil	Evergreen woody perennial to 5'
Mahonia trifoliolata Berberidaceae	Agarita	Sun, well-drained soil	Evergreen woody perennial to 10'
Michelia figo Magnoliaceae	Banana shrub	Part shade, well-drained soil	Evergreen woody perennial to 10'
Nandina domestica Berberidaceae	Sacred-bamboo	Part shade, well-drained soil	Evergreen woody perennial to 5'
Osmanthus fragrans 'aurantica' Oleaceae	Fragrant tea olive	Part shade, well-drained soil	Evergreen woody perennial to 15'

SHRUBS (*CONTINUED*)

PLANT (*CONTINUED*)	**CONCERNS**	**ORNAMENTAL FEATURES**	**NOTES**
Hydrangea macrophylla	None	Flowers, foliage	Durable, showy, many cultivars, best performance when well-watered in summer
Hydrangea paniculata	None	Flowers, foliage	Durable, showy, many cultivars
Hydrangea quercifolia	Establishment	Flowers, foliage, fall color	Many cultivars, vigorous in the right spot, showy bloom
Ilex cornuta	None	Foliage, form, berries	Few cultivars, durable, good screen
Ilex crenata	Establishment, short life	Foliage, form, berries	Many cultivars, proper siting important
Ilex myrtifolia	None	Foliage, form, berries	Underutilized, several cultivars
Illicium floridanum	Establishment	Foliage, flowers, form	Underutilized, several cultivars, screen
Illicium henryi	Establishment	Foliage, flowers, form	Underutilized, screen, specimen
Jasminum humile	None	Flowers, foliage	Yellow flowers showy, good screen plant
Kerria japonica	None	Flowers	Flowers the main attribute
Leucophyllum frutescens	Establishment and attention to siting	Foliage, flowers, form	Uncommon in our region, proper siting important durable in the right spot
Leucothoe populifolia	None	Foliage, flowers, form	Underutilized, good choice for a screen, can be renewed by strong cutting back
Lindera aggregata	None	Foliage, form	Underutilized, appealing foliage is unique, good form
Lindera glauca	None	Foliage, fall color	Underutilized, fall color is striking
Lonicera fragrantissima	None	Flowers in winter, fragrance	Winter flowers are very fragrant, durable
Loropetalum chinense	Size can be greater than expected	Flowers, foliage, form	Many cultivars, pink flowers and burgundy foliage, dwarf forms
Mahonia bealei	Form	Foliage, flowers, form	Durable, architectural effect, winter flowers
Mahonia fortunei	Freeze damage	Foliage, flowers, form	Durable, flowers are stiking, frost damage in some years, can be cut back
Mahonia gracilis	Growth rate	Foliage, flowers, form	Underutilized, glossy leaves and graceful form, yellow flowers
Mahonia trifoliolata	None	Foliage, flowers, form, fruit	Underutilized, thorny, yellow flowers, durable
Michelia figo	None	Flowers, foliage, form	Common, fragrant flowers and glossy foliage, durable once established
Nandina domestica	None, invasive in north Florida	Foliage, form, berries	Common, durable, some indications of invasiveness
Osmanthus fragrans 'aurantica'	None	Flowers, foliage, form	Underutilized, durable, several cultivars, revered in China

SHRUBS (*CONTINUED*)

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Osmanthus heterophyllus Oleaceae	False holly	Part shade, well-drained soil	Evergreen woody perennial to 10'
Philadelphus × virginalis Saxifragaceae	Mock orange	Sun, well-drained soil	Deciduous woody perennial to 10'
Pittosporum tobira Pittosporaceae	Green pittosportum	Sun, well-drained soil	Evergreen woody perennial to 10'
Platycladus orientalis Cupressaceae	Oriental arborvitae	Sun, well-drained soil	Evergreen woody perennial to 15'
Podocarpus macrophyllus Podocarpaceae	Shrubby podocarpus	Part shade, well-drained soil	Evergreen woody perennial to 15'
Punica granatum Punicaceae	Pomegranate	Sun, well-drained soil	Deciduous woody perennial to 10'
Pyracantha coccinea Rosaceae	Fire thorn	Sun, well-drained soil	Deciduous woody perennial to 12'
Rhaphiolepis indica Rosaceae	Indian hawthorne	Sun, well-drained soil	Evergreen woody perennial to 10'
Rhaphiolepis umbellata Rosaceae	Yeddo rhaphiolepis	Sun, well-drained soil	Evergreen woody perennial to 15'
Rhododendron indicum Ericaceae	Indica azaleas	Part shade, well-drained soil	Evergreen woody perennial to 5'
Rhododendron Kurume hybrids Ericaceae	Kurume azaleas	Part shade, well-drained soil	Evergreen woody perennial to 5'
Rosa chinensis Rosaceae	China rose	Sun, well-drained soil	Deciduous woody perennial to 15'
Rosmarinus officinalis Lamiaceae	Rosemary	Sun, well-drained soil	Evergreen woody perennial to 4'
Sarcococca spp. Buxaceae	Sweetbox		Evergreen woody perennial to 10'
Scutellaria suffrutescens Lamiaceae	Mexican scutellaria	Sun, well-drained soil	Deciduous woody perennial
Serissa foetida Rubiaceae	Yellow-rim	Sun, well-drained soil	Evergreen woody perennial to 4'
Spiraea japonica Rosaceae	Japanese spiraea	Sun, well-drained soil	Deciduous woody perennial to 6'
Trachycarpus fortunei Arecaceae	Windmill palm	Sun, well-drained soil	Evergreen woody perennial to 12'
Viburnum macrocephalum Caprifoliaceae	Chinese snowball Viburnum	Sun, well-drained soil	Deciduous woody perennial to 15'
Viburnum obovatum Caprifoliaceae	Walter's viburnum	Sun, well-drained soil	Evergreen woody perennial to 10'
Viburnum propinquum Caprifoliaceae	Propinquum viburnum	Sun, well-drained soil	Evergreen woody perennial to 8'
Viburnum tinus Caprifoliaceae	Laurustinus	Sun, well-drained soil	Evergreen woody perennial to 10'

SHRUBS (*CONTINUED*)

PLANT (*CONTINUED*)	**CONCERNS**	**ORNAMENTAL FEATURES**	**NOTES**
Osmanthus heterophyllus	None	Flowers, foliage, form	Many cultivars, growth rate is slow
Philadelphus ×*virginalis*	None	Fragrant flowers	Underutilized, many cultivars, durable
Pittosporum tobira	Freeze damage	Foliage, form	Cultivar development for hardiness
Platycladus orientalis	Foliage diseases	Foliage, form	Durable, several cultivars, long-lived in the right site
Podocarpus macrophyllus	Freeze damage	Foliage, form	Common, damage from hard freezes remains a problem
Punica granatum	Freeze damage	Flowers, fruit	Common, good fruiting forms available, showy in bloom, form a problem
Pyracantha coccinea	Thorns, pruning needed in early years	Flowers, berries, form	Many cultivars, durable once established, showy in flower and berry
Rhaphiolepis indica	Foliage diseases	Flowers, foliage, form	Common, many improved cultivars
Rhaphiolepis umbellata	None	Flowers, foliage, form	Uncommon and problem-free, pruning in early years
Rhododendron indicum	Foliar insects	Flowers, foliage, form	Common, many cultivars, numerous other related hybrids
Rhododendron Kurume hybrids	Foliar insects	Flowers, foliage, form	Common, many cultivars, numerous other related hybrids
Rosa chinensis	Bacterial spot in some years, vigor	Flowers, foliage, form	Old Blush', 'Martha Gonzalez', 'Mutabilis' and many hybrid old roses are durable and dependable
Rosmarinus officinalis	Freeze damage, short life	Foliage, form, flowers	Common, needs very well-drained sunny spot for best performance, 'Arp' is a superior hardy form
Sarcococca spp.	None	Foliage, form	Underutilized, several varieties and related species, durable once established
Scutellaria suffrutescens	None	Flowers, form	Uncommon, durable, full sun position with very well-drained soil
Serissa foetida	None	Flowers, foliage, form	Underutilized, several cultivars, can be hedged
Spiraea japonica	None	Flowers, foliage	Common, showy white flowers a harbinger of spring
Trachycarpus fortunei	None	Foliage, form	Durable, hardy form, tropical effect
Viburnum macrocephalum	None	Flowers, foliage	Durable, very showy large blooms, needs pruning to shape
Viburnum obovatum	None	Foliage, flowers, form	Durable, popular, many cultivars
Viburnum propinquum	None	Flowers, foliage, form	Underutilized, durable, smaller stature
Viburnum tinus	Freeze damage	Flowers, foliage, form	Common, freeze damage in some years

SHRUBS (CONTINUED)

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Weigela florida Caprifoliaceae	Weigela	Sun, well-drained soil	Deciduous woody perennial to 10'
Zenobia pulverulenta Ericaceae	Dusty zenobia	Part shade, well-drained moist soil	Deciduous woody perennial to 8'

VINES

Kadsura japonica Schisandraceae	Kadsura vine	Part shade, well-drained soil	Evergreen woody perennial
Milletia reticulata Fabaceae	Scarlet wisteria	Full sun, well-drained soil	Evergreen woody perennial
Rosa banksiae Rosaceae	Banksia rose	Full sun, well-drained soil	Evergreen woody perennial
Stauntonia hexaphylla Lardizabalaceae	Sausage vine	Part shade, well-drained soil	Evergreen woody perennial
Wisteria floribunda Fabaceae	Japanese wisteria	Full sun, well-drained soil	Deciduous woody perennial

GRASSES

Arundo donax 'variegata' Poaceae	Giant reed	Sun, well-drained to moist soil	Clumping grass, perennial
Cortaderia selloana Poaceae	Pampas grass	Sun, well-drained soil	Clumping grass, perennial
Miscanthus sinensis Poaceae	Silver grass, Japanese maiden grass	Sun, well-drained soil	Clumping grass, perennial
Pennisetum alopecuroides Poaceae	Fountain grass	Sun, well-drained soil	Clumping grass, perennial
Pennisetum setaceum 'Rubrum' Poaceae	Purple fountain grass	Sun, well-drained soil	Clumping grass, tender annual

WILDFLOWERS

Agastache × Lamiaceae	Anise hyssop	Sun, well-drained soil	Herbaceous perennial
Ammi majus Apiaceae	Greater ammi, bishop's weed	Sun, well-drained soil	Biennial
Angelonia angustifolia Scrophulariaceae	Summer snapdragon	Sun, well-drained soil	Tender annual
Antirrhinum majus Scrophulariaceae	Snapdragon	Sun, well-drained soil	Hardy annual
Asclepias curassavica Asclepiadaceae	Tropical milkweed	Sun, well-drained soil	Tender perennial
Aster oblongifolius Asteraceae	Aromatic aster	Sun, well-drained soil	Herbaceous perennial
Aster pringlei 'Monte Casino' Asteraceae	Pringle's aster	Sun, well-drained soil	Herbaceous perennial
Begonia × semperflorens Begoniaceae	Wax begonia	Full sun to shade	Tender annual

SHRUBS (*CONTINUED*)

PLANT (*CONTINUED*)	CONCERNS	ORNAMENTAL FEATURES	NOTES
Weigela florida	None	Flowers	Uncommon, flowers the main attribute, unkempt growth
Zenobia pulverulenta	Establishment, siting	Flowers, foliage, form	Underutilized, unique blue foliage, showy blueberry like blooms

VINES (*CONTINUED*)

Kadsura japonica	Establishment	Foliage, flowers	Underutilized, green forms can tolerate full sun, several cultivars
Milletia reticulata	Freeze damage	Flowers, foliage	Uncommon, hardiness issues remain, fragrant bloom
Rosa banksiae	None	Flowers, foliage, form	Common, aggressive and requires pruning
Stauntonia hexaphylla	Establishment	Flowers, foliage	Uncommon, flowers and foliage are attributes
Wisteria floribunda	Aggressive and requires pruning	Flowers, form	Common, flowers are striking

GRASSES (*CONTINUED*)

Arundo donax 'variegata'	Invasiveness in some areas	Large grass, clumping	Common, durable, variegated form is not invasive
Cortaderia selloana	None	Large grass, clumping	Common, durable, dwarf forms available, screening
Miscanthus sinensis	Invasiveness in some areas	Interesting foliage with decorative flower plumes	Drought, insect, disease tolerant
Pennisetum alopecuroides	Invasiveness in some areas	Foliage and form	Durable, many cultivars,
Pennisetum setaceum 'Rubrum'	None	Dark purple foliage with burgundy flowers	Very useful as a bedding plant and container specimen, treat as annual

WILDFLOWERS (*CONTINUED*)

Agastache ×	None	Light blue flowers	Well-drained soils, excellent nectar source
Ammi majus	Skin irritant	Large, flat heads of white flowers	Used as a cut flower
Angelonia angustifolia	None	Spikes of purple, pink, white or bi-colored flowers	Extremely heat tolerant
Antirrhinum majus	Aphids, spider mites in warm weather	Spikes of large colorful flowers	Excellent cut flower
Asclepias curassavica	Oleander aphid, big milkweed bug	Flat heads of bright orange and yellow flowers	Host plant for monarch, can reseed aggressively in warm climates
Aster oblongifolius	None	Masses of purple to blue flowers in fall	Late season nectar source for pollinators
Aster pringlei 'Monte Casino'	None	A profusion of tiny white flowers in fall	Excellent filler in cut flower bouquets
Begonia × *semperflorens*	None	Glossy green leaves covered in red, pink, or white flowers	Often used as a summer bedding plant

WILDFLOWERS (CONTINUED)

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Belamcanda chinensis Iridaceae	Blackberry lily	Sun, well-drained soil	Hardy bulb
Beta vulgaris Chenopodiaceae	Beet, Swiss chard	Sun, well-drained soil	Hardy annual
Bletilla striata Orchidaceae	Chinese ground orchid	Shade, well-drained soil	Herbaceous perennial
Brassica oleracea Brassicaceae	Broccoli, brussel-sprouts ornamental cabbage and kale	Sun, well-drained soil	Hardy annual
Brugmansia candida Solanaceae	Angel's trumpet	Sun, well-drained soil	Tender perennial
Calendula officinalis Asteraceae	Calendula, pot marigold	Sun, well-drained soil	Hardy annual
Canna × generalis Cannaceae	Canna lily	Sun, well-drained soil	Rhizome
Catharanthus roseus Apocynaceae	Madagascar periwinkle	Sun, well-drained soil	Tender annual
Celosia argentea Amaranthaceae	Cockscomb	Sun, well-drained soil	Tender annual
Centaurea cyanus Asteraceae	Bachelor's-button, cornflower	Sun, well-drained soil	Hardy annual
Coleus × hybridus Lamiaceae	Sun coleus	Sun, well-drained soil	Tender annual
Colocasia esculenta 'Black Magic' Araceae	Purple elephant's-ear	Sun, well-drained soil	Tuber
Consolida ambigua Ranunculaceae	Larkspur	Sun, well-drained soil	Biennial
Coreopsis integrifolia Asteraceae	Chipola river daisy	Sun, well-drained soil	Herbaceous perennial
Cosmos bipinnatus Asteraceae	Cosmos	Sun, well-drained soil	Tender annual
Costus speciosus Costaceae	Spiral ginger	Full sun to part shade	Tender rhizome
Cuphea hyssopifolia Lythraceae	Mexican heather	Sun, well-drained soil	Tender perennial
Cuphea 'David Verity' Lythraceae	Cigar flower	Sun, well-drained soil	Herbaceous perennial
Curcuma elata Zingiberaceae	Giant plume ginger	Part sun	Tender bulb
Cynoglossum amabile Boraginaceae	Chinese forget-me-not	Sun, well-drained soil	Hardy Annual
Datura metel Solanaceae	Horn-of-plenty, double purple datura	Sun, well-drained soil	Tender annual

WILDFLOWERS (*CONTINUED*)

PLANT (*CONTINUED*)	CONCERNS	ORNAMENTAL FEATURES	NOTES
Belamcanda chinensis	Iris borer	Flowers fall in a wide color range from yellow to orange	Seed pods open to expose shiny black seeds and resemble blackberries
Beta vulgaris	Aphids, cabbage looper	Glossy green foliage with brightly colored ribs and veins	Edible, high in vitamins A, C, and iron
Bletilla striata	None	White or pink flowers	Long lasting cut flower
Brassica oleracea	Cabbage worms, cut worms, aphids	Colorful foliage, late fall and winter	Edible
Brugmansia candida	Tomato horn worm, plant is powerfully hallucinogenic	Huge, trumpet shaped flowers emit a sweet fragrance at night	Many garden worthy hybrids are available
Calendula officinalis	Aphids, aster yellows	Bright orange to yellow flowers	Edible, treats eczema
Canna × *generalis*	Canna leaf roller, Frangipani rust	Wide variety of colorful foliage and flowers	Tolerates wet soils
Catharanthus roseus	Phytopthora root rot	Heat tolerant flowers in shades of pink, red, and white	Don't plant in early spring when days are cool and moist
Celosia argentea	None	Brightly colored flowers in yellow, orange, pink, red and purple	Very long lasting cut flowers
Centaurea cyanus	None	Blue, white, pink, or maroon flowers	Good cut or dried flower
Coleus × *hybridus*	Mealy bug	Brightly colored foliage	Keep flowers pinched
Colocasia esculenta 'Black Magic'	Spider mites	Substantial, dark purple foliage	Does not spread aggressively like green variety
Consolida ambigua	None	Tall spikes of blue, white, or pink	Reseeds readily, excellent cut flower
Coreopsis integrifolia	None	Bright yellow flowers in late summer and fall	Thrives in low, moist areas
Cosmos bipinnatus	None	Medium sized flowers in bright pinks and white	Direct sow seeds in successive plantings to extend bloom time
Costus speciosus	None	White flowers protrude from bright red bracts	Plants bloom better and are more compact in full sun
Cuphea hyssopifolia	None	Numerous, tiny purple flowers persist through summer	Heat tolerant, exceptional summer bedding plant
Cuphea 'David Verity'	None	Many tiny orange flowers tipped in yellow	Nectar source for butterflies and hummingbirds, durable
Curcuma elata	Root rot in heavy soils	Unique, pink, pine-cone shaped flowers appear before foliage	Valuable cut flower
Cynoglossum amabile	None	Masses of small, electric blue flowers	Use in place of *Myostis* in the south
Datura metel	Toxic if ingested	Huge, double, purple trumpet shaped flowers	Good container plant

WILDFLOWERS (*CONTINUED*)

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Echinacea purpurea Asteraceae	Purple coneflower	Sun, well-drained soil	Herbaceous perennial
Farfugium japonicum Asteraceae	Leopard plant	Shade	Hardy Perennial
Gladiolus byzantinus Iridaceae	Byzantine gladiolus	Sun, well-drained soil	Corm
Gomphrena globosa Amaranthaceae	Common globe-amaranth	Sun, well-drained soil	Tender annual
Hamelia patens Rubiaceae	Firebush	Sun, well-drained soil	Tender perennial
Hedychium coccineum Zingiberaceae	Orange bottlebrush ginger	Full sun to light shade	Rhizome
Hedychium coronarium Zingiberaceae	Butterfly ginger	Full sun to part shade	Rhizome
Hibiscus 'Muy Grande' Malvaceae	Perennial hibiscus	Sun, well-drained soil	Herbaceous perennial
Hippeastrum bifidum Amaryllidaceae	Ox-blood lily, school-house lily	Sun, well-drained soil	Bulb
Hippeastrum × johnsonii Amarylidaceae	St. Joseph's lily	Sun, well-drained soil	Tender bulb
Ipomoea batatas Convolvulaceae	Sweet-potato	Sun, well-drained soil	Tender annual
Justicia spicigera Acanathaceae	Mexican honeysuckle	Full sun to light shade	Tender perennial
Kaempferia pulchra Zingiberaceae	Peacock ginger	Heavy shade	Tender perennial
Lantana × hybrida Verbenaceae	Lantana	Sun, well-drained soil	Herbaceous perennial
Leucanthemum vulgare Asteraceae	Ox-eye daisy	Sun, well-drained soil	Herbaceous perennial
Leucanthemum 'Country Girl' Asteraceae	Garden mum	Sun, well-drained soil	Herbaceous perennial
Leucojum aestivum Amaryllidaceae	Giant snowflake, summer snowflake	Full sun to shade	Hardy bulb
Lilium formosanum Liliaceae	Philippine lily	Sun to part shade, well-drained soil	Hardy bulb
Lilium lancifolium Liliaceae	Tiger lily	Sun, well-drained soil	Hardy bulb
Linaria maroccana Scrophulariaceae	Toadflax	Sun, well-drained soil	Hardy annual
Lycoris radiata Amaryllidaceae	Spider lily, Chinese sacred lily	Sun to part shade, well-drained soil	Hardy bulb
Malva sylvestris Malvaceae	High mallow	Sun, well-drained soil	Biennial
Matthiola incana Brassicaceae	Stock	Sun, well-drained soil	Annual
Monarda didyma Lamiaceae	Bee balm	Sun, well-drained soil	Herbaceous perennial

WILDFLOWERS (*CONTINUED*)

PLANT (*CONTINUED*)	CONCERNS	ORNAMENTAL FEATURES	NOTES
Echinacea purpurea	None	Light purple rays surround large orange cone	Deadhead to encourage repeat bloom
Farfugium japonicum	Poisonous if eaten	Bold, semi-evergreen foliage, yellow flowers in fall	Grown for foliage; good Hosta replacement in the South
Gladiolus byzantinus	Thrips	Fuschia flowers loosely arranged on a long raceme	Heirloom plant, excellent cut flower
Gomphrena globosa	None	Clover-like flowers in purple, pink or white	Excellent cut or dried flower
Hamelia patens	Can be frost tender	Clusters of orange tubular flowers	Nectar source for hummingbirds
Hedychium coccineum	Can stretch and flop in too much shade	Spikes of fragrant orange flowers	Prefers moist, rich soil
Hedychium coronarium	Can stretch and flop in too much shade	Spikes of fragrant white flowers	Prefers a moist, rich soil
Hibiscus 'Muy Grande'	Japanese Beetles	Massive, iridescent mauve flowers	Can tolerate wet soils, many other cultivars and related crosses
Hippeastrum bifidum	None	Brilliant red flowers in early fall	Heirloom plant
Hippeastrum × *johnsonii*	None	Large, red, trumpet shaped flowers	Hardiest amaryllis for outdoor planting
Ipomea batatas	Sweet potato weevil	Colorful, trailing foliage	Good groundcover, or container plant
Justicia spicigera	Can be frost tender	Clusters of bright orange tubular flowers	Do not over water
Kaempferia pulchra	Not hardy north of Zone 8, slugs	Patterned leaves, and lavender flowers	Plants break dormancy late, often in June
Lantana × *hybrida*	Immature fruits are poisonous	Multi-colored clusters of flowers	Butterfly nectar source
Leucanthemum vulgare	None	White, daisy-like flowers with yellow centers	Naturalizes easily
Leucanthemum 'Country Girl'	None	Pink flowers in fall	Excellent performing mum in the south
Leucojum aestivum	None	Fragrant, white bell-shaped flowers	Easily naturalized
Lilium formosanum	Can reseed prolifically	Long, white lilies	Can reach 8 feet
Lilium lancifolium	None	Orange flowers with numerous black spots	Bulbils produced in leaf axils can form new plants
Linaria maroccana	None	White, yellow, pink or purple flowers	Reseeds easily, good cut flower
Lycoris radiata	None	Bright red flowers in fall	Blooms appear before foliage
Malva sylvestris	Spider mites	Pink or purple flowers with dark veins	Seed easily collected for fall planting
Matthiola incana	Damping off in seedling stage	Spikes of densely packed flowers in various colors	Fragrant cut flower
Monarda didyma	Can spread vigorously, powdery mildew	Whorls of tubular flowers	'Jacob Cline' is a red, mildew resistant variety

Wildflowers (continued)

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Narcissus jonquilla Amaryllidaceae	Jonquil	Sun, well-drained soil	Hardy bulb
Narcissus × odorus Amaryllidaceae	Campernelle jonquil	Sun, well-drained soil	Hardy bulb
Nigella damascena Ranunculaceae	Love-in-a-mist	Sun, well-drained soil	Hardy annual
Orthosiphon stamineus Lamiaceae	Cat whiskers	Sun, well-drained soil	Tender annual
Oxalis regnellii 'Triangularis' Oxalidaceae	Purple wood sorrell	Full sun to part shade	Bulb
Pentas lanceolata Rubiaceae	Pentas	Sun, well-drained soil	Tender perennial
Phlox paniculata Polemoniaceae	Garden phlox	Sun, well-drained soil	Herbaceous perennial
Ricinus communis Euphorbiaceae	Castor-bean	Sun, well-drained soil	Tender annual
Rudbeckia fulgida Asteraceae	Perennial black-eyed susan	Sun, well-drained soil	Hardy Perennial
Ruellia brittoniana Acanthaceae	Mexican petunia	Sun, well-drained soil	Herbaceous perennial
Salvia greggii Lamiaceae	Autumn sage	Sun, well-drained soil	Hardy perennial
Salvia koyamae Lamiaceae	Japanese yellow sage	Part shade to shade, well-drained soil	Hardy perennial
Salvia leucantha Lamiaceae	Mexican bush sage	Sun, well-drained soil	Herbaceous perennial
Salvia microphylla Lamiaceae	Little leaf sage	Sun, well-drained soil	Herbaceous perennial
Salvia 'Indigo Spires' Lamiaceae	Indigo spires sage	Sun, well-drained soil	Herbaceous perennial
Stokesia laevis Asteraceae	Stoke's aster	Sun, well-drained soil	Herbaceous perennial
Strobilanthes dyerianus Acanthaceae	Persian shield	Part shade to shade, well-drained soil	Tender annual
Tagetes lucida Asteraceae	Mexican mint marigold	Sun, well-drained soil	Herbaceous perennial
Tecoma stans Bignoniaceae	Esperanza	Sun, well-drained soil	Tender perennial
Tricyrtis hirta Liliaceae	Toad lily	Shade, well-drained, moist soil	Hardy perennial
Tulbaghia violacea Liliaceae	Society garlic	Sun, well-drained soil	Rhizome
Verbena × hybrida Verbenaceae	Garden verbena	Sun, well-drained soil	Herbaceous perennial
Vetiveria zizanioides Poaceae	Vetiver	Sun, well-drained soil	Herbaceous perennial
Viola × wittrockiana Violaceae	Garden pansy	Sun, well-drained soil	Hardy annual
Zephranthes candida Amaryillidaceae	White rain lily	Sun to shade, well-drained soil	Bulb

WILDFLOWERS (CONTINUED)

PLANT (CONTINUED)	CONCERNS	ORNAMENTAL FEATURES	NOTES
Narcissus jonquilla	Bulbs toxic	Fragrant yellow flowers in early spring	Will naturalize and reseed if allowed
Narcissus × *odorus*	Bulbs toxic	Fragrant yellow flowers in early spring	Naturalized easily in the South
Nigella damascena	None	Unique blue or white flowers, lacy foliage	Flowers and seed pods used as cut flowers
Orthosiphon stamineus	Mealy bug	Spikes white or purple flowers with prominent stamens	Interesting cut flower, attracts butterflies
Oxalis regnellii 'Triangularis'	None	Dark purple shamrocks, lavender flowers	Flowers close at night
Pentas lanceolata	None	Clusters of star shaped flowers	Attracts butterflies
Phlox paniculata	Powdery mildew	Large panicles of fragrant flowers. Shades from white to pink	Choose mildew resistant varieties. 'Robert Poore,' 'John Fanick'
Ricinus communis	Seeds highly toxic if ingested	Stately plants with huge, palmately lobed leaves	Very drought tolerant
Rudbeckia fulgida	None	Yellow petals surround dark brown cones	Deadhead to increase bloom time
Ruellia brittoniana	Can reseed and become invasive	Purple flowers throughout the summer	Drought tolerant
Salvia greggii	None	Flowers can be white, yellow orange, pink, or red	Drought tolerant, attracts hummingbirds
Salvia koyamae	None	Short spikes of yellow flowers	Prized for color in the shade
Salvia leucantha	Not hardy north of Zone 7b	Long spikes of purple flowers in fall	Drought tolerant, attracts hummingbirds
Salvia microphylla	None	Vivid flowers in shades of orange, red, or dark pink	Attracts hummingbirds
Salvia 'Indigo Spires'	None	Extremely long spikes of blue flowers	Sterile flowers last a very long time
Stokesia laevis	None	Large aster-like flowers in spring	Attracts butterflies
Strobilanthes dyerianus	None	Iridescent purple foliage	Good summer color in the shade
Tagetes lucida	None	Bright yellow flowers in fall	Licorice scented foliage used as tarragon replacement
Tecoma stans	Aphids	Clusters of large, tubular, yellow flowers	Can be used as a small vine or arching shrub
Tricyrtis hirta	None	Small, orchid-like flowers in fall	Good cut flower
Tulbaghia violacea	None	Clusters of small, tubular purple flowers	Flowers and leaves edible, reported to deter moles
Verbena × *hybrida*	Summer die out	Flowers	Numerous varieties, common
Vetiveria zizanioides	None	Finely textured clumping grass	Roots used as fixatives in perfumes
Viola × *wittrockiana*	Stem rot	Very common cool season annual, with a wide variety of colors	Used extensively as bedding plant, flowers edible if grown organically
Zephyranthes candida	None	Cupped, white flowers appear after late summer rains	Easily divided and moved

Ground Covers

PLANT	COMMON NAME	HABITAT REQUIREMENTS	VEGETATIVE MORPHOLOGY; DURATION
Ardisia japonica Myrsinaceae	Ardisia	Shade, well-drained soil	Evergreen semi-woody perennial
Aspidistra elatior Convallariaceae	Cast iron plant	Shade, well-drained soil	Evergreen herbaceous perennial
Euonymus fortunei Celastraceae	Wintercreeper euonymus	Shade, well-drained soil	Evergreen woody perennial
Ficus pumila Moraceae	Creeping fig	Sun to part shade, well-drained soil	Woody evergreen perennial
Gardenia radicans Rubiaceae	Dwarf gardenia	Part shade, well-drained soil	Woody evergreen perennial
Hedera helix Araliaceae	English-ivy	Part shade, well-drained soil	Woody evergreen perennial
Juniperus conferta Cupressaceae	Shore juniper	Sun to part shade, well-drained soil	Woody evergreen perennial
Juniperus horizontalis Cupressaceae	Creeping juniper	Sun, well-drained soil	Woody evergreen perennial
Pachysandra terminalis Buxaceae	Japanese spurge	Shade, well-drained soil	Evergreen herbaceous perennial
Rohdea japonica Convallariaceae	Sacred-lily-of-the-valley	Shade, well-drained soil	Evergreen herbaceous perennial
Trachelospermum asiaticum Apocycaceae	Asian-jasmine	Sun to shade, well-drained soil	Woody evergreen perennial
Trachelospermum jasminoides Apocynaceae	Star-jasmine, Confederate jasmine	Sun to part shade, well-drained soil	Woody evergreen perennial
Tradescantia pallida Verbenaceae	Purple Heart	Sun to shade	perennial
Vitex rotundifolia Verbenaceae	Chaste vine	Sun, well-drained soil	Semi-evergreen woody perennial

Ground Covers (*continued*)

PLANT (*continued*)	**CONCERNS**	**ORNAMENTAL FEATURES**	**NOTES**
Ardisia japonica	None	Foliage	Durable, many cultivars, underutilized
Aspidistra elatior	None	Foliage	Durable, many cultivars, 'Asahi' a superior form, can be renewed by cutting to ground
Euonymus fortunei	None	Foliage, form	Many cultivars, proper siting important
Ficus pumila	Freeze damage, difficult to remove, mars surfaces	Foliage	Attractive and best when sheltered from hard freezes
Gardenia radicans	Scale, foliar insects	Flowers, foliage	Underutilized, good siting required, 'variegata' is a superior form
Hedera helix	Aggressive runner in part shade, mars surfaces	Foliage, form	Many cultivars, select less aggressive clones
Juniperus conferta	Foliage diseases	Foliage, form	Many cultivars, 'Silver Mist' a superior form
Juniperus horizontalis	Foliage diseases	Glossy foliage, flowers	Many cultivars, proper siting important
Pachysandra terminalis	Establishment, vigor	Foliage	'Green sheen' is a superior variety
Rohdea japonica	Establishment, slow growth rate	Foliage, fruit	Underutilized, good siting required, dramatic in the shade garden
Trachelospermum asiaticum	None	Foliage, form	Common, several varieties, durable, resistant to glyphosate
Trachelospermum jasminoides	None	Foliage, flowers, form	Common, several varieties
Tradescantia pallida	None	Purple folieage, pink flowers	Will not withstand foot traffic
Vitex rotundifolia	Can be aggressive	Foliage, flowers, form	Uncommon, aggressive nature must be taken into account

A Suggested List of Ornamental Native Plants: Trees, Shrubs, Vines, Grasses, Wildflowers[1]

for Dallas, Texas by Benny Simpson 1928–1996

Range: 50 Mile Radius

Note: Many of the plants listed are not cultivated for sale through retail outlets.
Please do not remove them from the wild.
[Nomenclatural changes have been made to match the treatments elsewhere in this volume.]

Trees/ Scientific Name	Common Name
Aesculus arguta	TEXAS BUCKEYE
Carya texana	BLACK HICKORY
Cercis canadensis var. *canadensis*	EASTERN REDBUD
Cercis canadensis var. *texensis*	TEXAS REDBUD
Cornus florida	FLOWERING DOGWOOD
Crataegus reverchonii	REVERCHON'S HAWTHORN
Diospyros virginiana	COMMON PERSIMMON
Forestiera acuminata	SWAMP-PRIVET
Fraxinus americana	WHITE ASH
Fraxinus pennsylvanica	GREEN ASH
Fraxinus texensis	TEXAS ASH
Ilex decidua	DECIDUOUS HOLLY
Juglans nigra	BLACK WALNUT
Maclura pomifera	BOIS D'ARC
Morus microphylla	TEXAS MULBERRY
Morus rubra	RED MULBERRY
Prosopis glandulosa	HONEY MESQUITE, MESQUITE
Prunus mexicana	MEXICAN PLUM
Prunus munsoniana	MUNSON'S PLUM
Ptelea trifoliata	WAFER-ASH
Quercus buckleyi	TEXAS RED OAK
Quercus fusiformis	ESCARPMENT LIVE OAK
Quercus macrocarpa	BUR OAK
Quercus muehlenbergii	CHINKAPIN OAK
Quercus nigra	WATER OAK
Quercus shumardii	SHUMARD'S RED OAK
Quercus sinuata var. *breviloba*	BIGELOW OAK, SCALY-BARK OAK
Rhamnus caroliniana	CAROLINA BUCKTHORN
Rhus copallina	SHINING SUMAC, WING-RIB SUMAC
Rhus lanceolata	PRAIRIE FLAMELEAF SUMAC
Salix exigua	SANDBAR WILLOW, COYOTE WILLOW
Sapindus saponaria var. *drummondii*	WESTERN SOAPBERRY
Sophora affinis	EVE'S-NECKLACE
Ulmus americana	AMERICAN ELM
Ulmus crassifolia	CEDAR ELM
Ulmus rubra	SLIPPERY ELM

[1]Reprinted from Diggs et al. (1999).

TREES/ (*CONTINUED*) SCIENTIFIC NAME	COMMON NAME
Zanthoxylum clava-herculis	HERCULES'-CLUB, TICKLETONGUE
Zanthoxylum hirsutum	TICKLETONGUE, PRICKLY-ASH

SHRUBS/

Aloysia gratissima	WHITEBRUSH, COMMON BEEBUSH
Amorpha fruticosa	WILD INDIGO 'DARK LANCE'
Baccharis neglecta	NEW DEAL WEED
Berberis trifoliolata	AGARITO
Callicarpa americana	AMERICAN BEAUTY-BERRY
Ceanothus americanus	NEW JERSEY-TEA
Ceanothus herbaceus	REDROOT
Cephalanthus occidentalis	COMMON BUTTONBUSH
Cornus drummondii	ROUGH-LEAF DOGWOOD
Dalea frutescens	BLACK DALEA
Euonymus atropurpurea	WAHOO
Forestiera pubescens	SPRING-HERALD
Lonicera albiflora	WHITE HONEYSUCKLE
Nolina lindheimeriana	DEVIL'S-SHOESTRING
Prunus angustifolia	CHICKASAW PLUM
Prunus gracilis	OKLAHOMA PLUM
Prunus rivularis	CREEK PLUM
Rhus aromatica	FRAGRANT SUMAC
Rhus glabra	SMOOTH SUMAC
Rosa foliolosa	WHITE PRAIRIE ROSE
Rosa setigera	CLIMBING PRAIRIE ROSE
Sabal minor	DWARF PALMETTO
Sambucus nigra var. *canadensis*	COMMON ELDERBERRY
Sideroxylon lanuginosum subsp. *oblongifolium*	CHITTAMWOOD
Symphoricarpos orbiculatus	CORAL-BERRY
Ungnadia speciosa	MEXICAN-BUCKEYE
Viburnum rufidulum	RUSTY BLACKHAW
Yucca arkansana	ARKANSAS YUCCA
Yucca constricta	BUCKLEY'S YUCCA
Yucca pallida	PALE YUCCA

VINES/

Ampelopsis cordata	HEART-LEAF AMPELOPSIS
Campsis radicans	TRUMPET-CREEPER
Cissus incisa	IVY-TREEBINE, COWITCH
Clematis crispa	CURLY CLEMATIS
Clematis pitcheri	LEATHER-FLOWER
Cocculus carolinus	SNAILSEED
Ibervillea lindheimeri	BALSAM GOURD, LINDHEIMER'S GLOBEBERRY
Lonicera sempervirens	CORAL HONEYSUCKLE
Parthenocissus quinquefolia	VIRGINIA-CREEPER
Passiflora incarnata	PASSION FLOWER
Vitis spp.	GRAPES

Grasses/ SCIENTIFIC NAME	COMMON NAME
Andropogon gerardii	BIG BLUESTEM
Andropogon glomeratus	BUSHY BLUESTEM
Andropogon ternarius	SPLIT-BEARD BLUESTEM
Andropogon virginicus	BROOMSEDGE BLUESTEM
Bothriochloa laguroides	SILVER BLUESTEM
Bouteloua curtipendula	SIDE-OATS GRAMA
Bouteloua gracilis	BLUE GRAMA
Bouteloua pectinata	TALL GRAMA (HAIRY)
Chasmanthium latifolium	BROADLEAF WOOD-OATS, INLAND SEA OATS
Elymus canadensis	CANADIAN WILD RYE
Elymus smithii	WESTERN WHEATGRASS
Elymus virginicus	VIRGINIA WILD RYE
Eragrostis trichodes	SAND LOVE GRASS
Eriochola sericea	TEXAS CUP GRASS
Koeleria macrantha	JUNE GRASS, PRAIRIE JUNE GRASS
Muhlenbergia reverchonii	SEEP MUHLY
Panicum virgatum	SWITCH GRASS
Paspalum floridanum	FLORIDA PASPALUM
Poa arachnifera	TEXAS BLUEGRASS
Schizachyrium scoparium	LITTLE BLUESTEM
Sorghastrum nutans	INDIAN GRASS
Spartina pectinata	PRAIRIE CORD GRASS
Sphenopholis obtusata	PRAIRIE WEDGESCALE
Tridens flavus	PURPLETOP
Tridens strictus	LONG-SPIKE TRIDENS
Tripsacum dactyloides	EASTERN GAMA GRASS

Wildflowers/

Acacia angustissima	FERN ACACIA
Allium drummondii	DRUMMOND'S ONION
Allium stellatum	PRAIRIE ONION
Alophia drummondii	PURPLE PLEAT-LEAF
Amsonia ciliata	NARROW-LEAF SLIMPOD, TEXAS SLIMPOD
Amsonia tabernaemontana	BLUESTAR, WILLOW SLIMPOD
Androstephium coeruleum	BLUE FUNNEL-LILY
Arnoglossum plantagineum	PRAIRIE-PLANTAIN
Aster spp.	ASTER
Baptisia australis	WILD BLUE-INDIGO
Baptisia sphaerocarpa	YELLOW BUSH PEA
Berlandiera betonicifolia	GREENEYES
Callirhoe spp.	WINECUPS
Calylophus spp.	HALF-SHRUB SUNDROPS, SUNDROPS
Camassia scilloides	WILD-HYACINTH
Castilleja purpurea (3 var.)	PURPLE PAINTBRUSH
Conoclinium coelestinum	MISTFLOWER
Dalea compacta var. *pubescens*	SHOWY PRAIRIE-CLOVER
Dalea multiflora	WHITE PRAIRIE-CLOVER
Datura wrightii	ANGEL-TRUMPET
Delphinium carolinianum var. *carolinianum*	WILD BLUE LARKSPUR
Delphinium carolinianum var. *virescens*	PRAIRIE LARKSPUR

WILDFLOWERS/(CONTINUED) SCIENTIFIC NAME	COMMON NAME
Dodecatheon meadia	COMMON SHOOTING-STAR
Echinacea spp.	CONEFLOWER, PURPLE CONEFLOWER
Engelmannia peristenia	CUT-LEAF DAISY, ENGELMANN'S DAISY
Erigeron philadelphicus	PHILADELPHIA FLEABANE DAISY
Erodium texanum	TEXAS STORK'S-BILL
Gaura spp.	GAURA, BUTTERFLY-WEED
Hedeoma reverchonii	ROCK HEDEOMA
Helianthus grosseserratus	SAW-TOOTH SUNFLOWER
Helianthus hirsutus	HAIRY SUNFLOWER
Helianthus maximiliani	MAXIMILIAN SUNFLOWER
Helianthus mollis	DOWNY SUNFLOWER
Helianthus pauciflorus	STIFF SUNFLOWER
Helianthus salicifolius	WILLOW-LEAF SUNFLOWER
Helianthus tuberosus	CHOKE SUNFLOWER, JERUSALEM-ARTICHOKE
Hibiscus laevis	HALBERD-LEAF HIBISCUS
Hypericum punctatum	SPOTTED ST. JOHN'S-WORT
Lesquerella engelmannii	ENGELMANN'S BLADDERPOD
Liatris elegans	BLAZING STAR, PINK-SCALE GAYFEATHER
Liatris mucronata	GAYFEATHER, NARROW-LEAF GAYFEATHER
Liatris squarrosa var. *glabrata*	GAYFEATHER, SMOOTH GAYFEATHER
Lippa spp. (PREVIOUSLY *Phyla*)	FROGFRUIT
Lithospermum caroliniense	CAROLINA PUCCOON
Lithospermum incisum	NARROW-LEAF PUCCOON
Lobelia cardinalis	CARDINAL FLOWER
Manfreda virginica	MANFREDA, RATTLE-SNAKE MASTER
Marshallia caespitosa	BARBARA'S-BUTTONS
Melampodium leucanthum	BLACK-FOOT DAISY
Mimosa nuttallii (PREVIOUSLY *Schrankia*)	NUTTALL'S SENSITIVE-BRIAR
Monarda fistulosa	WILD BERGAMOT
Nemastylis geminiflora	PRAIRIE CELESTIAL
Oenothera macrocarpa	MISSOURI EVENING-PRIMROSE
Oenothera speciosa	SHOWY-PRIMROSE
Paronychia virginica	WHITLOW-WORT
Penstemon cobaea	COBAEA PENSTEMON, WILD FOXGLOVE
Penstemon digitalis	SMOOTH BEARDTONGUE
Penstemon laxiflorus	BEARDTONGUE
Phlox pilosa	DOWNY PHLOX
Physostegia spp.	OBEDIENT-PLANT
Phytolacca americana	POKEWEED, POKE SALAT
Pontederia cordata	PICKEREL WEED
Ratibida columnifera	MEXICAN-HAT
Rivina humilis	ROUGEPLANT, PIGEON-BERRY
Rudbeckia maxima	GREAT CONEFLOWER
Salvia azurea	BLUE SAGE
Salvia engelmannii	ENGELMANN'S SAGE
Salvia farinacea	MEALY SAGE
Salvia texana	TEXAS SAGE
Scutellaria resinosa	RESIN-DOT SKULLCAP
Scutellaria wrightii	WRIGHT'S SKULLCAP
Senna marilandica	MARYLAND SENNA

WILDFLOWERS/(CONTINUED) SCIENTIFIC NAME	COMMON NAME
Silphium albiflorum	WHITE ROSINWEED
Silphium laciniatum	COMPASSPLANT
Silphium spp.	ROSINWEED
Solidago spp.	GOLDENROD
Stenosiphon linifolius	STENOSIPHON, FALSE GAURA
Tephrosia virginiana	GOAT'S-RUE
Tetraneuris scaposa	FOUR-NERVE DAISY
Teucrium canadense	GERMANDER
Thelesperma spp.	GREENTHREAD
Vernonia baldwinii	IRONWEED, BALDWIN'S IRONWEED
Vernonia lindheimeri	IRONWEED, WOOLLY IRONWEED

ORNAMENTAL NATIVE PLANTS

FOR DALLAS, TEXAS

RANGE: BEYOND 50 MILE RADIUS

TREES/ SCIENTIFIC NAME	COMMON NAME
Acacia greggii var. *wrightii*	WRIGHT'S ACACIA, CATCLAW
Acer barbatum	CADDO MAPLE
Acer grandidentatum	BIG-TOOTH MAPLE
Acer leucoderme	CHALK MAPLE
Aesculus pavia var. *flavescens*	PALE BUCKEYE, TEXAS YELLOW BUCKEYE
Aesculus pavia var. *pavia*	RED BUCKEYE
Arbutus xalapensis	TEXAS MADRONE
Cercis canadensis var. *mexicana*	MEXICAN REDBUD
Cercocarpus montanus var. *glaber*	SMOOTHLEAF MOUNTAIN MAHOGANY
Chilopsis linearis	DESERT-WILLOW
Crataegus tracyi	TRACY'S HAWTHORN
Diospyros texana	TEXAS PERSIMMON
Fraxinus cuspidata	FRAGRANT ASH
Ilex vomitoria	YAUPON, YAUPON HOLLY
Juglans microcarpa	LITTLE WALNUT, TEXAS WALNUT
Leucaena retusa	GOLDEN-BALL LEADTREE
Liquidambar styraciflua	SWEETGUM
Magnolia grandiflora	SOUTHERN MAGNOLIA
Pinus cembroides	PINYON, MEXICAN PINYON
Quercus laceyi	LACEY'S OAK
Quercus mohriana	MOHR'S OAK, MOHR'S SHIN OAK
Quercus pungens var. *pungens*	SANDPAPER OAK
Quercus pungens var. *vaseyana*	VASEY'S OAK, VASEY'S SHIN OAK
Taxodium distichum	BALD CYPRESS
Vauquelinia corymbosa var. *angustifolia*	CHISOS ROSEWOOD, SLIM-LEAF VAUQUELINIA

SHRUBS/ SCIENTIFIC NAME	COMMON NAME
Anisacanthus quadrifidus var. *wrightii*	FLAME ACANTHUS, WRIGHT'S ACANTHUS
Atriplex canescens	FOUR-WING SALTBUSH
Atriplex confertifolia	SHADESCALE
Bouchea linifolia	FLAX-LEAF BOUCHEA
Cotinus obovatus	AMERICAN SMOKETREE
Croton alabamensis var. *texensis*	TEXABAMA CROTON
Dalea bicolor var. *argyrea*	SILVER DALEA
Dalea greggii	GREGG'S DALEA
Fallugia paradoxa	APACHE-PLUME
Fendlera spp.	FENDLERBUSH
Forestiera reticulata	NET-LEAF FORESTIERA
Garrya ovata subsp. *lindheimeri*	LINDHEIMER'S SILKTASSEL
Hesperaloe parviflora var. *parviflora*	RED-FLOWER-YUCCA
Lantana urticoides	TEXAS LANTANA
Leucophyllum spp.	SILVERLEAF
Menodora longiflora	SHOWY MENODORA
Myrica cerifera (INCLUDES DWARF FORMS)	SOUTHERN WAX-MYRTLE
Pavonia lasiopetela	WRIGHT'S PAVONIA
Philadelphus spp.	WILD MOCK ORANGE
Rhus microphylla	LITTLE-LEAF SUMAC
Ribes aureum var. *villosum*	BUFFALO CURRANT
Salix exigua	SANDBAR WILLOW, COYOTE WILLOW
Salvia ballotiflora	SHRUBBY BLUE SAGE
Salvia greggii	AUTUMN SAGE
Salvia regla	MOUNTAIN SAGE
Styrax platanifolius	SYCAMORE-LEAF SNOWBELL
Yucca rupicola	TWIST-LEAF YUCCA

List of Sources for Native Plants

Native Plant Society of Texas

State Office
Coordinator: Dar Richardson
P.O. Box 2762
Georgetown, TX 78627
512/868-8799
E-MAIL: coordinator@npsot.org

Nurseries

Anderson Landscape and Nursery
2222 Pech
Houston, TX 77055
713/984-1342

Barton Springs Nursery
3601 Bee Cave Rd.
Austin, TX 78746
512/328-6655

Blue Moon Gardens
13062 FM 279
Chandler, TX 75758
903/852-3897
INTERNET: www.bluemoongardens.com/index.htm

Bluestem Nursery
4101 Curry Rd.
Arlington, TX 76017
817/478-6202
Contact: John S. Snowden
Native ornamental grasses, catalog

Brazos Rim Farm, Inc.
433 Ridgewood
Ft. Worth, TX 76107
817/740-1184; FAX: 817/625-1327
Contact: Pat Needham
Wholesale

Buchanan's Native Plants
611 E. 11th Street
Houston, TX 77008
713/861-5702
Retail
INTERNET: www.buchanansplants.com

Discount Trees of Brenham
2800 N. Park Street
Brenham, TX 77833
979/836-7225
Retail

Dodd Family Tree Nursery
515 West Main
Fredericksburg, TX 78624
830/997-9571
Retail; native plants, organics, special order

Ecovirons
P.O. Box 520
Chireno, TX 75937
936/362-2215; FAX: 253/981-0901
Contact: Peter Loos
E-MAIL: info@ ecovirons.com
Wholesale/retail
INTERNET: www.ecovirons.com

Gottlieb Gardens
8263 Huber Rd.
Seguin, TX 78155
830/629-9876
Wholesale

Grown Better Naturally
140 Burnet County Rd. 410A
Spicewood, TX 78669
830/693-0138; FAX: 830/693-0138

Rendenta's
813 Straus Rd.
Cedar Hill, TX 75104
972/291-7650; FAX: 972/293-0920
Other locations

Madrone Nursery
2318 Hilliard
San Marcos, TX 78666
512/353-3944
Wholesale/retail
INTERNET: www.home.earthlink.net/~madronenursery/

Native American Seed
127 North 16th Street
Junction, TX 76849
1-800/728-4043
INTERNET: www.seedsource.com

Natives of Texas
Spring Canyon Ranch
4256 Medina Hwy.
Kerrville, TX 78028
830/896-2169; FAX: 830/257-3322
INTERNET: www.nativesoftexas.com
Contact: Betty Winningham

Native Texas Nursery
16019 Milo Rd.
Austin, TX 78725
254/276-9801
Wholesale only

The Natural Gardener
8648 Old Bee Caves Rd.
Austin, TX 78735
512/288-6113; FAX: 512/288-6114
Retail
INTERNET: www.naturalgardeneraustin.com

North Haven Gardens
7700 Northaven Road
Dallas, TX 75230-3297
214/363-5316
Wholesale/retail
INTERNET: www.nhg.com/Index.asp

The Rustic Wheelbarrow
416 W. Avenue D
San Angelo, TX 76903
915/659-2130

Southwest Wholesale Nursery
2220 Sandy Lake Rd.
Carrollton, TX 75006
214/245-4557
Wholesale only

Stan's Organic Lawn and Garden
798 W. Hwy 190
Nolanville, TX 76559
254/698-8622; FAX: 254/698-8623
Retail

Texzen Gardens
4806 Burnet Rd.
Austin, TX 78756
512/454-6471

Weston Gardens in Bloom, Inc.
8101 Anglin Dr.
Ft Worth, TX 76140
817/572-0549
INTERNET: www.westongardens.com

Wichita Valley Landscape
5314 SW Parkway
Wichita Falls, TX 76310
940/696-3082
Contact: Paul or Nila
INTERNET: www.fallsonline.com/wichitavalley/

Wildseed Farms, Inc.
425 Wildflower Hills
P.O. Box 3000
Fredericksburg, TX 78624-3000
1-800/848-0078; FAX: 830/990-8090
INTERNET: www.wildseedfarms.com
Wholesale/retail: seed and live plants

Landscape Professionals

Anderson Landscape & Nursery
2222 Pech
Houston, TX 77055
713/984-1342

Carol Feldman
P.O. Box 224077
Dallas, TX 75222
214/331-2337
E-MAIL: carolfeld@aol.com

Don Gardner
Consulting Arborist
Native Plant Preservation Specialist
13903 Murfin Rd.
Austin, TX 78734
512/263-2586

Home and Habitat
P.O. Box 2201
Bellaire, TX 77402
Contact: Janet W. Roberts
713/667-6938; FAX: 713/667-6946

Landscape Details
324 Cardinal
New Braunfels, TX 78130
830/629-9876
Contact: David E. Will

Place Collaborative, Inc.
8207 Callaghan Rd. #130
San Antonio, TX 78205
210/349-3434
Contact: Larry A. Hicks, ASLA

Dave Shows Associates
17320 Classen Rd.
San Antonio, TX 78247
210/497-3222

Wright Landscape for Texas
2922 High Plains Dr.
Katy, TX 77449
281/578-7304
Contact: Lisa Wright
Specializing in wildlife habitats

G. Owen Yost, ASLA
Landscape Architect
4516 Coyote Point
Denton, TX 76208
940/382-2099

Nature Centers

Cibolo Nature Center
P.O. Box 9
Boerne, TX 78006
(Adjacent to Boerne City Park off Hwy. 46)
Native plants in four habitats; riparian. upland woodlands, prairie, and marsh
INTERNET: cibolo.org

Heard Natural Science Museum
and Wildlife Sanctuary
One Nature Place
McKinney, TX 75069-8840
972/562-5566
E-MAIL: heardmuseum@texoma.net
INTERNET: www.heardmuseum.org

Lady Bird Johnson Wildflower Center
4801 LaCross Avenue
Austin, TX 78739
512/292-4100 (info line)
E-MAIL: wildflower@wildflower.org
INTERNET: www.wildflower.org/

Pineywoods Native Plant Center
Stephen F. Austin State University
PO Box 13000
Nacogdoches, TX 75962
936/468-1832
E-MAIL: erodewald@sfasu.edu
INTERNET: pnpc.sfasu.edu/

Riverside Nature Center
150 Francisco Lemos St.
Kerrville, TX 78024
830/257-4837
Non-profit organization;
Information and education on the Hill Country

Texas Discovery Gardens
(Dallas Horticultural Center)
3601 MLK Blvd. (in Fair Park)
Dallas, TX 75210
214/428-7476
Featuring the Benny Simpson Texas Native Plant Collection
INTERNET: texasdiscoverygardens.org

These listings were provided, in part, by the Native Plant Society of Texas; such listings are published regularly in the *Native Plant Society of Texas News*.

Native Plants Important to Wildlife in East Texas

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Plants provide wildlife (native invertebrates and vertebrates) with three basic life requisites—food, shelter, and necessities for reproduction. Food includes nectar, sap, buds, fruits, leaves, stems, shoots, rootstocks, and tubers. Shelter includes cover for concealment and escape; perches for eating, resting, and sleeping. Necessities for reproduction include sites for nests and dens (cavities and hollows) and nest materials. Each wildlife species has a unique set of life requisites. The complex of these requirements constitute its habitat. However, at certain times different species may use the same ecological resources (e.g., the same food source). When this occurs, they are said to be members of the same guild.

Each plant species is used in some capacity by at least one species of wildlife. Some plants are used by a large number of wildlife species, especially for food, e.g., the berries of Southern Wax-myrtle (*Myrica cerifera*) are eaten by over 40 species of birds. At the other extreme, some plants are not widely used by many species, but are extremely important for the life requisite of a particular species. For example, the Northern Parula (*Parula americana*) nests almost exclusively in hanging clusters of Spanish-Moss (*Tillandsia usneoides*).

Plant selection for wildlife use should include a diversity of species that provide life requisites for a large variety of wildlife. All plants should be co-adapted (native to the local area and occurring in association with one another) and have similar soil requirements. Plant selection should include species that bear flowers and fruits throughout the year: some should be evergreens, some should be light-adapted and others shade-adapted. There should be a mixture of plants at different heights, i.e., with various strata on and above ground level. Some species should be thicket-forming and some should bear thorns. Artificial and natural brush piles are also of importance. They soon become covered with vines and, if placed in gullies, can control erosion as well as be of benefit to wildlife. However, since they can attract some wildlife that may not be desirable (e.g., poisonous snakes, rats and mice, skunks) they should not be placed near homes or lawn areas.

In some plants species male and female flowers occur on separate plants so, plants of both sexes are locally necessary for pollination.

The following lists include only those plants that have wide distribution, are readily available commercially or can be grown from seeds, cuttings, or transplantings, and for which studies have demonstrated their uses by wildlife. In some cases, where there are many species, only the genus is given. In other cases, where there are introduced (exotic) species in the genus, the designation "native spp." denotes that the species referenced to are only those that are native. Plants listed include woody and herbaceous (non-woody) species in the categories of trees, shrubs, vines, forbs (herbaceous non-grasses and non-grasslike plants), grasses, and marsh plants (including wetland forbs and grasses). Although this is an artificial grouping, it is hopefully of practical use. An introduction to each category of plants provides basic information about their use by wildlife. Also included in this appendix are: **1)** criteria for the selection of preferred species, **2)** desirable characteristics of native plants, **3)** desirable characteristics of native plant associations, and **4)** selected references.

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Although each species of wildlife has specific life requisite requirements (habitat), these resources vary seasonally and locally, especially for those species that are distributed over a large area and are generalists rather than specialists in their requirements. Few wildlife species have been studied sufficiently to provide information that goes beyond the local area where the studies were conducted; therefore, so to generalize about their life requisites throughout their range of distribution is difficult. Also, the situation becomes extremely complex when multiple species are involved. The only specific assessment of plant values to wildlife that has been accomplished is the ranking of food use by species or wildlife groups. Therefore, in the following lists if an asterisk "*" is associated with the common name of a plant genus or species, it signifies an especially important food source for wildlife (**b** = deer browse (including fruits and herbage), **f** = fruit, **h** = hummingbird nectar, **n** = nectar source for bees and butterflies, **r** = rhizomes, **s** = seeds, **t** = tubers, **w** = whole plants as forage). In addition, an "**x**" designates a plant somewhat to mostly resistant or unpalatable to deer, but beneficial to other wildlife. However, few native plants are toxic or distasteful enough that deer will avoid them completely. Some plants are avoided at certain growth stages or seasons. During stress periods, and where deer numbers are high, even plants normally avoided may be eaten. Therefore, an "x" does not guarantee that the plant will not be damaged by deer under certain conditions.

If readers are interested in more information about these plants, they should refer to the individual species accounts via the index, consult the references, or access the Texas Plant Information Database (TPID) Web site (http://tpid.tpwd.state.tx.us/) where extensive data can be obtained.

WOODY PLANTS

Woody plants characterize the natural vegetation of the East Texas ecological region. The basic groups are trees, shrubs, and vines, each of which includes deciduous, evergreen, upland, and bottomland species. There is much variety within these vegetation associations (vegetation types). These include upland forests, bottomland forests, pine forests, deciduous forests, mixed forests (pines and hardwoods), pine and hardwood savannahs, riverine (riparian) zones, swamps, bayous, sloughs, and oxbow lakes.

TREES

Trees provide three distinct layers, strata, or galleries in the canopy (low, medium, and high). Some animals spend the majority of their lives in a single layer, while others may range over two or more layers. Unlike other types of vegetation, mature long-lived hardwood trees develop natural cavities, hollows, and loose bark that provide shelter and nest and den sites for many kinds of animals. Tree trunks are used by specialized birds such as woodpeckers, nuthatches, and the Brown Creeper (*Certhia americana*). Woodpeckers are especially important since their excavated cavities are also used by many other animals. Trees also provide attachment for climbing vines that add to the variety of canopy layers. Evergreen trees are important for escape cover and winter shelter.

Dead trees and large limbs (snags) should not be removed unless they pose a potential hazard. They provide important perches, and woodpeckers use the resonant qualities of deadwood for drumming—a communication technique used to indicate territorial boundaries and to attract mates. Downed decaying trees provide shelter and reproductive sites for a wide variety of invertebrates and vertebrates. Their eventual decay returns valuable nutrients to the soil.

Diversity of tree species produces a variety of insects and fruits available throughout the year. Oaks should include species of both the white oak and red oak groups. White oaks bear acorns that develop and mature at the end of one growing season, whereas acorns of red oaks mature at the end of 2 growing seasons. White oak acorns are "perishable" since they have "rapid-response" generation, i.e., ripen, fall, and sprout in the autumn. In contrast, red oak acorns are "storable" since they have "delayed-response" germination, i.e., ripen and fall in autumn, but do not sprout until spring. Some oaks bear large crops annually; but, most acorn crops are cyclic, heavy crops being produced about 1–2, 1–5, 2–3, 2–4, 3–4, 3–5, 4–6, and 4–10 years depending upon the species. Thus, a variety of species within and between the two oak groups insures some availability of acorns.

SCIENTIFIC NAME	WILDLIFE USE	COMMON NAME
Acer negundo		BOX-ELDER
Acer rubrum	*b,f	MAPLE, RED
Alnus serrulata		ALDER, HAZEL
Aralia spinosa		HERCULES'-CLUB; DEVIL'S WALKINGSTICK
Betula nigra		BIRCH, RIVER
Carpinus caroliniana		HORNBEAM, AMERICAN; BLUE-BEECH
Carya alba	*b,f	HICKORY, MOCKERNUT
Carya aquatica	*b,f	HICKORY, WATER; PECAN, BITTER
Carya cordiformis	*b,f	BITTER-NUT
Carya illinoinensis	*b,f	PECAN
Carya ovata	*b,f	HICKORY, SHAGBARK
Carya texana	*b,f	HICKORY, BLACK
Castanea pumila		CHINQUAPIN, ASHE
Celtis laevigata	*b,f	SUGARBERRY; HACKBERRY, SUGAR
Chionanthus virginicus	*b	FRINGETREE, WHITE
Cornus drummondii	*b,f	DOGWOOD, ROUGH-LEAF
Cornus florida	*b,f	DOGWOOD, FLOWERING
Diospyros virginiana	*b,f,x	PERSIMMON, COMMON
Fagus grandifolia		BEECH, AMERICAN
Forestiera acuminata		SWAMP-PRIVET
Fraxinus americana	*b	ASH, WHITE
Fraxinus caroliniana		ASH, CAROLINA
Fraxinus pennsylvanica		ASH, GREEN
Gleditsia aquatica		HONEY-LOCUST, WATER
Gleditsia triacanthos	*b	HONEY-LOCUST, COMMON
Ilex opaca	*f,x	HOLLY, AMERICAN
Juglans nigra	*f	WALNUT, BLACK
Juniperus virginiana	*f,x	RED-CEDAR, EASTERN
Liquidambar styraciflua	*s,x	SWEETGUM
Maclura pomifera		OSAGE-ORANGE; HORSE-APPLE; BOIS D'ARC
Magnolia grandiflora	*s,n,x	MAGNOLIA, SOUTHERN
Morus rubra	*b,f	MULBERRY, RED
Nyssa aquatica		TUPELO, WATER
Nyssa sylvatica	*f,b,n	BLACK-GUM
Ostrya virginiana		IRONWOOD; HOP-HORNBEAM, EASTERN
Persea borbonia	*b	BAY, RED
Pinus echinata	*s,x	PINE, SHORTLEAF
Pinus palustris	*s,x	PINE, LONGLEAF
Pinus taeda	*s,x	PINE, LOBLOLLY
Planera aquatica		WATER-ELM
Platanus occidentalis		SYCAMORE, AMERICAN
Populus deltoides		COTTONWOOD, EASTERN
Prunus mexicana	*b,f,n	PLUM, WILD; MEXICAN
Prunus serotina	*b,f,x	BLACKCHERRY
	White Oak Group:	
Quercus alba	*b,f	OAK, WHITE
Quercus lyrata	*f	OAK, OVERCUP
Quercus macrocarpa	*b,f	OAK, BUR
Quercus michauxii	*f	OAK, SWAMP CHESTNUT
Quercus muehlenbergii	*b,f	OAK, CHINQAPIN

SCIENTIFIC NAME	WILDLIFE USE	COMMON NAME
Quercus stellata	*b,f	Oak, post
Quercus similis	*f	Oak, bottomland post
Quercus margaretta	*f	Oak, sand post
Quercus virginiana	*f	Oak, live
Red Oak Group:		
Quercus falcata	*b,f	Oak, southern red
Quercus incana	*f	Oak, bluejack; Sandjack
Quercus laurifolia	*f	Oak, laurel
Quercus marilandica	*b,f	Oak, blackjack
Quercus nigra	*b,f	Oak, water
Quercus phellos	*b,f	Oak, willow
Quercus shumardii	*b,f	Oak, Shumard's
Quercus texana	*f	Oak, Nuttall's
Quercus velutina	*f	Oak, black
Salix nigra	*b	Willow, black
Sassafras albidum	*b,f	Sassafras
Sideroxylon lanuginosum subsp. *oblongifolium*	*b,f	Chittamwood
Tilia americana var. *caroliniana*		Basswood, Carolina; Linden, Florida
Taxodium distichum var. *distichum*	*s,x	Cypress, Bald
Ulmus alata	*b,s	Elm, winged
Ulmus americana		Elm, American
Ulmus crassifolia		Elm, cedar
Ulmus rubra		Elm, slippery
Zanthoxylum clava-herculis	*b	Prickly-ash; Hercules'-club

SHRUBS

There is not a uniform definition that distinguishes a short tree from a tall shrub, and definitions often differ significantly. So, for a practical definition, shrubs are short woody plants with a short stem and, usually, several basal branches of equal size. Shrubs are very important plants to wildlife in similar ways as trees. They provide life requisites from ground level to about 15 feet high.

SCIENTIFIC NAME	WILDLIFE USE	COMMON NAME
Aesculus pavia var. *pavia*	*h	Buckeye, red
Aronia arbutifolia	*f	Chokeberry, red
Asimina triloba		Pawpaw, common
Callicarpa americana	*b,f	Beauty-berry, American
Ceanothus americanus		Redroot; New Jersey-tea
Ceanothus herbaceus		Redroot
Cephalanthus occidentalis	*s,n	Buttonbush, common
Clethra alnifolia	*b	Summersweet; Pepperbush, sweet
Crataegus spp.	*b,f,n	Hawthorns
Cyrilla racemiflora	*b	Titi; Cyrilla, swamp
Erythrina herbacea	*h	Coral-bean
Euonymus americanus	*b	Spindletree; Strawberry-bush
Frangula caroliniana	*f,n,x	Buckthorn, Carolina
Hamamelis virginiana		Witch-hazel
Hypericum hypericoides	*b	St. Andrew's-cross
Ilex coriacea		Holly, baygall
Ilex decidua	*b,f,x	Holly, deciduous; Possumhaw
Ilex glabra		Inkberry

SCIENTIFIC NAME	WILDLIFE USE	COMMON NAME
Ilex vomitoria	*b,f	YAUPON
Itea virginica	*b	SWEETSPIRE, VIRGINIA
Lantana urticoides	*h,n,x	LANTANA, COMMON
Lindera benzoin var. *pubescens*		SPICEBUSH
Myrica cerifera	*f,x	WAX-MYRTLE, SOUTHERN
Opuntia humifusa		PRICKLY-PEAR, EASTERN
Opuntia macrorhiza		PRICKLY-PEAR, PLAINS; GRASSLAND
Prunus angustifolia	*b,f,n	PLUM, CHICKASAW
Prunus caroliniana	*f,n,x	CHERRY, LAUREL
Prunus gracilis	*b,f,n	PLUM, SAND
Prunus umbellata	*b,f,n	PLUM, FLATWOOD
Rhododendron spp.	*h	AZALEAS
Rhus spp.	*b,f,n	SUMACS
Ribes spp.		CURRANTS, GOOSEBERRIES
Rosa spp.	*b,f,h	ROSES, WILD (NATIVE spp.)
Sabal minor		PALMETTO, DWARF
Sambucus nigra var. *canadensis*	*b,f,n	ELDERBERRY, COMMON
Symphoricarpos orbiculatus	*f	INDIAN-CURRANT; CORAL-BERRY
Symplocos tinctoria	*b	SWEETLEAF, COMMON
Vaccinium arboreum	*b,f	FARKLE-BERRY
Vaccinium corymbosum		BLUEBERRY, ELLIOTT'S
Vaccinium stamineum		DEERBERRY, COMMON
Viburnum acerifolium		VIBURNUM, MAPLELEAF
Viburnum dentatum		ARROWWOOD, SOUTHERN
Viburnum nudum		VIBURNUM, POSSUMHAW
Viburnum prunifolium		BLACKHAW
Viburnum rufidulum	*b,n	BLACKHAW, SOUTHERN; RUSTY
Yucca arkansana		YUCCA, ARKANSAS
Yucca louisianensis		YUCCA, LOUISIANA

VINES

Some vines grow high in the tree canopy, others attach to shrubs, and some cover the ground. Vines fill spaces within and between trees and shrubs, thus enhancing life requisites available for wildlife. Some form dense thickets; some are evergreen. Some vines bear nectar-producing flowers important to bees, other pollinating insects, and hummingbirds. Vines provide excellent shelter and places for reproduction. Most species provide fruits that are eaten by a large variety of birds and mammals. Vines are excellent fence plants. However, when growing on small trees and shrubs, some vines become so prolific in growth that they strangle the stems and cover the foliage of the underlying plant.

SCIENTIFIC NAME	WILDLIFE USE	COMMON NAME
Ampelopsis arborea	*b	PEPPERVINE
Ampelopsis cordata		AMPELOPSIS, HEART-LEAF
Berchemia scandens	*b	SUPPLEJACK; RATTANVINE
Bignonia capreolata	*b,h,n	CROSSVINE
Campsis radicans	*b,h,n	TRUMPET-CREEPER, COMMON
Celastrus scandens		BITTERSWEET, CLIMBING
Cocculus carolinus		SNAILSEED, CAROLINA
Gelsemium sempervirens	*b,h,n	JESSAMINE, CAROLINA
Lonicera sempervirens	*b,f,h,n	HONEYSUCKLE, CORAL
Parthenocissus quinquefolia	*b,f	VIRGINIA-CREEPER
Passiflora incarnata		PASSION-FLOWER, MAYPOP

SCIENTIFIC NAME	WILDLIFE USE	COMMON NAME
Rubus spp.	*b,f	Dewberries; Blackberries
Smilax spp.	*b,f	Greenbriars
Toxicodendron radicans	*b,f	Poison-oak, Poison-ivy
Vitis spp.	*b,f	Grapes

Herbaceous Plants

Most nonwoody (herbaceous) plants in the East Texas ecological region are light-adapted and occur in open nonforested areas, in openings within wooded areas, or at the edges of wooded areas. Also, herbaceous plants may be divided into two basic ecological groups—those that occur in uplands and those that occur in wetlands.

FORBS (non-grasses and non-grasslike plants)

Forbs are commonly known as wildflowers or weeds. Most forbs are light-adapted and so occur in prairies, in open areas within wooded areas, at the outer edge of wooded areas, or in grassland islands within forests. Although grassland areas are dominated by grasses with respect to total plant weight (biomass), they are dominated by forbs in total number of species (diversity). Many forbs are important to wildlife, providing life requisites for ground-dwelling birds, rodents, and many species of insects. Many wildflowers produce nectar that attracts bees, butterflies, and hummingbirds.

SCIENTIFIC NAME	WILDLIFE USE	COMMON NAME
Acalypha gracilens		Copperleaf, slender
Agalinis purpurea		Gerardia, purple
Amaranthus spp.		Pigweeds; Amaranths
Ambrosia artemisiifolia	*b,s	Ragweed, common
Ambrosia trifida var. *trifida*		Ragweed, blood; giant
Asclepias tuberosa subsp. *interior*	*h,n,x	Butterfly-weed
Aster spp.		Asters
Bidens spp.		Beggar-ticks
Callirhoe involucrata	*n	Poppy-mallow, purple
Castilleja indivisa	*h,n	Paintbrush, Texas
Centrosema virginianum	*b	Butterfly-Pea
Chamaecrista fasciculata	*b,s	Partridge-pea; showy
Cirsium horridulum		Thistle, bull; yellow
Clitoria mariana		Spoonflower; Pigeon-wings, Atlantic
Cnidoscolus texanus		Bull-nettle, Texas
Commelina spp.	*b	Widow's-tears; Dayflowers
Coreopsis spp.	*n,s	Golden-waves; Tickseeds
Croptilon divaricatum		Goldenweed, slender
Croton spp.	*s	Crotons
Desmanthus illinoinensis	*s	Bundle-flower, Illinois
Desmodium spp.	*b,s	Tick-clovers
Diodia teres		Poor-joe
Diodia virginiana		Buttonweed, Virginia
Erechtites hieraciifolia		Burnweed, American
Engelmannia peristenia		Daisy, Engelmann's
Eupatorium spp.	*n	Bonesets, Thoroughworts
Euphorbia spp.	*s,x	Spurges
Gaillardia spp.	*n,s,x	Indian-blankets
Galactia spp.	*s	Milk-peas
Geranium spp.	*b	Geraniums (Crane's-bills)
Helianthus spp.	*b,n,s	Sunflowers

SCIENTIFIC NAME	WILDLIFE USE	COMMON NAME
Heterotheca subaxillaris		CAMPHORWEED
Ipomopsis rubra	*h,n	STANDING-CYPRESS
Lactuca canadensis		LETTUCE, WILD
Lespedeza spp.	*b,s	BUSH-CLOVERS (NATIVE spp.)
Liatris spp.	*n,x	BLAZINGSTARS; GAYFEATHERS
Lobelia cardinalis	*h,n,x	CARDINAL-FLOWER
Lupinus texensis	*n	BLUEBONNET, TEXAS
Malvaviscus arboreus var. *drummondii*	*f,h,n	WAX-MALLOW, DRUMMOND'S; TEXAS
Mimosa nuttallii	*b	SENSITIVE-BRIAR, CATCLAW
Mitchella repens		PARTRIDGEBERRY
Monarda spp.	*h,n	MINTS, HORSE; BEEBALMS
Oenothera spp.	*b,n,x	EVENING-PRIMROSES
Oxalis spp.	*n,x	WOODSORRELS
Penstemon murrayanus	*h,x	PENSTEMON, CUP-LEAF
Phytolacca americana	*f	POKEWEED
Psoralidium tenuiflorum		SCURF-PEA, SLIMLEAF; ALFALFA, WILD
Ratibida columnifera	*s,x	MEXICAN-HAT
Rhexia mariana		MEADOW-BEAUTY, MARYLAND
Rhynchosia spp.	*b,s	SNOUT-BEANS
Rudbeckia spp.	*b,n,s	CONEFLOWERS
Ruellia spp.		PETUNIAS, WILD
Rumex spp.	*s	DOCKS; SORRELS (NATIVE spp.)
Salvia spp.	*h,n,x	SAGES
Scutellaria spp.	x	SKULLCAPS
Solanum spp.	*f,x	NIGHTSHADES
Solidago spp.	*n	GOLDENRODS
Stillingia sylvatica		QUEEN'S-DELIGHT
Strophostyles spp.	*b,s	BEANS, WILD
Stylosanthes biflora		PENCIL-FLOWER, SIDE-BEAK
Tephrosia virginiana		GOAT'S-RUE
Tillandsia spp.		BALL-MOSS; SPANISH-MOSS
Tragia spp.		NOSEBURNS
Verbena spp.	*n,x	VERVAINS
Vicia spp.		VETCHES (NATIVE spp.)
Viola spp.		VIOLETS

GRASSES

Like forbs, most grasses are light-adapted and so occur in prairies, in open areas within wooded areas, at the edge of wooded areas, or in islands of grasslands within forested areas. Grasses provide wildlife with seeds for food and leaves and stems for food, shelter, nest sites, and nest materials. A large number of invertebrates occur in grassy areas, especially spiders and grasshoppers that are important food items of birds and rodents.

SCIENTIFIC NAME	WILDLIFE USE	COMMON NAME
Andropogon gerardii		BLUESTEM, BIG
Andropogon ternarius		BLUESTEM, SPLIT-BEARD
Andropogon virginicus		BLUESTEM, BROOMSEDGE
Arundinaria gigantea		CANE, GIANT
Bouteloua curtipendula	*s	GRAMMA, SIDE-OATS
Chasmanthium latifolium		OATS, WILD; WOOD-OATS, BROADLEAF
Chasmanthium sessiliflorum		WOOD-OATS, NARROW-LEAF

SCIENTIFIC NAME	WILDLIFE USE	COMMON NAME
Dichanthelium oligosanthes var. *scribnerianum*	*b,s	Rosette grass, Scribner's
Digitaria cognata subsp. *cognata*	*s	Witch grass, fall
Eragrostis spp.		Love grasses (native spp.)
Leptochloa spp.		Sprangletops
Panicum capillare	*s	Witch grass
Panicum hallii var. *hallii*	*s	Panic, Hall's
Paspalum floridanum	*s	Paspalum, Florida
Paspalum plicatulum	*s	Paspalum, brown-seed
Paspalum setaceum	*s	Paspalum, thin
Schizachyrium scoparium		Bluestem, little
Setaria spp.	*s	Bristle grasses; Foxtail grasses (native spp.)
Sorghastrum nutans		Indian grass, yellow
Sporobolus spp.		Dropseeds
Tridens flavus		Purpletop

MARSH PLANTS (INCLUDING WETLAND FORBS AND GRASSES)

Marsh plants have specialized adaptations for living in areas that have standing water for long periods, but can undergo drought, and where the soil conditions are devoid of oxygen much of the time. These plants occur in a variety of wetlands: marshes (wetlands dominated by water-adapted herbaceous plants), edges of swamps (wetlands dominated by water-adapted trees and shrubs), bogs, flats, glades, sloughs, bayous, backwaters, wet meadows, and beaver ponds.

These areas contain highly diverse distinctive plant communities that, in turn, provide food and cover for a great variety of wildlife species. Marshes have complex edge zones and vertical and horizontal strata that intensify their use by wildlife and fish (where there is permanent water). Marsh plants are disproportionately more diverse than plants in most adjacent upland areas. Many wildlife species are dependent on marshes, either directly or indirectly, since they reproduce in or near these areas and/or live and feed there or in adjacent areas.

Underwater portions of many marsh plants support abundant aquatic invertebrates that are important food of fish and wildlife. Also, they provide excellent foraging areas and spawning grounds for fish.

Some of these plants are very prolific and under some conditions can form dense stands and cover large areas and thereby crowd out other plants thus decreasing the overall diversity of vegetation and associated wildlife.

SCIENTIFIC NAME	WILDLIFE USE	COMMON NAME
Andropogon glomeratus		Bluestem, bushy
Bacopa spp.	*s,w	Water-hyssops
Brasenia schreberi	*s,w	Wen-dock, purple
Callitriche heterophylla	*s,w	Waterwort, larger
Carex spp.	*s	Sedges, caric
Ceratophyllum demersum	*f	Coontail
Cyperus spp.		Flat sedges
Dichanthelium scoparium		Rosette grass, velvet
Echinochloa spp.	*s	Barnyard grasses (Native spp.)
Echinodorus spp.		Burheads
Eleocharis spp.	*s,w	Spike-rushes
Heteranthera dubia		Mud-plantain, grass-leaf
Heteranthera limosa		Mud-plantain, blue
Justicia americana		Water-willow, American
Justicia ovata var. *lanceolata*		Water-willow, lance-leaved
Juncus spp.		Rushes
Leersia oryzoides		Cut grass, rice

SCIENTIFIC NAME	WILDLIFE USE	COMMON NAME
Leptochloa fascicularis	*s	Sprangletop, bearded
Lemnaceae	*w	Duckweeds; watermeals
Limnobium spongia		Frog's-bit
Ludwigia spp.		Seedboxes; Water-primroses
Najas guadalupensis	*s,w	Water-nymph, common
Nelumbo lutea		Lotus, yellow
Nuphar luteum		Cowlily, yellow; Spatterdock
Nymphaea odorata		Water lily, white
Panicum anceps	*s,r	Panicum, beaked
Panicum dichotomiflorum	*s	Panicum, fall
Panicum obtusum		Vine-mesquite
Panicum virgatum	*s	Switch grass
Paspalum boscianum		Paspalum, bull
Paspalum distichum		Knot grass
Paspalum fluitans		Paspalum, water
Paspalum setaceum		Paspalum, thin
Phragmites australis		Reed, common
Polygonum amphibium var. *emersum*	*s	Smartweed, water
Polygonum aviculare	*s	Knotweed, prostrate
Polygonum hydropiperoides	*s	Smartweed, swamp
Polygonum lapathifolium	*s	Smartweed, willow
Polygonum pensylvanicum	*s	Smartweed, Pennsylvania
Polygonum punctatum	*s	Smartweed, water
Polygonum ramosissimum	*s	Knotweed, bushy
Pontederia cordata		Pickerel-weed
Potamogeton diversifolius	*s,w	Pondweed, water-thread
Potamogeton foliosus	*s,w	Pondweed, leafy
Potamogeton nodosus	*s,w	Pondweed, long-leaf
Sagittaria spp.	*s,t	Arrowheads
Scirpus spp.	*s	Bulrushes
Sparganium spp.	*s,w	Bur-reeds
Typha spp.		Cattails
Vallisneria americana	*w	Wild-celery, American
Zannichellia palustris		Poolmat, common
Zizaniopsis miliacea		Wild rice, southern

***** = an especially important food source for wildlife, **b** = deer browse (including fruits and herbage), **f** = fruit, **h** = hummingbird nectar, **n** = nectar source for bees and butterflies, **r** = rhizomes, **s** = seeds, **t** = tubers, **w** = whole plants as forage), **x** =somewhat to mostly resistant or unpalatable to deer, but beneficial to other wildlife.

Common Native East Texas Plants Important for Wildlife Food

HUMMINGBIRDS

VEGETATION TYPE/SPECIES	COMMON NAME	SEASON OF FLOWER/ NECTAR AVAILABILITY		
Shrubs		SPRING	SUMMER	FALL
Aesculus pavia var. *pavia*	Buckeye, red	X		
Erythrina herbacea	Coral-bean	X	X	X
Lantana urticoides	Lantana, common	X	X	X
Rhododendron spp.	Azaleas	X		
Vines				
Bignonia capreolata	Crossvine	X		
Campsis radicans	Trumpet-creeper, common	X	X	X
Gelsemium sempervirens	Jessamine, Carolina	X		
Lonicera sempervirens	Honeysuckle, coral		X	X
Forbs				
Asclepias tuberosa subsp. *interior*	Butterfly-weed	X	X	X
Ipomopsis rubra	Standing-cypress	X	X	
Lobelia cardinalis	Cardinal-flower	X	X	X
Malvaviscus arboreus var. *drummondii*	Wax-mallow, Drummond's; Texas-mallow	X	X	X

UPLAND BIRDS AND SMALL MAMMALS

VEGETATION TYPE/SPECIES	COMMON NAME	SEASON OF SEED/ FRUIT AVAILABILITY			
Trees		SPRING	SUMMER	FALL	WINTER
Acer rubrum	Maple, red	X			
Carya spp.	Hickories/Pecans			X	
Celtis laevigata	Sugarberry; Hackberry, sugar		X	X	
Cornus florida	Dogwood, flowering			X	X
Diospyros virginiana	Persimmon, common			X	X
Ilex opaca	Holly, American			X	X
Juniperus virginiana	Red-cedar, eastern			X	X
Liquidambar styraciflua	Sweetgum			X	X
Morus rubra	Mulberry, red	X			
Nyssa sylvatica	Black-gum			X	X
Pinus spp.	Pines			X	X
Prunus spp.	Plums; Cherries	X	X	X	
Quercus spp.	Oaks			X	X
Sassafras albidum	Sassafras			X	
Shrubs					
Callicarpa americana	Beauty-berry, American			X	X
Crataegus spp.	Hawthorns			X	X
Myrica cerifera	Wax-myrtle, southern			X	X
Prunus angustifolia	Plum, Chickasaw	X	X	X	
Prunus caroliniana	Cherry, laurel			X	X
Rhus spp.	Sumacs		X	X	X
Sambucus nigra var. *canadensis*	Elderberry, common		X	X	
Vaccinium arboreum	Farkle-berry			X	X

VEGETATION TYPE/SPECIES	COMMON NAME	SEASON OF SEED/ FRUIT AVAILABILITY			
VINES		SPRING	SUMMER	FALL	WINTER
Cocculus carolinus	Snailseed, Carolina			X	
Parthenocissus quinquefolia	Virginia-creeper			X	
Smilax spp.	Greenbriars		X	X	
Toxicodendron radicans	Poison-oak; poison-ivy			X	X
Vitis spp.	Grapes		X	X	
FORBS					
Ambrosia artemisiifolia	Ragweed, common			X	
Chamaecrista fasiculata	Partridge-pea			X	X
Cirsium spp.	Thistles			X	X
Coreopsis spp.	Golden-waves; Tickseeds			X	X
Croton spp.	Crotons		X	X	
Desmanthus illinoinensis	Bundle-flower, Illinois			X	X
Desmodium spp.	Tick-clovers		X	X	X
Gaillardia spp.	Indian-blankets	X	X	X	
Galactia spp.	Milk-peas		X	X	X
Geranium spp.	Geraniums; Crane's-bills	X	X		
Helianthus spp.	Sunflowers		X	X	X
Oenothera spp.	Evening-primroses		X	X	X
Oxalis spp.	Woodsorrels	X	X	X	
Phylolacca americana	Pokeweed		X	X	X
Ratibida columnifera	Mexican-hat			X	X
Rhynchosia spp.	Snoutbeans		X	X	X
Rudbeckia hirta var. *pulcherrima*	Black-eyed Susan			X	X
Rumex spp.	Docks		X		
Solanum spp.	Nightshades		X	X	X
Strophostyles spp.	Wildbeans		X	X	X
Stylosanthes biflora	Pencil-flower, side-beak		X	X	
GRASSES					
Bouteloua curtipendula	Grama, side-oats		X	X	
Dichanthelium oligosanthes var. *scribnerianum*	Rosette grass, Scribner's	X			
Digitaria cognata subsp. *cognata*	Witch grass, fall	X	X	X	X
Panicum anceps	Panicum, beaked			X	
Panicum virgatum	Switch grass			X	
Paspalum floridanum	Paspalum, Florida		X	X	
Paspalum plicatum	Paspalum, brown-seed		X	X	
Setaria parviflora	Bristelegrass, knot-root		X		
Tridens flavus	Purpletop			X	

WATERFOWL

VEGETATION TYPE/SPECIES	COMMON NAME	SEASON OF AVAILABILITY			
Marsh Plants		SPRING	SUMMER	FALL	WINTER
Carex spp.	Sedges, caric	X	X	X	X
Cephalanthus occidentalis	Buttonbush, common			X	X
Echinochloa spp.	Barnyard grasses (native spp.)		X	X	
Eleocharis quadrangulata	Spike-rush, square-stem	X	X	X	X
Lemnaceae	Duckweeds; watermeals	X	X	X	X
Leptochloa spp.	Sprangletops	X	X	X	X
Ludwigia repens	Seedbox, round-leaf		X	X	
Najas guadalupensis	Water-nymph, common	X	X	X	X
Polygonum spp.	Knotweeds; Smartweeds	X	X	X	X
Potamogeton spp.	Pondweeds	X	X	X	X
Quercus nigra	Oak, water			X	X
Quercus phellos	Oak, willow			X	X
Sagittaria platyphylla	Arrowhead, delta	X	X	X	X
Scirpus spp.	Bulrushes	X	X	X	X

DEER

Deer eat a very large variety of plants, but most of them are consumed in small quantities (< 10% of the total diet). Also, plant use is seasonal in relation to availability and palatability, so a plant may be used more in one area than another and more during one season than another. Therefore, few plants provide the bulk of the diet. The following list of plants in at least 10% of deer diet is compiled from information from unpublished file data provided by several colleagues, as well as their expertise: Kevin R. Herriman, District 5 Leader (Post Oak Savannah); Gary E. Calkins, District 6 Leader (Piney Woods); Clayton R. Wolf, Deer Project Leader; Harry H. Haucke, Manager, Gus Engeling Wildlife Management Area; Billy C. Lambert, Jr., District 5 Wildlife Biologist; and James H. Yantis, District 5 Wildlife Biologist, retired.

VEGETATION TYPE/SPECIES	COMMON NAME	SEASON OF AVAILABILITY			
Trees		SPRING	SUMMER	FALL	WINTER
Carya aquatica	Hickory, water		X	X	X
Carya texana	Hickory, black		X	X	X
Celtis laevigata	Sugarberry; Hackberry, sugar		X	X	X
Cornus florida	Dogwood, flowering		X	X	X
Gleditsia triacanthos	Honey-locust, common		X	X	X
Nyssa sylvatica	Black-gum			X	X
Quercus spp.	Oaks	X	X	X	X
Sassafras albidum	Sassafras	X	X		X
Ulmus spp.	Elms	X	X		
Zanthoxylum clava-herculis	Prickly-ash, Hercules'-club		X	X	X
Shrubs					
Callicarpa americana	Beauty-berry, American	X	X	X	X
Crataegus spp.	Hawthorns	X	X	X	X
Hypericum hypericoides	St. Andrew's-cross	X	X	X	X
Ilex vomitoria	Yaupon			X	X
Rhus spp.	Sumacs		X	X	X
Vaccinium arboreum	Farkle-berry	X	X	X	X

VEGETATION TYPE/SPECIES	COMMON NAME	SEASON OF AVAILABILITY			
VINES		SPRING	SUMMER	FALL	WINTER
Berchemia scandens	Supplejack; rattanvine	X	X	X	X
Bignonia capreolata	Crossvine	X	X	X	X
Campsis radicans	Trumpet-creeper, common	X	X		
Gelsemium sempervirens	Jessamine, Carolina	X	X	X	X
Smilax spp.	Greenbriars	X	X	X	X
Rubus spp.	Dewberries; Blackberries	X	X	X	X
Vitis spp.	Grapes		X	X	X
GRASSES					
Dichanthelium spp.	Rosette grasses	X			X

Species Selection

A. Selection of preferred native plants is based on the following criteria

1) Emphasize native plant species that occur locally, i.e., in the area. Mast producers, especially a diversity of oaks, walnut, hickories, persimmon, and plums are examples. They are important food and cover plants.
2) Weedy, invader native species should not be emphasized (e.g., ash, cottonwood, pine, sycamore, and willow). In general, such species have great capacity for natural dispersal and are adapted to disturbed soil sites.
3) Oaks, walnuts, and hickories should be planted as saplings because they have limited capacity for dispersal. In contrast, trees, shrubs, and woody vines with winged or fleshy fruits are dispersed by wind or animals. Thus, these plants can be provided more sparingly.
4) Native plants are adapted to the local environment and will persist through periods of environmental stress. Most exotic plants cannot similarly persist and are also overrated as wildlife food and cover. However, a few exotic species can establish themselves by out-competing native plants. They then become serious persistent pests, difficult if not impossible to control or eradicate. Therefore, exotic species should not be planted.

B. Desirable Characteristics of Native Plants

Native plants should possess as many of the following characteristics as possible.

1) Thrive under specific climatic and soil conditions.
2) Compete with other plant species occurring in these conditions.
3) Cover as much area as possible. Desirable characteristics include spreading by stolons, runners, or rhizomes; forming thickets, mats, or coppices; rooting from decumbent or declining branches, or forming root shoots (suckers).
4) Produce fertility-enriching litter with high water holding capacity.
5) Inexpensive, readily available form local sites or nurseries, and easy to propagate and maintain.
6) Rapid-growing and long-lived.
7) Possess hardy characteristics such as resistance or adaptability to grazing or browsing, drought, fire, shade, insect damage, and diseases; and growing rapidly on soils with a wide range of fertility and chemical characteristics.
8) Produce dense foliage (deciduous and evergreen), stems, or thorns, preferably close to the ground.
9) Produce seasonally abundant shoots, leaves, buds, and fruits that have high nutritive value for many species of wildlife.
10) Produce annual, persistent fruits that have high seed germination ratios.

11) For tall-growing plants, they should not produce inhibitors that prevent other plant species from growing beneath them.
12) Preferably, non-poisonous to man and livestock.

C. Desirable Characteristics of Native Plant Associations

1) Plants should be of the same local climatic and ecological region, topography, and soil conditions.
2) Plants should be noncompetitive, i.e., compatible.
3) The association should cover as much area as possible (overlapping canopies).
4) The association should form at least 2 canopy layers above the soil surface.
5) Plants should include a mixture of physical and habit forms, e.g., deciduous, evergreen, tree, shrub, vine, forb, grass.
6) The association should provide annual, all-season fruits.
7) The association should provide areas of adequate cover.
8) Some components of the association should establish quickly and provide rapid growth.
9) Selected plants should include at least one nitrogen-fixing species, if feasible.
10) Planting should be arranged in irregular groups rather than uniform rows so that the association will produce a more natural form.

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I sincerely appreciate the biological and editorial expertise of four colleagues who read the manuscript and offered valuable suggestions and comments. They are: Timothy J. Bister, Fisheries Biologist, Tyler; Carl D. Frentress, Waterfowl Biologist, Athens; Harry H. Haucke, Manager of the Gus Engeling Wildlife Management Area, Tennessee Colony; and James H. Yantis, District 5 Wildlife Biologist, retired.

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LARVAL HOST PLANTS OF LEPIDOPTERA OF EAST TEXAS

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Most butterflies are host specific. That is, the caterpillars must feed and grow to pupation only on plants in a particular family. An example is the monarch that feeds on milkweed. On these plants, the female, sensitive to the odors of secondary plant chemicals and to textures, deposits her eggs. However, some butterflies, such as the tiger swallowtail (*Papilio glaucus*) and the buckeye (*Junonia coenia*) are polyphagous, using species of plants in a number of families. Even those selections are limited. This list may not include all of the plants that the butterflies use, but only those which are most commonly observed in this area.

♒ INDICATES LARVAE THAT MAY BE PESTS ON CULTIVATED PLANTS
✿ INDICATES LARVAE EAT BUDS AND BLOSSOMS ● INDICATES LARVAE EAT FRUIT
IN NORTH AMERICA NO BUTTERFLY AT ANY STAGE IS INJURIOUS TO HUMAN BEINGS.

PLANT		BUTTERFLY
ACANTHACEAE	*Dicliptera brachiata*| *Siphonoglossa pilosella*| *Ruellia* spp.	TEXAN CRESCENT (*Athanassa texana*) VESTA CRESCENT (*Phyciodes vesta*)
AGAVACEAE	*Yucca* spp.	GIANT YUCCA SKIPPER (*Megathymus yuccae*)
AMARANTHACEAE	*Amaranthus* spp.	COMMON SOOTYWING (*Pholisora catullus*)
ANACARDACEAE	*Rhus aromatica*| *R. copallina*	RED-BANDED HAIRSTREAK (*Calycopis cecrops*)
ANNONACEAE	*Asimina parviflora*| *A. triloba*	ZEBRA SWALLOWTAIL (*Eurytides marcellus*)
APIACEAE	*Daucus* spp.| *Bifora americana*| *Polytaenia nuttallii*	BLACK SWALLOWTAIL (*Papilio polyxenes*)
APOCYNACEAE	*Apocynum cannabinum*	MONARCH (*Danaus plexippus*) QUEEN (*Danaus gilippus*)
ARISTOLOCHIACEAE	*Aristolochia* spp.	PIPEVINE SWALLOWTAIL (*Battus philenor*)
ASCLEPIADACEAE	*Asclepias amplexicaulis*| *A. asperula*| *A.curassavica*| *A. incarnata*| *A. oenotheroides*| *A. purpurascens*| *A. tuberosa*| *A. verticillata*	MONARCH (*Danaus plexippus*) QUEEN (*Danaus gilippus*)
	Cynanchum leave| *Funastrum cynanchoides*| *Matelea reticulata*	QUEEN (*Danaus gilippus*)

<table>
<tr><th colspan="2">PLANT</th><th>BUTTERFLY</th></tr>
<tr><td>ASTERACEAE</td><td>Ambrosia spp.</td><td>Bordered patch (Chlosyne lacinia)
Silvery checkerspot (Chlosyne nycteis)</td></tr>
<tr><td></td><td>Artemesia ludoviciana</td><td>American painted lady (Vanessa virginiensis)</td></tr>
<tr><td></td><td>Aster spp.</td><td>Pearl crescent (Phyciodes tharos)</td></tr>
<tr><td></td><td>Bidens spp.</td><td>Dainty sulphur (Nathalis iole)</td></tr>
<tr><td></td><td>Centaurea spp.</td><td>Painted lady (Vanessa cardui)</td></tr>
<tr><td></td><td>Cirsium spp.</td><td>Painted lady (Vanessa cardui)</td></tr>
<tr><td></td><td>Cirsium horridulum</td><td>Little metalmark (Calephelis virginiensis)</td></tr>
<tr><td></td><td>Dyssodiopsis tagetoides</td><td>Dainty sulphur (Nathalis iole)</td></tr>
<tr><td></td><td>Gamochaeta spp.</td><td>American painted lady (Vanessa virginiensis)</td></tr>
<tr><td></td><td>Helenium spp.</td><td>Dainty sulphur (Nathalis iole)</td></tr>
<tr><td></td><td>Helianthus annuus</td><td>Gorgone checkerspot (Chlosyne gorgone)
Bordered patch (Chlosyne lacinia)
Silvery checkerspot (Chlosyne nycteis)</td></tr>
<tr><td></td><td>Palafoxia spp.</td><td>Dainty sulphur (Nathalis iole)</td></tr>
<tr><td></td><td>Pseudognaphalium spp.</td><td>American painted lady (Vanessa virginiensis)</td></tr>
<tr><td></td><td>Thelesperma spp.</td><td>Dainty sulphur (Nathalis iole)</td></tr>
<tr><td></td><td>Verbesina encelioides|
V. virginica</td><td>Bordered patch (Chlosyne lacinia)
Gorgone checkerspot (Chlosyne gorgone)</td></tr>
<tr><td>BRASSICACEAE</td><td>Arabis spp.| Brassica spp.|
Draba spp.| Lepidium spp.|
Lesquerella spp.|
Sisymbrium spp.|
Capsella bursa-pastoris</td><td>Checkered white (Pontia protodice)
Cabbage white (Pieris rapae) ♒</td></tr>
<tr><td></td><td>Arabis spp.| Draba spp.|
Descurainia pinnata</td><td>Olympia marble (Euchloe olympia)</td></tr>
<tr><td></td><td>Arabis canadensis|
Cardamine spp.</td><td>Falcate orangetip (Anthocaris midea)</td></tr>
<tr><td>CANNACEAE</td><td>Canna spp.</td><td>Brazilian skipper (Calpodes ethlius)</td></tr>
<tr><td>CHENOPODIACEAE</td><td>Atriplex spp.
Chenopodium album</td><td>Western pigmy blue (Brephidium exile)
Common sootywing (Pholisora catullus)
Hayhurst's scallopwing (Staphylus hayhurstii)</td></tr>
<tr><td>CUPRESSACEAE</td><td>Juniperus ashei|
J. pinchotii|
J. virginiana</td><td>Juniper hairstreak (Callophrys gryneus)</td></tr>
<tr><td>CYPERACEAE</td><td>Carex spp.</td><td>roadwing skipper (Poanes viator)
Dun skipper (Euphyes vestris)
Dion skipper (Euphyes dion)</td></tr>
<tr><td>EBENACEAE</td><td>Diospyros texana|
D. virginiana</td><td>Henry's elfin (Callophrys henrici)
Grey hairstreak (Strymon melinus)</td></tr>
<tr><td>ERICACEAE</td><td>Vaccinium spp.</td><td>Striped hairstreak (Satyrium liparops)</td></tr>
<tr><td>EUPHORBIACEAE</td><td>Croton spp.</td><td>Goatweed leafwing (Anaea andria)</td></tr>
</table>

PLANT		**BUTTERFLY**
FABACEAE	*Acacia angustissima* var. *hirta*	Outis skipper (*Cogia outis*)
	Amorpha spp.	Southern dogface (*Zerene cesonia*)
		Marine blue (*Leptotes marina*)
		Silver-spotted skipper (*Epargyreus clarus*)
		Northern cloudywing (*Thorybes pylades*)
	Astragalus spp.	Orange sulphur (*Colias eurytheme*)
		Southern cloudywing (*Thorybes bathyllus*)
		Northern cloudywing (*Thorybes pylades*)
		Confused cloudywing (*Thorybes confusis*)
		Wild indigo duskywing (*Erynnis baptisiae*)
	Baptisia spp.	Orange sulphur (*Colias eurytheme*)
		Frosted elfin (*Callophrys irus*)
		Eastern tailed-blue (*Cupido comyntas*)
		Wild indigo duskywing (*Erynnis baptisiae*)
	Centrosema virginianum	Orange sulphur (*Colias eurytheme*)
		Marine blue (*Leptotes marina*)
		Eastern tailed-blue (*Cupido comyntas*)
		Silver-spotted skipper (*Epargyreus clarus*)
	Cercis canadensis	Henry's elfin (*Callophrys henrici*)
	Chamaecrista fasciculata	Cloudless sulphur (*Phoebis sennae*)
		Sleepy orange (*Abaeis nicippe*)
		Little sulphur (*Pyrisitia lisa*)
	Clitoria mariana	Orange sulphur (*Colias eurytheme*)
		Marine blue (*Leptotes marina*)
		Eastern tailed-blue (*Cupido comyntas*)
		Silver-spotted skipper (*Epargyreus clarus*)
	Dalea spp.	Southern dogface (*Zerene cesonia*)
		Reakirt's blue (*Echinargus isola*)
		Marine blue (*Leptotes marina*)
	Desmodium spp.	Eastern tailed-blue (*Cupido comyntas*)
		Silver-spotted skipper (*Epargyreus clarus*)
		Southern cloudywing (*Thorybes bathyllus*)
		Northern cloudywing (*Thorybes pylades*)
	Eysenhardtia texana	Southern dogface (*Zerene cesonia*)
	Galactia spp.	Orange sulphur (*Colias eurytheme*)
		Marine blue (*Leptotes marina*)
		Eastern tailed-blue (*Cupido comyntas*)
		Silver-spotted skipper (*Epargyreus clarus*)
	Indigofera spp.	Reakirt's blue (*Echinargus isola*)
		Funereal duskywing (*Erynnis funeralis*)
	Lespedeza spp.	Eastern tailed-blue (*Cupido comyntas*)
		Silver-spotted skipper (*Epargyreus clarus*)
		Southern cloudywing (*Thorybes bathyllus*)
		Northern cloudywing (*Thorybes pylades*)
	Lupinus spp.	Henry's elfin (*Callophrys henrici*)
		Frosted elfin (*Callophrys irus*)
		Eastern tailed-blue (*Cupido comyntas*)
		Wild indigo duskywing (*Erynnis baptisiae*)
	Medicago spp.	Orange sulphur (*Colias eurytheme*)
		Southern dogface (*Zerene cesonia*)

PLANT		**BUTTERFLY**
FABACEAE (CONTINUED)	*Acacia angustissima*	Outis skipper (*Cogia outis*)
	Melilotus spp.	Orange sulphur (*Colias eurytheme*)
		Southern dogface (*Zerene cesonia*)
	Prosopsis glandulosa	Reakirt's blue (*Echinargus isola*)
		Ceraunus blue (*Hemiargus ceraunus*)
		Eastern tailed-blue (*Cupido comyntas*)
		Marine blue (*Leptotes marina*)
	Rhynchosia spp.	Orange sulphur (*Colias eurytheme*)
		Eastern tailed-blue (*Cupido comyntas*)
		Marine blue (*Leptotes marina*)
	Robinia pseudoacacia	Funereal duskywing (*Erynnis funeralis)*
		Zarucco duskywing (*Erynnis zarucco*)
	Senna spp.	Cloudless sulphur (*Phoebis sennae*)
		Sleepy orange (*Abaeis nicippe*)
		Little yellow (*Pyrisitia lisa*)
	Sesbania drummondii	Funereal duskywing (*Erynnis funeralis*)
	Sophora affinis|	Henry's elfin (*Callophrys henrici*)
	S. secundiflora	Wild indigo duskywing (*Erynnis baptisiae*)
	Trifolium. spp.	Orange sulphur (*Colias eurytheme*)
		Southern dogface (*Zerene cesonia*)
	Vicia spp.	Orange sulphur (*Colias eurytheme*)
		Northern cloudywing (*Thorybes pylades*)
		Funereal duskywing (*Erynnis funeralis*)
	Wisteria spp.	Silver-spotted skipper (*Epargyreus clarus*)
FAGACEAE	*Quercus* spp.	Banded hairstreak (*Satyrium calanus*)
		Edwards hairstreak (*Satyrium edwardsii*)
		White m hairstreak (*Parrhasius m-album*)
		Northern Oak hairstreak (*Satyrium favonius ontario*)
		Meridian duskywing (*Erynnis meridianus*)
		Juvenal's duskywing (*Erynnis juvenalis*)
		Horace's duskywing (*Erynnis horatius*)
		Sleepy duskywing (*Erynnis brizo*)
JUGLANDACEAE	*Juglans* spp.|	Banded hairstreak (*Satyrium calanus*)
	Carya spp.	Striped hairstreak (*Satyrium liparops*)
LAURACEAE	*Lindera benzoin*|	Spicebush swallowtail (*Papilio troilus*)
	Persea borbonia|	Palamedes Swallowtail (*Papilio palamedes*)
	Sassafras albidum	
LINACEAE	*Linum* spp.	Variegated fritillary (*Euptoieta claudia*)
MAGNOLIACEAE	*Liriodendron tulipifera*	Tiger swallowtail (*Papilio glaucus*)
MALVACEAE	*Abutilon fruticosum*|	Common checkered skipper (*Pyrgus communis*)
	Callirhoe spp.|	Tropical skipper (*Pyrgus oileus*)
	Malva spp.| *Sida* spp.|	Streaky skipper (*Celotes nessus*)
	Sphaeralcea spp.	
	Gossypium herbaceum	Gray hairstreak (Cotton Square Borer Caterpillar) (*Strymon melinus*)
	Hibiscus spp.	Gray hairstreak (*Strymon melinus*)

PLANT		**BUTTERFLY**
MORACEAE	*Morus* spp.	Mourning cloak (*Nymphalis antiopa*)
MYRICAEAE	*Myrica cerifera*| *M. heterophylla*	Red-banded hairstreak (*Calycopis cecrops*)
OLEACEAE	*Fraxinus* spp.	Tiger swallowtail (*Papilio glaucus*)
PASSIFLORACEAE	*Passiflora incarnata*| *P. caerulea*	Gulf fritillary (*Agraulis vanillae*)
		Variegated fritillary (*Euptoieta claudia*)
		Zebra heliconian (*Heliconius charithonius*)
PINACEAE	*Pinus* spp.	Eastern pine elfin (*Callophrys niphon*)
PLANTAGINACEAE	*Plantago* spp.	Buckeye (*Junonia coenia*)
POACEAE	*Andropogon* spp.	Common wood nymph (*Cercyonis pegala*)
		Arogos Skipper (*Atrytone arogos*)
		Delaware skipper (*Atrytone logan*)
		Dusted skipper (*Atrytonopsis hianna*)
	Arundinaria gigantea	Southern pearly-eye (*Enodia portlandia*)
		Creole pearly-eye (*Enodia creola*)
		Yehl skipper (*Poanes yehl*)
		Lace-winged skipper (*Amblyscirtes aesculapias*)
		Dusky roadside skipper (*Amblyscirtes alternata*)
	Bouteloua curtipendula	Orange skipperling (*Copaeodes aurantiacus*)
	Bouteloua gracilis	Green skipper (*Hesperia viridis*)
		Dotted skipper (*Hesperia attalus*)
	Chasmanthium latifolium	Bell's roadside skipper (*Amblyscirtes belli*)
	Cenchrus spp.	Eufala skipper (*Lerodea eufala*)
	Cynodon dactylon	Swarthy skipper (*Nastra lherminier*)
		Orange skipperling (*Copaeodes aurantiacus*)
		Southern skipperling (*Copaeodes minima*)
		Whirlabout (*Polites vibex*)
		Sachem (*Atalopedes campestris*)
		Eufala skipper (*Lerodea eufala*)
	Dichanthelium spp.	Northern broken dash (*Wallengrenia egeremet*)
	Digitaria spp.	Sachem (*Atalopedes campestris*)
		Nysa roadside skipper (*Amblyscirtes nysa*)
	Echinochloa crusgalli	Eufala skipper (*Lerodea eufala*)
	Eleusine indica| *Festuca* spp.	Sachem (*Atalopedes campestris*)
	Leersia oryzoides	Least skipper (*Ancyloxypha numitor*)
	Nasella leucotricha	Common wood nymph (*Cercyonis pegala*)
	Panicum spp.	Least skipper (*Ancyloxypha numitor*)
		Delaware skipper (*Anatrytone logan*)
		Broadwing skipper (*Poanes viator*)
		Northern broken dash (*Wallengrenia egeremet*)
	Panicum obtusum	Dotted roadside skipper (*Amblyscirtes eos*)
	Paspalum setaceum	Whirlabout (*Polites vibex*)
		Nysa roadside skipper (*Amblyscirtes nysa*)
	Phragmites australis	Broadwing skipper (*Poanes viator*)
	Poa pratensis	Least skipper (*Ancyloxypha numitor*)
		Fiery skipper (*Hylephila phyleus*)

PLANT		**BUTTERFLY**
POACEAE (*continued*)		Whirlabout (*Polites vibex*)
		Common roadside skipper (*Amblyscirtes vialis*)
	Schizachyrium scoparium	Swarthy skipper (*Nastra lherminier*)
		Cobweb skipper (*Hesperia metea*)
		Meske's skipper (*Hesperia meskei*)
		Arogos skipper (*Atrytone arogos*)
	Setaria spp.	Least skipper (*Ancyloxypha numitor*)
		Eufala skipper (*Lerodea eufala*)
		Nysa roadside skipper (*Amblyscirtes nysa*)
	Sorghum spp.	Eufala skipper (*Lerodea eufala*)
		Clouded skipper (*Lerema accius*)
		Celia's roadside skipper (*Amblyscirtes celia*)
	Stenotaphrum secundatum	Clouded skipper (*Lerema accius*)
		Whirlabout (*Polites vibex*)
		Sachem (*Atalopedes campestris*)
		Common roadside skipper (*Amblyscirtes vialis*)
	Tridens flavus	Common wood nymph (*Cercyonis pegala*)
		Little glassywing (*Pompeius verna*)
	Zea mays	Eufala skipper (*Lerodea eufala*)
	Zizaniopsis miliacea	Broadwing skipper (*Poanes viator*)

Note: All of the satyr butterflies (Satyrinae) and all of the "grass skippers" (Hesperiinae) use various grasses, only some of which are known. There may be many grasses used by these butterflies in addition to the ones listed above.

RHAMNACEAE	*Ceanothus americanus*	Red-banded hairstreak (*Calycopis cecrops*)
		Grey hairstreak (*Strymon melinus*)
		Mottled duskywing (*Erynnis martialis*)
ROSACEAE	*Prunus angustifolia*|	Red-spotted purple (*Limenitis arthemis astyanax*)
	P. gracilis| *P. mexicana*|	Grey Hairstreak (*Strymon melinus*) ✿
	P. munsoniana| *P. rivularis*|	Coral hairstreak (*Satyrium titus*) ●
	P. serotina| *P. umbellata*	Striped hairstreak (*Satyrium liparops*)
RUTACEAE	*Ptelea trifoliata*|	Giant swallowtail (*Papilio cresphontes*)
	Zanthoxylum spp.	
	Ruta graveolens	Black swallowtail (*Papilio polyxenes*)
		Giant swallowtail (*Papilio cresphontes*)
SALICACEAE	*Populus deltoides*	Tiger swallowtail (*Papilio glaucus*)
	Salix spp.	Tiger swallowtail (*Papilio glaucus*)
		Viceroy (*Limenitis archippus*)
		Red-spotted admiral (*Limenitis arthemis astyanax*)
		Mourning cloak (*Nymphalis antiopa*)
SAPINDACEAE	*Sapindus saponaria*|	Soapberry hairstreak (*Phaeostrymon alcestis*)
	Ungnadia speciosa	
	Ungnadia speciosa	Henry's elfin (*Callophrys henrici*)
SCROPHULARIACEAE	*Agalinis* spp.|	Buckeye (*Junonia coenia*)
	Castilleja indivisa|	
	C. purpurea|	
	Linaria vulgaris|	

PLANT		BUTTERFLY
SCROPHULARIACEAE (CONTINUED)	*Maurandya antirrhiniflora*| *Nuttallanthus canadensis*| *N. texana*	BUCKEYE (*Junonia coenia)*
SYMPLOCACEAE	*Symplocos tinctoria*	KING'S HAIRSTREAK (*Satyrium kingi*)
ULMACEAE	*Ulmus* spp.	TIGER SWALLOWTAIL (*Papilio glaucus*)
		RED-SPOTTED ADMIRAL (*Limenitis arthemis astyanax*)
		MOURNING CLOAK (*Nymphalis antiopa*)
		QUESTIONMARK (*Polygonia interrogationis*)
		COMMA (*Polygonia comma*)
	Celtis spp.	HACKBERRY EMPEROR (*Asterocampa celtis*)
		TAWNY EMPEROR (*Asterocampa clyton*)
		QUESTIONMARK (*Polygonia interrogationis*)
		COMMA (*Polygonia comma*)
		AMERICAN SNOUT (*Libytheana carinenta*)
URTICACEAE	*Boehmeria* spp.| *Urtica* spp.	RED ADMIRAL (*Vanessa atalanta*)
		COMMA (*Polygonia comma*)
VERBENACEAE	*Lippia* spp.	PHAON CRESCENT (*Phyciodes phaon*)
	Lantana spp.	GREY HAIRSTREAK (*Strymon melinus*) {buds and flowers only}
VIOLACEAE	*Viola* spp.	VARIEGATED FRITILLARY (*Euptoieta claudia*)
VISCACEAE	*Phoradendron tomentosa*	GREAT PURPLE HAIRSTREAK (*Atlides halesus*)

LARVAL HOST PLANTS OF EAST TEXAS MOTHS

The caterpillars of many moths, such as the Io moth (*Automeris io*) are polyphagous, that is, these larvae consume the leaves of many different plants in different families, completing their larval stages on the plant where the eggs were laid. The most common host plants in this area are listed.

The list of moths is by no means complete. An effort has been made to list the largest, the most spectacular, and/or the most common moths in this region.

♒ INDICATES LARVAE MAY BE VERY DESTRUCTIVE TO CULTIVATED PLANTS
✴ INDICATES LARVAE HAVE URTICATING SPINES AND SHOULD BE AVOIDED

PLANT		MOTH
ACERACEAE	*Acer* spp.	IMPERIAL MOTH (*Eacles imperialis*)
		CECROPIA MOTH (*Hyalophora cecropia*)
		POLYPHEMUS MOTH (*Antherea polyphemus*)
		ROSY-MAPLE MOTH (*Dryocampa rubicunda*)
		FOREST TENT CATERPILLAR (*Malacosoma disstria*) ♒
		AMERICAN DAGGER MOTH (*Acronicta americana*)
		FIGURE-EIGHT SALLOW (*Psaphida resumens*)
AGAVACEAE	*Yucca* spp.	YUCCA MOTH (*Tegeticula yuccasella*)
ANACARDIACEAE	*Rhus* spp.	LUNA MOTH (*Actias luna*)

PLANT		**MOTH**
ANNONACEAE	*Asimina parviflora*|	Pink-spotted sphinx (*Agrius cingulatus*)
	A. triloba	Pawpaw sphinx (*Dolba hyloeus*)
		Tulip tree beauty (*Epimecis hortaria*)
APOCYNACEAE	*Apocynum cannabinum*	Snowberry clearwing (*Hemaris diffinis*)
AQUIFOLIACEAE	*Ilex decidua*| *I. glabra*| *I. vomitoria*	Pawpaw sphinx (*Dolba hyloeus*)
ASCLEPIADACEAE	*Asclepias* spp.| *Cynanchum leave*| *Funastrum cynanchoides*	Milkweed tussock moth (*Euchaetes egle*)
ASTERACEAE	*Ambrosia* spp.	Ragweed flower moth (*Schinia rivulosa*)
	Ambrosia trifida	Thoreau's flower moth (*Schinia thoreaui*)
		Wavy-lined emerald (*Synchlora aerata*)
	Aster spp.	Arcigera flower moth (*Schinia arcigera*)
		Goldenrod flower moth (*Schinia nundina*)
		Wavy-lined emerald (*Synchlora aerata*)
	Brickellia eupatorioides	Three-lined flower moth (*Schinia trifascia*)
	Cirsium spp.	Parthenice tiger moth (*Grammia parthenice*)
	Erigeron spp.	Lynx flower moth (*Schinia lynx*)
		Wavy-lined emerald (*Synchlora aerata*)
	Eupatorium spp.	Clymene moth (*Haploa clymene*)
		Eupatorium borer moth (*Carmenta bassiformis*) ♒
	Liatris spp.	Glorious flower moth (*Schinia gloriosa*)
	Solidago spp.	Goldenrod flower moth (*Schinia nundina*)
	Vernonia spp.	Parthenice tiger moth (*Grammia parthenice*)
BETULACEAE	*Betula nigra*	Cecropia moth (*Hyalophora cecropia*)
		Large tolype (*Tolype velleda*)
		Black-blotched prominent (*Schizura leptinoides*)
		Unicorn caterpillar moth (*Schizura unicornis*)
		Elm spanworm (*Ennomos subsignaria*)
		Small parasa (*Parasa chloris*) ✴
	Ostrya virginiana	Skiff moth (*Prolimacodes badia*) ✴
BIGNONIACEAE	*Catalpa* spp.|	Catalpa sphinx (*Ceratomia catalpae*)
	Campsis radicans|	Rustic sphinx (*Manduca rustica*)
	Chilopsis linearis	Plebian sphinx (*Paratrea plebeja*)
CAPRIFOLIACEAE	*Lonicera* spp.	Hummingbird clearwing (*Hemaris thysbe*)
	Symphoricarpos orbiuclatus	Snowberry clearwing (*Hemaris diffinis*)
	Viburnum spp.	Azalea sphinx (*Darapsa pholus*)
CONVOLVULACEAE	*Ipomoea* spp.	Morning glory prominent (*Schizura ipomoeae*)
CORNACEAE	*Cornus* spp.	Cecropia moth (*Hyalophora cecropia*)
		Dogwood borer moth (*Synanthedon scitula*) ✴
	Cornus florida	Dogwood thyatrid (*Euthyatria pudens*)
CUCURBITACEAE	*Cucurbita* spp.	Squash vine borer moth (*Melittia cucurbitae*) ♒
CUPRESSACEAE	*Juniperus virginiana*	Curve-lined angle (*Semiothisa continuata*)
		Juniper geometer (*Patalene olyzonaria*)
	Taxodium spp.	Cypress sphinx (*Isoparce cupressi*)

<table>
<tr><th>PLANT</th><th></th><th>MOTH</th></tr>
<tr><td>EBENACEAE</td><td>Diospyros spp.</td><td>Luna moth (Actias luna)
Royal walnut moth (hickory horned devil) (Citheronia regalis)
The penitent (Catocala piatrix)
Red-humped caterpillar moth (Schizura concinna)
Southern flannel moth (Megalopyge opercularis) ✳</td></tr>
<tr><td>ERICACEAE</td><td>Rhododendron spp.</td><td>Azalea sphinx (Darapsa pholus)</td></tr>
<tr><td>FABACEAE</td><td>Acacia spp.</td><td>Black witch (Ascalapha odorata)</td></tr>
<tr><td></td><td>Amorpha canescens|
Amorpha fruticosa</td><td>Black-spotted prominent (Dasylophia anguina)</td></tr>
<tr><td></td><td>Baptisia spp.</td><td>Black-spotted prominent (Dasylophia anguina)
Three-staffed underwing (Catocala amestris)</td></tr>
<tr><td></td><td>Cassia spp.</td><td>Black witch (Ascalapha odorata)</td></tr>
<tr><td></td><td>Cercis canadensis</td><td>Io moth (Automeris io) ✳
White flannel moth (Norape ovina) ✳</td></tr>
<tr><td></td><td>Gleditsia spp.|
Gymnocladus dioicus</td><td>Honey locust moth (Sphingicampa bicolor)
Bisected honey locust moth (Sphingicampa bisecta)</td></tr>
<tr><td></td><td>Lespedeza spp.|
Lupinus spp.</td><td>Bella moth (Utetheisa bella)</td></tr>
<tr><td></td><td>Prosopis spp.</td><td>Io moth (Automeris io) ✳</td></tr>
<tr><td></td><td>Robinia spp.</td><td>The betrothed (Catocala innubens)
Magdalen underwing (Catocala illecta)
Black-spotted prominent (Dasylopha anguina)</td></tr>
<tr><td>FAGACEAE</td><td>Fagus grandifolia</td><td>Luna moth (Actias luna)
Morning glory prominent (Schizura ipomoeae)</td></tr>
<tr><td></td><td>Quercus spp.</td><td>Waved sphinx (Ceratomia undulosa)
Blinded sphinx (Paonias excaecatus)
Buckmoth (Hemileuca maia) ✳
Grote's buckmoth (Hemileuca grotei) ✳
Polyphemus moth (Antherea polyphemus)
Imperial moth (Eacles imperialis)
Spiny oakworm moth (Anisota stigma)
Pink-striped oakworm moth (Anisota virginiensis)
Discolored oak-worm moth (Anisota discolor)
Ilia underwing (Catocala ilia)
Delilah underwing (Catocala delilah)
Scarlet underwing (Catocala coccinata)
Little nymph (Catocala micronympha)
Girlfriend underwing (Catocala amica)
Connubial underwing (Catocala connubialis)
Fall webworm moth (Hyphantria cunea) ♒
Lobelia dagger moth (Acronicta lobeliae)
Confused meganola (Meganola minuscula)
Oblique heterocampa (Heterocampa obliqua)
Mottled prominent (Macrurocampa marthesia)
White-streaked prominent (Oligocentria lignicolor)
Unicorn caterpillar moth (Schizura unicornis)
Tephra tussock moth (Dasychira tephra)
Elm spanworm (Ennomos subsignaria)</td></tr>
</table>

PLANT		**MOTH**
FAGACEAE (continued)	*Quercus* spp.	Spiny oak slug (*Euclea delphinii*) ✳
		Crowned slug (*Isa textula*) ✳
		Small parasa (*Parasa chloris*) ✳
		Southern flannel moth (Texas "asp") (*Megalopyge opercularis*) ✳
		Figure-eight sallow (*Psaphida resumens*)
		Hag moth (*Phobetron pithecium*) ✳
	Quercus fusiformis	Buckmoth (*Hemileuca maia*) ✳
		Grote's buckmoth (*Hemileuca grotei*) ✳
GENTIANACEAE	*Sabatia* spp.	Short-lined chocolate moth (*Argyrostrotis anilis*)
HAMAMELIDACEAE	*Hamamelis virginiana*	Figure-seven moth (*Synedoida grandirena*)
	Liquidambar styraciflua	Luna moth (*Actias luna*)
		Regal moth (*Citheronia regalis*)
		Imperial moth (*Eacles imperialis*)
JUGLANDACEAE	*Carya* spp.	Royal walnut moth (*Citheronia regalis*)
		Sad underwing (*Catocala maestosa*)
		The consort (*Catocala consors*)
		Epione underwing (*Catocala epione*)
		The penitent (*Catocala piatrix*)
		Tearful underwing (*Catocala lacrymosa*)
		The bride (*Catocala neogama*)
		Hickory tussock moth (*Lophocampa caryae*) ✳
		Walnut caterpillar (*Datana integerrima*) ♒
	Carya illinoinensis	Agrippina underwing (*Catocala agrippina*)
	Juglans nigra	Walnut sphinx (*Laothoe juglandis*)
		Royal walnut moth (*Citheronia regalis*)
		Sad underwing (*Catocala maestosa*)
		The bride (*Catocala neogama*)
LAURACEAE	*Lindera benzoin*	Promethea (*Callosamia promethea*)
	Sassafras albidum	Promethea (*Callosamia promethea*)
		Imperial moth (*Eacles imperialis*)
		Tulip-tree beauty (*Epimecis hortaria*)
		Black-waved flannel moth (*Lagoa crispata*) ✳
LILIACEAE	*Hymenocallis* spp.	Spanish moth (*Xanthopastis timais*)
MAGNOLIACEAE	*Liriodendron tulipifera*	Promethea (*Callosamia promethea*)
	Magnolia spp.	Tulip-tree beauty (*Epimecis hortaria*)
MALVACEAE	*Gossypium hirsutum*	Regal moth (*Citheronia regalis*)
		Corn earworm moth (*Heliothis zea*) ♒
MORACEAE	*Maclura pomifera*	Hagen's sphinx moth (*Ceratomia hageni*)
MYRICACEAE	*Myrica* spp.	The little wife (*Catocala muliercula*)
		Plain Schizura (*Schizura apicalis*)
		Skiff moth (*Prolimacodes badia*) ✳
		Black-waved flannel moth (*Lagoa crispata*) ✳
NYCTAGINACEAE	*Mirabilis* spp.	White-lined sphinx (*Hyles lineata*)
OLEACEAE	*Fraxinus* spp.	Waved sphinx (*Ceratomia undulosa*)

PLANT		**MOTH**
OLEACEAE (continued)	*Ligustrum* spp.	Ash sphinx (*Manduca jasminearum*)
		Great ash sphinx (*Sphinx chersis*)
		The penitent (*Catocala piatrix*)
ONAGRACEAE	*Calylophus* spp.	Proud sphinx (*Proserpinus gaurae*)
	Gaura spp.| *Ludwigia* spp.	White-lined sphinx (*Hyles lineata*)
		Banded sphinx (*Eumorpha fasciata*)
		Pearly wood nymph (*Eudryas unio*)
		Primrose moth (*Schinia florida*)
		Clouded crimson (*Schinia gaurae*)
	Oenothera spp.	Primrose moth (*Schinia florida*)
PASSIFLORACEAE	*Passiflora* spp.	Plebian sphinx (*Paratrea plebeja*)
PINACEAE	*Pinus*	Imperial moth (*Eacles imperialis*)
		Eastern panthea (*Panthea furcilla*)
		Small tolype (*Tolype notialis*)
		Nameless pinion (*Lithophane innominata*)
		Yellow headed looper moth (*Lambdina pellucidaria*)
PLANTAGINACEAE	*Plantago* spp.	Figured tiger moth (*Grammia figurata*)
POACEAE	*Andropogon* spp.|	Io Moth (*Automeris io*) ✷
	Bouteloua spp.|	Isabella tiger moth (*Pyrrharctia isabella*)
	Digitaria spp.|	Forage looper moth (*Caenurgina erechtea*)
	Tridens spp.	Texas mocis (*Mocis texana*)
	(+ many others)	Saddleback caterpillar (*Sibine stimulea*) ✷
	Zea mays	Corn earworm moth (*Heliothis zea*) ♒
ROSACEAE	*Crataegus* spp.	Waved sphinx (*Ceratomia undulosa*)
		Texarkana underwing (*Catocala texarkana*)
		Orba underwing (*Catocala orba*)
		Wonderful underwing (*Catocala mira*)
		Woody underwing (*Catocala grynea*)
		Johnson's euchlaena (*Euchlaena johnsonaria*)
	Malus domestica	Red-humped caterpillar moth (*Schizura concinna*) ♒
	Prunus spp.	One-eyed sphinx (*Smerinthus cerisyi*)
		Blinded sphinx (*Paonias excaecatus*)
		Small-eyed sphinx (*Paonias myops*)
		Walnut sphinx (*Laothoe juglandis*)
		White-lined sphinx (*Hyles lineata*)
		Saddleback caterpillar moth (*Sibine stimulea*) ✷
	Prunus persica	Reversed haploa (*Haploa reversa*) ♒
		Peachtree borer (*Synanthedon exitiosa*) ♒
	Prunus serotina	Cecropia moth (*Hyalophora cecropia*)
		Cherry dagger moth (*Acronicta hasta*)
		Lobelia dagger moth (*Acronicta lobeliae*)
		White furcula (*Furcula borealis*)
		Unicorn caterpillar moth (*Schizura unicornis*)
		Common metarranthis (*Metarranthis hypocharia*)
		Forked euchlaena (*Euchlaena pectinaria*)
		Large maple spanworm moth (*Prochoerodes transversata*)
		Purple-crested slug (*Adoneta spinuloides*) ✷

PLANT		**MOTH**
RUBIACEAE	*Cephlanthus occidentalis*	TERSA SPHINX (*Xylophanes tersa*) HYDRANGEA SPHINX (*Darapsa versicolor*)
SALICACEAE	*Populus* spp.| *Salix* spp.	BIG POPLAR SPHINX (*Pachysphinx modesta*) ONE-EYED SPHINX (*Smerinthus cerisyi*) TWIN-SPOTTED SPHINX (*Smerinthus jamaicensis*) POLYPHEMUS (*Antherea polyphemus*) CECROPIA (*Hyalophora cecropia*) THE BROTHER (*Raphia frater*) THE ABRUPT BROTHER (*Raphia abrupta*) BLACK-RIMMED PROMINENT (*Pheosia rimosa*) RED-MARKED TENTMAKER (*Clostera apicalis*) WESTERN FURCULA (*Furcula occidentlis*) LACK-ETCHED PROMINENT (*Cerura scitiscripta*) COMMON GLUPHISIA (*Gluphisia septentrionis*) PLAIN SCHIZURA (*Schizura apicalis*)
	Populus ssp.	ELEGANT PROMINENT (*Odontosia elegans*)
	Salix ssp.	JOINED UNDERWING (*Catocala junctura*) UNICORN CATER-CATERPILLAR MOTH (*Schizura unicornis*)
	Salix nigra	DARLING UNDERWING (*Catocala cara*)
SCROPHULARIACEAE	*Leucophyllum frutescens*	GREAT ASH SPHINX (*Sphinx chersis*)
SMILACACEAE	*Smilax rotundifolia*	SPOTTED PHOSPHILA (*Phosphila miselioides*)
SOLANACEAE	*Datura* spp.| *Solanum* spp.| *Nicotiana* spp.	PINK-SPOTTED HAWKMOTH (*Agrius cingulatus*) ♒ CAROLINA SPHINX (*Manduca sexta*) ♒ FIVE-SPOTTED HAWKMOTH (*Manduca quinquemaculata*) ♒ TOBACCO BUDWORM MOTH (*Heliothis virescens*) ♒ CORN EARWORM MOTH (*Heliothis zea*) ♒
TILIACEAE	*Tilia* spp.	FOUR-HORNED SPHINX (*Ceratomia amyntor*) WAVED SPHINX (*Ceratomia undulosa*) IMPERIAL MOTH (*Eacles imperialis*)
ULMACEAE	*Ulmus* spp.| *Celtis* spp.	ELM SPHINX (*Ceratomia amyntor*) BLINDED SPHINX (*Paonias excaecatus*) IO MOTH (*Automeris io*) ✴ OCHRE DAGGER MOTH (*Acronicta morula*) DOUBLE-TOOTHED PROMINENT (*Nerice bidentata*) ELM SPANWORM (*Ennomos subsignaria*) ♒ SADDLEBACK CATERPILLAR MOTH (*Sibine stimulea*) ✴ Small parasa (*Parasa chloris*) ✴ PEPPER & SALT GEOMETER (*Biston betularia cognataria*) WHITE FLANNEL MOTH (*Norape ovina*) ✴ SOUTHERN FLANNEL MOTH (*Megalopyge opercularis*) ✴
VITACEAE	*Ampelopsis* spp.| *Cissus* spp.| *Parthenocissus* spp. *Vitis* spp.	HOG SPHINX (*Darapsa myron*) VINE SPHINX (*Eumorpha vitis*) ABBOTT'S SPHINX (*Sphecodina abbottii*) NESSUS SPHINX (*Amphion nessus*) GAUDY SPHINX (*Eumorpha labruscae*) PANDORA SPHINX (*Eumorpha pandora*)

PLANT		**MOTH**
VITACEAE (*CONTINUED*)	*Vitis* spp.	ACHEMON SPHINX (*Eumorpha achemon*) EIGHT-SPOTTED FORESTER (*Alypia octomaculata*) EPIMENIS MOTH (*Psychomorpha epimenis*) SADDLEBACK CATERPILLAR MOTH (*Sibine stimulea*) ✳ GRAPEVINE SKELETONIZER MOTH (*Harrisina americana*)

Commercially Important Timber Trees of East Texas

No wonder the hotel was empty, the bank closed, the stores out of business: for on the other side of the railroad, down by the wide pond that once held beautiful, fine-grained logs of longleaf pine, the big sawmill that for twenty years had been the pulsing heart of this town was already sagging on its foundations, its boilers dead, its deck stripped of all removable machinery. Within the town grass was beginning to grow in the middle of every street, and broken window lights bespoke deserted houses. In county after county across the South the pinewoods have passed away. Their villages are Nameless Towns, their monuments huge piles of saw dust, their epitaph: "The mill cut out."

—R.D. Forbes, 1923 (from Sitton & Conrad 1989)

East Texas is truly a transformed land. Commercial lumbering began in the early 1800s with only a few isolated mills harvesting lumber for such uses as boat building, barrel staves, and shingles. In the late 1880s, commercial lumbering exploded in East Texas due to an abundance of huge, highly valuable longleaf pines, relatively cheap land prices, homesteading, and particularly, the opening of the area to railroads. By 1917, old-growth pine stands were rare, and by 1930, virtually nonexistent. In the first 50 years of major commercial pine lumbering, an entire ecosystem was transformed. Early lumber harvesting in East Texas was perhaps the most incredible and ecologically devastating commercial enterprise ever undertaken in the state. For many decades, there were virtually no resource management strategies or sustainable harvesting practices, though some early voices (e.g., W. Goodrich Jones—the "father of Texas forestry"), called for reforestation and planned-cutting. Lumbering was purely an "extractive industry," much like mining. Historical information and photographs of early Texas forests and lumbering can be found in the introduction of this volume beginning on pages 80 and 183.

Today, things are very different. Modern lumber companies still have an impact in the Pineywoods, but their methods are, for the most part, scientifically based and sustainable. The remaining large lumber companies in Texas (e.g., Temple-Inland) are active in researching and implementing new methods that will increase productivity without sacrificing the ecosystem or the ability to regrow trees on their lands. Further, the National Forests in East Texas are managed based on a Land Management Plan that limits clearcuts to 40 acres and requires loggers to leave stumps and slash (tree tops and limbs) to decay on-site, thus recycling nutrients to the soil. While private landowners can log in any way they deem fit, and examples of short-sighted methods are still frequently seen, the Texas Forest Service and the Texas Forestry Association encourage responsible logging, and in general, the situation is significantly improved.

The vast areas of Texas once inhabited by longleaf and shortleaf pines are now largely farms, cities, roads, and loblolly pine plantations. Most early lumbering was softwood-specific, so a few old-growth and significant amounts of second- or third-growth hardwoods remain. These hardwoods are coming under increasing pressure as their bottomland habitats are destroyed (e.g., water impoundment projects) and because they are becoming more and more valuable commercially as new uses for them are found. Since most hardwoods grow more slowly than pines, their harvesting needs to be carefully managed and monitored.

The Texas Forest Service, part of the Texas A&M University System, is active in many kinds of forestry research. Its mission is to provide statewide leadership to assure the state's forests, trees, and related natural resources are wisely used, nurtured, protected and perpetuated for the benefit of all Texans.

This appendix is intended to provide information on some of the commercially most important timber trees in East Texas. The information includes descriptions, range and habitat data, historical and current uses of the wood of each species, and other significant information. Nineteen tree species, listed in the table below, are included in this appendix. They represent the majority of current timber production and/or possess a great deal of historical significance.

Acer rubrum	RED MAPLE
Carya tomentosa	MOCKERNUT HICKORY
Celtis laevigata	HACKBERRY
Fraxinus pennsylvanica	GREEN ASH
Juglans nigra	BLACK WALNUT
Liquidambar styraciflua	SWEETGUM
Nyssa sylvatica	BLACK TUPELO
Pinus echinata	SHORTLEAF PINE
Pinus palustris	LONGLEAF PINE
Pinus taeda	LOBLOLLY PINE
Platanus occidentalis	AMERICAN SYCAMORE
Quercus alba	WHITE OAK
Quercus falcata	SOUTHERN RED OAK
Quercus nigra	WATER OAK
Quercus phellos	WILLOW OAK
Quercus shumardii	SHUMARD'S OAK
Quercus stellata	POST OAK
Taxodium distichum	BALD-CYPRESS
Ulmus americana	AMERICAN ELM

In addition to original observations and measurements, material for this appendix was obtained from a variety of sources listed in the literature cited. Of particular assistance were the following: Hough 1898; Sargent 1922; Peattie 1948; Kingsbury 1964; Walker 1975; Elias 1980; Little 1980; Paushin & deZeeuw 1980; Stalter 1981; Simpson 1988; Stahle et al. 1988; Cox & Leslie 1991; Zhicheng 1992; Flora of North America Editorial Committee 1993, 1997; Appel & Billings 1995; Desch & Dinwoodie 1996; Stahle 1996a; Kaul 1997; Nesom 1998; Sitton & Conrad 1998; Burnham & Graham 1999; Diggs et al. 1999; Graham 1999; Burrows & Tyrl 2001; Boyer et al. 2003; Natural Source 2005a, 2005b; Texas Forest Service 2005; Glenn Donnahoe, pers. comm.

ACER RUBRUM L. RED MAPLE (ACERACEAE, MAPLE FAMILY)

Other Common Names: DRUMMOND RED MAPLE, TRIDENT RED MAPLE, SWAMP MAPLE, WATER MAPLE, SCARLET MAPLE, SOFT MAPLE, CAROLINA RED MAPLE

Form and Size: medium to tall tree to 28+ m; trunk straight, to 1.5 m in diameter; crown narrow to broadly rounded.

Leaves: leaves deciduous, simple, opposite, 5–15 cm long, 3.5–10 cm wide, bright green above, pale or whitish and finely hairy beneath, but turning vivid red, orange and yellow in autumn, 3–5 lobed, the spaces (= sinuses) between the main lobes sharply angled or V-shaped, the lobes pointed at the tip, marginally coarsely singly or doubly toothed; petioles slender, 5–10 cm long, smooth to slightly hairy, usually red.

Buds: 3–4 mm long, broadest near the base and rounded at the tip, covered with overlapping, dark red scales.

Flowers: flowers usually unisexual, the male and female flowers usually occurring on separate trees (plants dioecious), sometimes with some perfect flowers (plants polygamo-dioecious) or with many-flowered clusters of male and female flowers on the same tree; flowers appearing before the leaves develop, each flower on a slender stalk, reddish, with a 5-lobed calyx and 5 short (ca. 2 mm), inconspicuous petals; male flowers with 5–8 stamens; female flowers with a single pistil.

Fruits: paired, one-seeded, winged samaras, dry, (12–)15–26 mm long, 6–12 mm wide, hanging on a slender stalk; wing red, reddish-brown, or yellow, the wings spreading at a 50°–60° angle.

Bark: dark gray, thin to 1.4 cm thick, smooth at first, later developing shallow furrows and flat scaly plates or broad ridges.

Wood: sapwood white, wide; heartwood light brown, sometimes with a grayish or greenish tinge or with a faint purplish cast; wood straight-grained (sometimes curly-grained), moderately heavy and hard; growth rings not very distinct; the wood is known in the lumber industry as "soft maple" (in contrast to the term "hard maple" used for the wood of *Acer saccharum*, sugar maple).

Habitat: most common in wet or swampy sites and low woods but also found on drier uplands.

Range: Pineywoods and eastern Post Oak Savannah, west in Red River drainage to Fannin Co., and in northern Gulf Prairies and Marshes; widespread in the eastern U.S. and southern Canada.

Principal Uses: furniture, cabinet work, flooring, interior finish material, boxes, crates, veneers, gun stocks, woodenware, pulpwood; burned in kilns to produce wood acetate and charcoal.

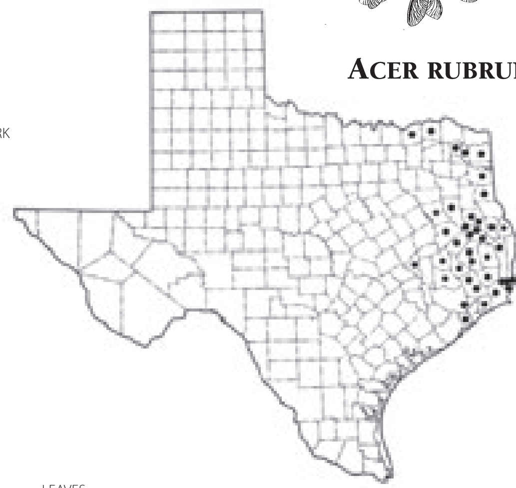
Historical Uses: plates, spinning wheels, spools and other turnery, feet for chairs and beds; pioneers made ink by adding sulfate of iron to the tannin extracted from the bark.

Other Significant Information: *Acer rubrum* has something red about it in all seasons. In winter the buds are red; in spring red flowers are present; in summer the leaf stalks are reddish; and in autumn the foliage turns crimson or wine red. This brilliant fall foliage makes red maple extremely popular as an ornamental. The spring sap is sweet and can be used like that of sugar maple for making syrup. However, red maple buds break dormancy earlier in the spring and the chemical content of the sap soon changes, giving the syrup an undesirable flavor; thus there is a shorter tapping season. The leaves and bark are poisonous to livestock. Ingestion can disrupt hemoglobin's ability to bind oxygen, and at relatively high doses death can result in as little as 18 hours. The specific toxins are not known, although it is thought that tannins may be involved. Varieties are often recognized in this species; in var. *rubrum* the lower surface of the leaf blades are glabrous or with hairs only along the veins, while in var. *trilobum* Torr. & A. Gray ex K. Koch and var. *drummondii* (Hook. & Arn. ex Nutt.) Sarg. the lower surface of the leaf blades are densely and usually permanently hairy; var. *trilobum* is differentiated by having 3-lobed leaf blades, the smaller lateral basal lobes suppressed, while var. *rubrum* and var. *drummondii* have leaf blades usually with 5 lobes (the lateral basal lobes small).

Recognition in the Field: leaves simple, *opposite*, with *3–5 obvious, pointed, coarsely toothed lobes*, the central lobe not narrowed at base, the sinuses between the main lobes sharply angled or V-shaped; fruits paired, one-seeded, *winged samaras* which eventually separate and function as wind-dispersed small "helicopters."

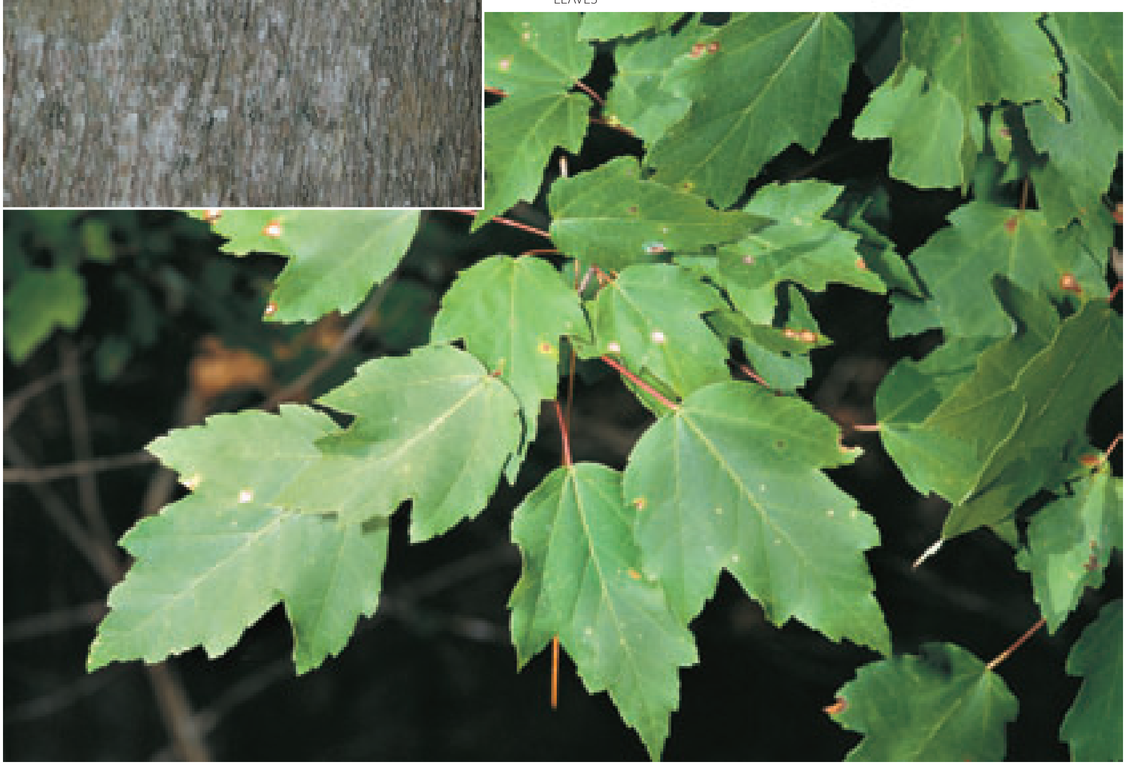
WOOD

BARK



Acer rubrum

LEAVES



Carya tomentosa (Lam. ex Poir.) Nutt. MOCKERNUT HICKORY (Juglandaceae, walnut family)

Other Common Names: WHITE HICKORY, HOGNUT, BULLNUT, FRAGRANT HICKORY, BIGBUD HICKORY, HARD-BARK HICKORY, WHITE-HEART HICKORY.

Form and Size: large tree to 36 m; trunk straight, to 1.5 m in diameter, unbranched for about half its height in the forest or widely branched and spreading in the open; crown shape highly variable.

Leaves: deciduous, compound, alternate, with (5–)7–9 leaflets per leaf; leaflets fragrant, having a spicy odor when crushed, 4–22 cm long and 2–12.5 cm wide, the lower pairs slightly smaller than upper, symmetrical (not falcate), the upper surfaces dark yellow-green, the lower surfaces velvety to the touch.

Buds: terminal buds tan (after early loss of reddish brown outer scales), broadly ovoid, very broad at the base, 8–20 mm long, tomentose; bud scales 3–4, imbricate (= overlapping); axillary buds about half the size of the terminal bud, protected by bracteoles fused into a hood.

Flowers: flowers unisexual, the male and female flowers on same tree (plants monoecious), appearing with the leaves in spring, inconspicuous, without corollas; male flowers usually with 4 stamens, in stalked, 3-clustered, light green catkins 10–15 cm long; female flowers 2–5 on short spikes at the ends of new branches.

Fruits: occurring singly or in small clusters, spherical to ellipsoid or obovoid, 30–50 mm long and almost as wide, with husk ca. 3–15 mm thick splitting to expose the nut; nuts tan, spherical to ellipsoid, prominently to faintly 4-angled, the shells usually very thick, the kernels sweet.

Bark: dark gray or brownish and relatively thin with a crisscross or net-like pattern of shallow furrows and flat narrow ridges, close (not shaggy).

Wood: sapwood whitish to pale brown, wide; heartwood pale brown to brown, or reddish brown; wood straight-grained, very hard; growth rings distinct.

Habitat: well-drained sandy soils, typically in uplands (particularly on Ultisols = deeply weathered, somewhat infertile, acidic soils).

Range: Pineywoods and northeastern Post Oak Savannah, also Gonzales Co. and northern Gulf Prairies and Marshes; widespread in the eastern half of the U.S. west to IA and TX.

Principal Uses: the wood is among the best produced by hickories, with excellent hardness, strength, shock resistance, bending, and compression qualities; as a result uses include tool handles (especially hammers, axes, and sledges), ladders, gymnastic bars, poles, agricultural implements, and dowels. Other uses include lumber, pulpwood, veneer, rustic furniture, wood splints, woodenware and novelties, charcoal, and firewood; sawdust, chips, and some wood is used to smoke meats; even the nuts can be soaked in water and used without the husk in fires to give food a hickory-smoked flavor.

Historical Uses: tool handles, agricultural implements, fuel wood because of high caloric/heating value, skis; early settlers in the northern U.S. extracted a black dye by boiling small pieces of bark in a vinegar solution. Native Americans used the species as an analgesic.

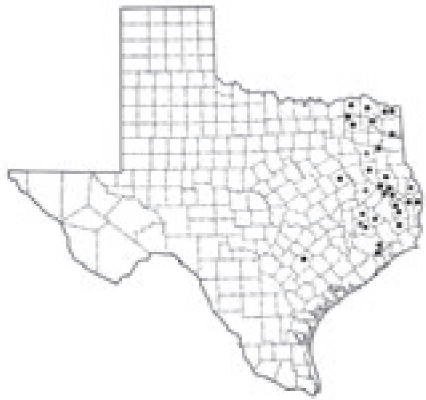
Other Significant Information: because of its wood, HICKORY was a symbol of strength in the pioneer mind, and MOCKERNUT HICKORY was among the strongest. The species is long-lived, with individual trees surviving up to 500 years. The nuts are tasty but hardly worth the effort needed to extract them from their hard thick shell—the common name MOCKERNUT apparently resulted from the difficulty of removing the sweet but small kernels. The genus *Carya* has a fascinating worldwide distribution, being known from only two areas: eastern North America (including East Texas) and eastern Asia. In the distant past (e.g., 30 million years ago during the mid-Tertiary Period), under very different conditions (e.g., sea level, temperature, continental arrangement), dispersal of plants and animals between the Eurasian and North American continents was possible. The fossil record shows that many plants had extensive distributions across the Northern Hemisphere—for example, temperate forests with tropical elements occurred very broadly, with similar floras known widely from North America, Europe and Asia. There have been great geologic and climatic changes over millions of years and many once widespread plants have become extinct in all but one or a few places—*Carya* is an example. This species, which is the most common hickory in the southern U.S., has sometimes gone under the scientific name *Carya alba* (L.) Nutt. ex Elliott. However, many recent authors, such as Stone (1997 in *Flora of North America*), treat the species as *C. tomentosa*. According to Stone (1997), "Both the mockernut hickory and the shagbark hickory were formerly known as *Carya alba* (L.) K. Koch [or *Hicoria alba* (L.) Britton], based on *Juglans alba* of Linnaeus. A.J. Rehder (1945) pointed out that the original circumscription included two taxa, and *C. alba* (*J. alba*) should therefore be rejected as ambiguous in favor *of C. tomentosa* and *C. ovata*, respectively."

Recognition in the Field: *alternate*, *odd-pinnately compound* leaves with (5–)7–9 leaflets per leaf, the leaves fragrant, with a spicy odor if crushed, the leaflets velvety to the touch beneath; *fruit hard, nut-like*, covered by a husk 3–15 mm thick that splits vertically into 4 sections; bark not shaggy.

FRUIT
HUSK
& NUT

WOOD

CARYA TOMENTOSA



LEAVES

BARK

CELTIS LAEVIGATA Willd. HACKBERRY (ULMACEAE, ELM FAMILY)

Other Common Names: SUGARBERRY, SUGAR HACKBERRY, TEXAS SUGARBERRY, SOUTHERN HACKBERRY, LOWLAND HACKBERRY, PALO BLANCO

Form and Size: medium-size tree to 30 m; trunk straight, 0.3–1 m in diameter; crown spreading and broadly rounded.

Leaves: deciduous, simple, alternate, (4–)6–8(–15) cm long, (2–)3–4 cm wide, often curved, relatively narrow, elliptic-lanceolate to ovate-lanceolate, broadest below the middle, tapering to a long-pointed tip, rounded and uneven at the base, marginally entire or with a few small teeth, thin, light green and smooth above, paler and smooth beneath; petiole slender, 6–10 mm long, smooth.

Buds: tiny, broadest near the base and tapering to a point, 1.5–3 mm long, covered with tiny dark-brown scales.

Flowers: usually unisexual, the staminate and pistillate on the same plant (plants monoecious), but bisexual flowers also present, borne in small fascicles (= clusters or bundles) or solitary, at the base of the leaves on younger branchlets, inconspicuous, greenish, each flower with a 4- or 5-lobed calyx; corollas absent; stamens 4–5; pistil 1.

Fruits: small, spherical, smooth drupes, 6–8 mm in diameter, with a thin layer of flesh around a single hard stone, orange, brown, dull or dark red to reddish black, sometimes with a raisin-like flavor; persisting after the leaves fall.

Bark: light gray to pinkish, smooth or typically conspicuously covered with wart-like or corky projections.

Wood: sapwood pale yellow to grayish or greenish yellow, frequently discolored with blue sap stain, wide; heartwood, when present, yellowish gray to light brown streaked with yellow; wood soft, weak, straight- or sometimes interlocked-grained; growth rings distinct.

Habitat: stream bottoms, floodplains, slopes, rocky hillsides; generally in clay soils.

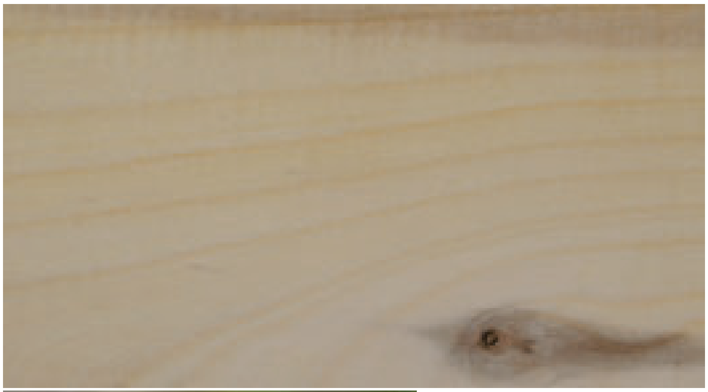
Range: widespread in the eastern 2/3 of Texas; mainly southeastern U.S. from MD south to FL west to KS and TX.

Principal Uses: often not distinguished from and used for the same purposes as AMERICAN and SLIPPERY ELMS or WHITE ASH. The better grades are used principally for furniture and to a lesser extent for millwork and sporting goods. Low-grade lumber is used to make boxes and crates. It is particularly used for furniture since the light-colored wood can be stained light- to medium-brown without prior bleaching.

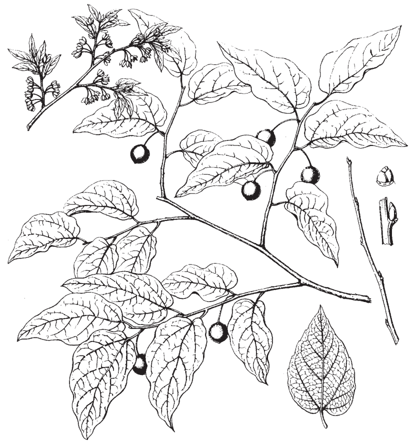
Historical Uses: the species was not important when other woods were plentiful.

Other Significant Information: *Celtis laevigata* is a fast growing species that probably does not live more than 125–150 years. In the past it was used as an ornamental and street tree due to its drought resistance, but it is less used at present because of problems including the weak wood (and thus susceptibility to ice and wind damage). In addition, leachates from the leaves reduce the germination and growth of grasses beneath the trees. Hackberry trees are almost never seen in East Texas without the presence of parasites—mistletoe and/or various galls. The galls sometimes affect the leaves, while in other cases the twigs can be involved. "In autumn ... the berries exude a sweet sticky substance, which attracts millions of mealy-bugs. When overstuffed with it they secrete a honeydew of saccharine sweetness, known as ghost rain" (Peattie 1948).

Recognition in the Field: the combination of *alternate*, *simple*, usually *entire*, relatively narrow leaves with *uneven leaf bases*, often conspicuously *warty bark*, and *small (6–8 mm) spherical fruits* make the species distinctive.

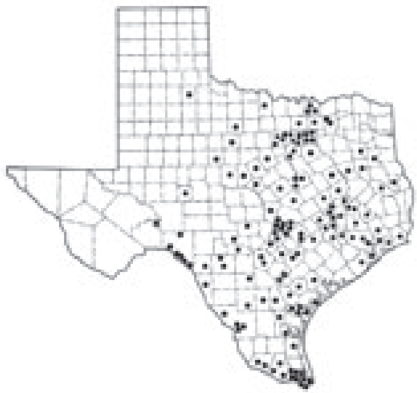


WOOD



FRUIT

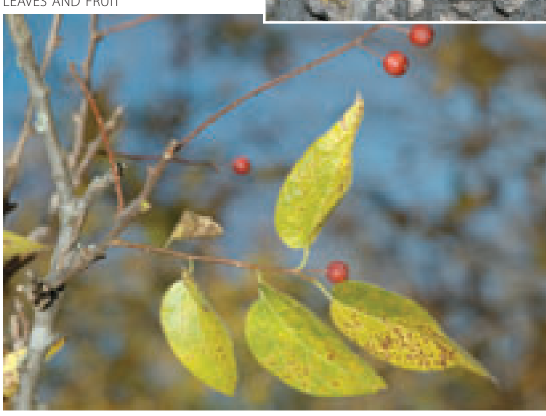
CELTIS LAEVIGATA



BARK

LEAVES

LEAVES AND FRUIT



FRAXINUS PENNSYLVANICA Marshall GREEN ASH (OLEACEAE, OLIVE FAMILY)

Other Common Names: RED ASH, DARLINGTON ASH, SWAMP ASH, RIVER ASH, WATER ASH

Form and Size: small to medium-size tree to 20 m; trunk tall, slender, to 0.5 m in diameter, rarely larger, may be swollen at the base when growing in old sloughs; crown round-topped to somewhat narrowed.

Leaves: deciduous, opposite, odd-pinnately (= feather-like) compound, composed of 5–7(–9) leaflets; leaflets lanceolate to ovate, 10–15 cm long, 1.2–3 cm wide, long pointed at the tip, entire to toothed mainly above the middle, bright green to yellowish-green above, lighter green below but not noticeably pale (turning yellow in fall), usually gradually narrowed basally and long-decurrent (sometimes with blade tissue to petiolule base, causing leaflet to appear sessile); petiolules of lateral leaflets 0–7 mm long.

Buds: 3–5 mm long, broadest near the base, usually rounded at the tip, covered with 3 pairs of rust colored, overlapping scales.

Flowers: male and female flowers produced in clusters on different trees (plants dioecious), appearing early spring before or with the expanding new leaves, inconspicuous, lacking petals; male flowers in relatively tight clusters, each with a tiny, cup-shaped calyx and 2 stamens; female flowers with a deeply lobed calyx and 1 pistil.

Fruits: produced in clusters, each dry, flattened, 2.5–7.5 cm long, 5–8(–9) mm wide, conspicuously winged, the wing straight, elongate, decurrent over half way on fruit body (wing extending along body of fruit).

Bark: light brown when young, turning gray-brown to brown, sometimes with reddish tinges, developing interwoven diamond patterns of narrow flat-topped ridges at an early age.

Wood: sapwood nearly white, wide; heartwood grayish brown, light brown, or pale yellow streaked with brown; wood somewhat lustrous, ± straight-grained, heavy, hard; growth rings distinct; the wood is often marketed together with that of *Fraxinus americana* (WHITE ASH), though that of *F. pennsylvanica* is not quite as straight-grained and is slightly inferior.

Habitat: along streams, bottomland woods, depressions in savannahs, or on slopes; the species is flood tolerant.

Range: East Texas w to Rolling Plains; this is the most wide-ranging of all ashes in Texas; widespread in the eastern and central U.S. and southern Canada. This species has the widest distributions of any native American ash.

Principal Uses: handles and baseball bats (because of strength, hardness, high shock resistance, and excellent bending qualities; second only to hickory for such uses), furniture, especially for bent parts and chair bottoms, oars, snowshoes, boxes, baskets, crates, pallets, kitchen cabinets, toys, woodenware, and novelties.

Historical Uses: vehicle parts––parts for truck bodies, racks, framing, and bottom boards, also tennis-racket frames, skis, polo and hockey sticks, agricultural implements, ship and boat building materials, wood pipe.

Other Significant Information: because the species has good form and pleasing fall foliage (yellow coloration) and is resistant to both insects and disease, it is widely used as an ornamental. The species is also being used in revegetating spoil banks resulting from strip-mining.

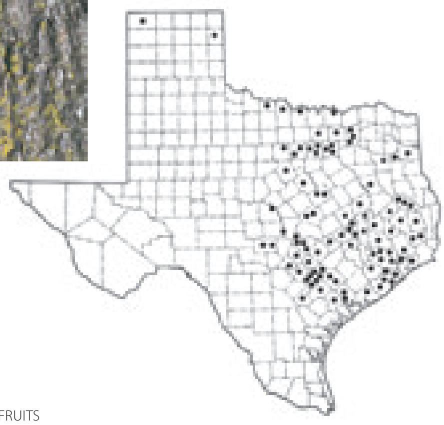
Recognition in the Field: *opposite*, *odd-pinnately compound* leaves with 5–7(–9) leaflets, these usually gradually narrowed basally and long-decurrent; petiolules short (0–7 mm long); *fruit winged,* with the wing decurrent over half way on fruit body.

WOOD

BARK

Fraxinus pennsylvanica

LEAVES AND FRUITS



FRUITS

LEAF

Juglans nigra L. BLACK WALNUT (JUGLANDACEAE, WALNUT FAMILY)

Other Common Names: EASTERN BLACK WALNUT, AMERICAN BLACK WALNUT, AMERICAN WALNUT

Form and Size: large tree, 30–40 m tall, rarely to 50 m; trunk straight for about half its height, to 2 m in diameter; the crown open and rounded at the top.

Leaves: deciduous, alternate, pinnately (=feather-like) compound, composed of (9–)15–19(–23) leaflets, the terminal leaflet small or often absent; leaflets lanceolate to ovate-lanceolate, (3–)6–15 cm long, 1.5–5.5 cm wide, pointed at the tip, rounded and uneven at the base, the margins conspicuously toothed, the upper surface yellow-green and glabrous except for scattered capitate-glandular and other hairs on the midrib, the lower surface paler, with capitate-glandular hairs, and other hairs and scales; foliage aromatic with distinctive spicy odor, turning yellow in fall.

Buds: terminal buds blunt, broadest at the base and slightly rounded at the top, slightly flattened, pale brown, hairy, 8–10 mm long; lateral buds smaller.

Flowers: unisexual, inconspicuous, male and female flowers on the same tree (plants monoecious), appearing with the leaves; male flowers in hanging, 5–10 cm long, yellow-green catkins; stamens 17–50 per flower; female flowers usually 1–4 per short spike at the end of new growth, each with a single pistil.

Fruits: large, ± globose, single or in pairs, 3.5–8 cm in diameter, the outer husk thick, green to yellow-green, turning dark brown at maturity (capable of staining skin or clothing), slightly hairy, not splitting open to expose nut, with distinctive spicy odor; nut ± globose, 3–4 cm diameter, its shell (visible only when the outer husk of fruit is removed) irregularly and deeply furrowed, the surface between grooves coarsely warty, the kernel 4-lobed, oily, sweet.

Bark: medium to dark gray or brownish, to almost blackish, darkening with age, deeply split into narrow, rough, intersecting ridges.

Wood: sapwood whitish to yellowish brown (in the trade commonly darkened by streaming or staining to match the heartwood); heartwood light brown to rich chocolate or purplish brown (the lighter shades from trees grown in the open); wood with mild characteristic odor; grain straight or irregular (the wavy, curly figures for which this wood is famous come from burls, crotches, and stump wood); growth rings distinct.

Habitat: stream bottom woods or rich woods on calcium rich soils, with best growth on deep, well-drained, fertile soils.

Range: Pineywoods and northern Gulf Prairies and Marshes west to East Cross Timbers and eastern Edwards Plateau, plus several locations in northwest Texas; widespread in the eastern and central U.S. w to SD and TX.

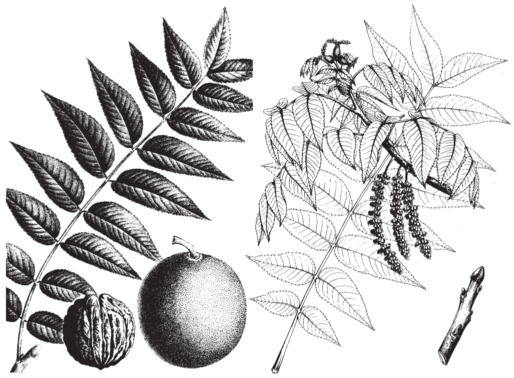
Principal Uses: this is one of the most valuable North American woods and is considered by some to be the finest cabinet wood; currently, because of its rareness, more BLACK WALNUT is being made into veneer, with the veneer used extensively in furniture and cabinets; the lumber is used for gunstocks (absorbs recoil and does not shrink or warp with age), furniture, paneling, caskets, and coffins; the ground shells are variously used, including as a non-slip agent for automobile tires and as a filtering agent for scrubbers in smoke stacks.

Historical Uses: furniture, gunstocks, radio, television, and phonograph cabinets, piano cases, sewing machines, woodenware, and in pioneer times (when it was abundant) railroad ties and rail fences; Native Americans and settlers obtained a brown dye from the husk of the fruit.

Other Significant Information: although *Juglans nigra* is not an abundant tree in East Texas, it is certainly commercially important. The wood, which is richly colored, beautifully grained, and easily worked, is so valuable that a single tree can be worth thousands of dollars, and trees are sometimes "rustled." This species exhibits allelopathy, the inhibition of one plant by another via the release of chemicals into the environment. The chemical secreted is known as juglone, and it has been investigated for pharmaceutical and other applications. There are at least 73 patents involving juglone, demonstrating a range of potential applications from a drug useful for AIDS treatment to hair-dyes. Juglone is secreted primarily by roots but is also found in other tissues (e.g., leaves) and can continue to be secreted for several years after a tree has been cut. The chemical, technically a naphthoquinone, inhibits the growth of many plants, especially vegetables, though some species are tolerant. Because of the possible allelopathic effects, some organic gardeners are careful concerning the use of BLACK WALNUT leaves as mulch. Horses have developed laminitis, a malady of the hoof, from bedding in stalls filled with small portions of walnut shavings. The nuts have a strong distinctive taste and are used in baked goods and ice cream. The walnut species now used most frequently commercially is the Old World *J. regia* L., ENGLISH or PERSIAN WALNUT.

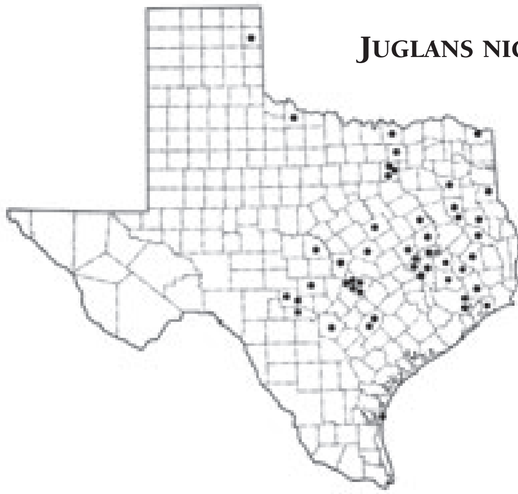
Recognition in the Field: *alternate, pinnately compound* leaves with (9–)15–19(–23) leaflets, the terminal 2–3 leaflets usually smaller than the middle lateral leaflets; *fruits large, round, nut-like, with an indehiscent husk.*

WOOD



BARK

JUGLANS NIGRA



LEAVES AND BRANCHES

LIQUIDAMBAR STYRACIFLUA L. SWEETGUM (HAMAMELIDACEAE, WITCH-HAZEL FAMILY)

Other Common Names: REDGUM, WHITEGUM, STAR-LEAVED GUM, ALLIGATOR TREE, BILSTED, SATIN-WALNUT

Form and Size: medium to tall trees to 41 m; trunk straight, tall, often free of branches on lower half, 0.6–1.5(–2.25) m in diameter; crown often pyramid-shaped but commonly more rounded in the western part of the range.

Leaves: deciduous, simple, alternate; leaf blades to 19(–25) cm long and 12(–16) cm wide, deeply palmately 5–7 lobed, star-like in shape, the lobes acuminate, marginally toothed, bright green and smooth above, paler and smooth beneath except for a few clusters of hairs in the axils of the main veins, pleasantly fragrant if crushed, quite showy in fall, turning yellow to orange, red, deep crimson, or purplish; petioles (4.4–)6–10(–15) mm long.

Buds: terminal buds 6–12 mm long, broadest near the base and cone-shaped, sharp-pointed at the tip, covered with shiny, reddish-brown scales.

Flowers: unisexual, male and female flowers on the same tree (plants monoecious), appearing in spring, without sepals or petals; male flowers in several tight green clusters on an upright stalk ca. 5–9 cm long, the clusters produced at the tips of branchlets; female flowers tightly clustered at the end of a hanging stalk produced in the axils of newer leaves, the stalk 2.5–5 cm long, the flower cluster 1.2–1.7 cm in diameter.

Fruits: fruits in hard, woody, light brown, globose clusters 2.5–4 cm in diameter, these clusters composed of many individual small capsules, each ending in 2 curved, horn-like points and each maturing 1–2 winged seeds, the fruits maturing in autumn and persistent in winter.

Bark: grayish-brown, thick, with deep fissures separating the narrow, scaly ridges; small branches often with irregular corky wings.

Wood: sapwood (called *sapgum* in the lumber industry) white, frequently with a pinkish tinge, often discolored with blue sap stain; heartwood (called *redgum*) gray to varying shades of reddish-brown, the darker grades frequently with darker streaks of pigment (called *figured redgum*); dull yellowish to brown discolorations indicate early stages of decay and should not be confused with figured redgum; wood hard, heavy, not particularly strong, with grain frequently interlocked; growth rings inconspicuous. The wood is capable of taking a high polish and has sometimes been exported as “Satin Walnut”; it has also been passed off as mahogany, rosewood, or circassian walnut.

Habitat: flood plains, low hammocks (= thickly wooded areas), swamps, riverbanks, fields, woodlands, often in successional areas (the species is frequently a pioneer species in areas such as old fields and logged areas and can form dense stands).

Range: mostly Pineywoods and eastern Post Oak Savannah in Texas, but also native west in Red River drainage to Lamar Co., widely cultivated further west; widespread primarily in the southeastern U.S. from CT south to FL west to TX and OK.

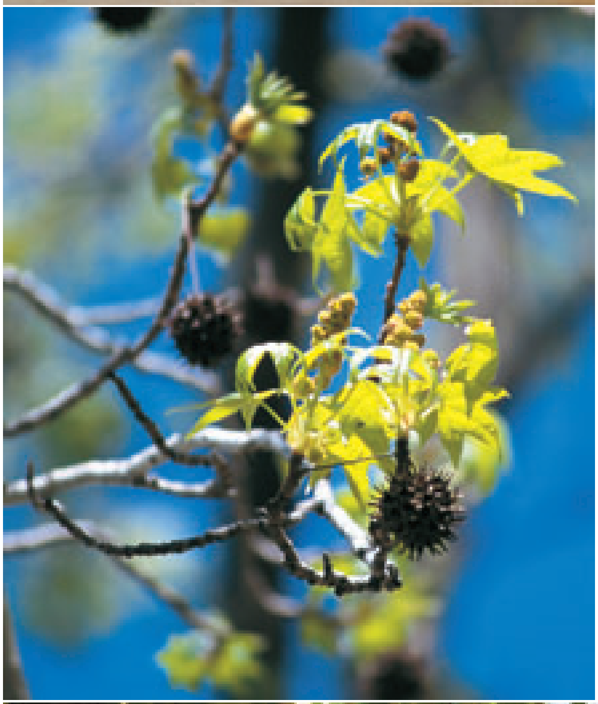
Principal Uses: this is the most important species in the U.S.A. for hardwood veneer production, with the veneer used extensively in furniture, panels, baskets, boxes, crates, and cigar boxes. The gum (oleoresin) obtained from the bark is used in soaps and cosmetics, adhesives, lacquers, incense, and as a flavoring in tobacco.

Historical Uses: barrels (slack cooperage), mine props, railroad ties, pulp, planing-mill products (especially trim), radio and television cabinets; oleoresin used medicinally by Native American groups and settlers as an antiseptic and in treating skin diseases and dysentery, and also as a natural chewing gum. During World Wars I and II, the oleoresin was used as a base in the manufacture or soaps, drugs, and adhesives.

Other Significant Information: SWEETGUM is the leading commercial hardwood species in East Texas and one of the most important hardwoods in the southeastern U.S. It also produces a gum (balsamic oleoresin), called American styrax or storax, a thick, clear, brownish yellow, semisolid or solid with a distinctive odor. The resin is collected from the inner bark by gashing the outer bark. The strikingly colorful foliage in fall makes this a widely used lawn and street tree. The species is one of the most adaptable hardwoods in terms of site and soil differences. It can even be planted on the alkaline black “gumbo” of the Blackland Prairie, though care must be taken to prevent iron deficiencies. One is taken aback when encountering SWEETGUM in montane cloud forests on the Mexico-Guatemala border. SWEETGUM is but one example of the numerous East Texas deciduous forest genera that show a floristic relationship between some isolated forests in the mountains of Mexico and Guatemala and those in the eastern United States. This relationship represents a Middle Miocene (15–14 mya) extension of deciduous forests and associated fauna (particularly amphibians) to the south during a period of widespread climatic cooling (e.g„ Antarctic glaciation). Subsequently, during the Pliocene (5.3–1.8 mya) and later, the climate warmed and dried, and other types of vegetation (e.g., prairie and dry area shrub communities) spread at the expense of deciduous forest. As a result, the once continuous deciduous forests became fragmented—many plants thus have a disjunct distribution.

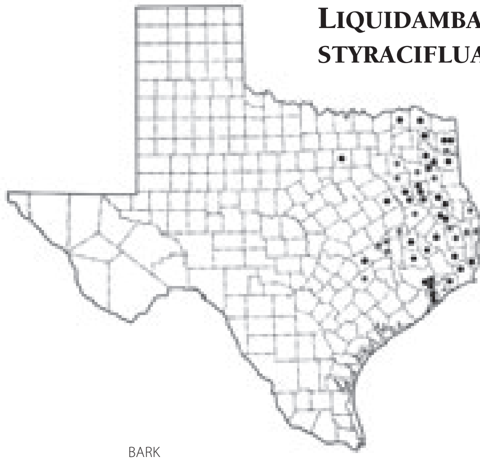
Recognition in the Field: the alternate, simple*, deeply palmately 5–7 lobed, ±star-shaped*, fragrant leaves and *woody globose clusters* (to 3 cm in diam.) of 2-beaked fruits are distinctive.

WOOD



LEAVES, FLOWERS AND OLD FRUITS

LIQUIDAMBAR STYRACIFLUA



BARK

LEAVES

NYSSA SYLVATICA Marshall BLACK TUPELO (CORNACEAE, DOGWOOD FAMILY)

Other Common Names: BLACK-GUM, SOUR-GUM, PEPPERIDGE, TUPELO, TUPELO-GUM, COTTON-GUM

Form and Size: medium-size tree to 30(–40) m; trunk straight, to 2 m in diameter, usually unbranched nearly to the top; crown narrow, oblong, with a flattened top.

Leaves: deciduous, simple, alternate, often crowded near the tips of the branchlets, the blades to ca. 5–10(–15) cm long and 2.5–7(–10) cm wide, obovate to widely elliptic, blunt or short broad-pointed at the tip, rounded to tapering at the base, wavy, entire or rarely few-toothed above middle, thin-textured, dark green and shiny above, paler and often hairy below, turning bright crimson or burgundy in fall; this species is among the first to show fall color, with a few leaves turning by late August; petioles 1–2.5 cm long

Buds: 3–6 mm long, blunt or rounded at the tip, covered with overlapping, dark brown scales.

Flowers: unisexual, male and female flowers on different trees (plants dioecious) or some bisexual flowers present (plants polygamo-dioecious), appearing in early spring at the base of new leaves (when the leaves are nearly fully expanded), small, greenish, with reputation as excellent source of nectar for bees (e.g., tupelo honey); male flowers in dense, many-flowered heads, the heads on slender stalks; female flowers in small greenish clusters of 2–8.

Fruits: a one-seeded, blue-black, ellipsoid to subglobose drupe, 10–15 mm long, on peduncles to 7 cm long, often 2–3 together, ripening in fall.

Bark: gray or light to dark brown, rough, becoming deeply furrowed, with scaly longitudinal ridges, sometimes compared to alligator hide.

Wood: sapwood white to grayish white, gradually merging into the darker heartwood; heartwood greenish or brownish gray; grain usually interlocked (making it very difficult to split) and hence showing a distinct ribbon figure when quarter-sawn; growth rings usually indistinct, even under a lens.

Habitat: swamps, low woods and open woods, terraces, poorly drained sites.

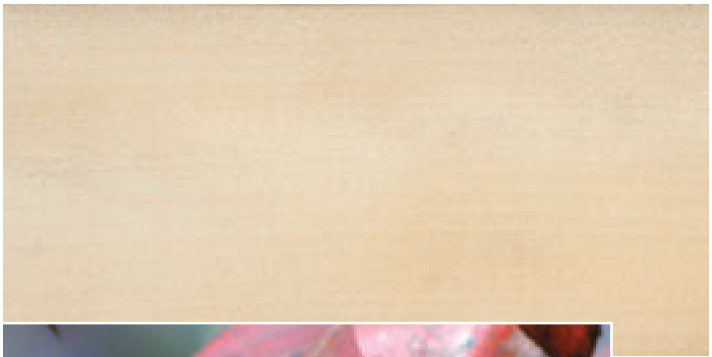
Range: Pineywoods and Post Oak Savannah; widespread in the eastern U.S. west to TX and OK.

Principal Uses: this species became commercially important only with the development of pressure treatment (previously it warped and shrank excessively); veneer used for fruit and berry boxes and similar containers, other boxes, crates, and pallets (color shows stenciling well), furniture, kitchen cabinets, plywood for panels, railroad ties, planing-mill products, pulp, cigar boxes, woodenware, handles.

Historical Uses: not a historically important species, though used for applications where the interlocked grain and consequent difficulty of splitting proved an advantage—e.g., tool handles, agricultural equipment, factory floors, docks.

Other Significant Information: the striking autumn leaf coloration and abundant blue-black fruit make these trees excellent as ornamentals and for shade. The common name TUPELO is apparently derived from the Native American Creek language**:** *eto*, tree, and *opelwv*, swamp. The fruits (rich in lipids) are an important wildlife food and the tree, which is known as a cavity producer, is an important den tree for wildlife. *Nyssa biflora* Walter, SWAMP TUPELO, is sometimes treated as a variety of this species; when submerged the base of its trunk is conspicuously swollen.

Recognition in the Field: trees with leaves *alternate, simple, entire or rarely few-toothed* above the middle *and fruits one-seeded, blue-black*, ellipsoid to subglobose, stalked drupes, 10–15 mm long, often 2–3 together.



WOOD

NYSSA SYLVATICA

LEAVES
AND FRUITS

BARK

PINUS ECHINATA Mill. SHORTLEAF PINE (PINACEAE, PINE FAMILY)

Other Common Names: SHORTLEAF YELLOW PINE, LONGTAG PINE, SHORTSTRAW PINE, ARKANSAS PINE, ARKANSAS SOFT PINE, SOUTHERN YELLOW PINE, OLDFIELD PINE

Form and Size: tall tree to 25–40 m; trunk to 1.2 m in diameter; crown rounded to cone-shaped.

Leaves: needles 2(–3) per bundle, (5–)7–11(–13) cm long, yellowish-green to gray-green; bundle sheath 0.5–1(–1.5) cm long.

Buds: terminal buds 0.5–0.7(–1) cm long, ovoid to cylindrical, red-brown.

Seed Cones: solitary or clustered, 4–6(–7) cm long, red-brown, aging gray, nearly sessile or on stalks to 1 cm, the scales with an elongate to short, stout, sharp prickle, maturing in two years.

Pollen Cones: cylindrical, 15–20 mm long at time of pollen release, yellow to pale purple-green.

Bark: on older stems red-brown, 2–2.8 cm thick, furrowed, and separated into irregular, flat, scaly plates, with evident resin pockets.

Wood: sapwood nearly white to yellowish, orange-white or pale yellow, thin to very thick; heartwood distinct, ranging through shades of yellow and orange to red-brown or light brown, resinous; grain coarse and generally straight but uneven; wood with a distinct resinous odor.

Habitat: uplands and dry forests, often on abandoned fields or exhausted farmland; adaptable in terms of site and soil conditions.

Range: Pineywoods and Post Oak Savannah as far west as Brazos, Leon, Henderson, Red River, and Lamar cos. and spreading from cultivation in Fannin Co. in Red River drainage; most prevalent in the northeastern part of East Texas, extending into the southeastern areas of higher moisture along deep sand ridges; this species has the widest range of any *Pinus* in the southeastern U.S. growing from NY s to FL w to OK and TX.

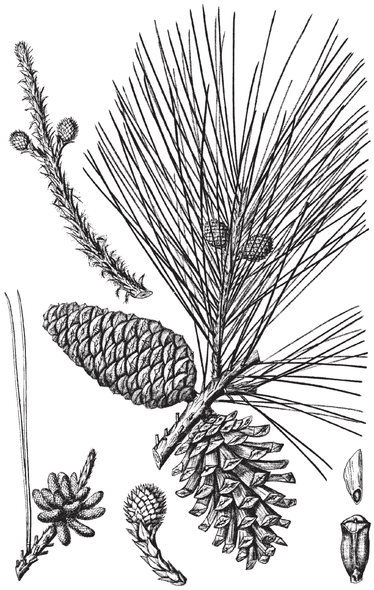
Principal Uses: pulpwood (converted for use in the manufacture of kraft paper, insulation, and other types of fiberboard), plywood and lumber (used principally for such building materials as interior finish, frame and sash, joists, and subflooring), particle board, poles, railroad ties, crates and pallets, boxes.

Historical Uses: used from the early days of colonization as a wood for ship construction (e.g., masts, spars, decks, cabins), mine timbers, cooperage (barrels), agricultural implements, tanks and silos, and railroad-car construction. Resinous splinters of the heartwood were widely used as kindling and known as "fat pine," "lightwood," or "light'd."

Other Significant Information: this is the most cold hardy of all the southern pines. Though highly valued for timber and pulpwood, it is afflicted by root rot. It also tends to grow relatively slowly during the early years after establishment. Mixed forests containing this species are frequently replaced by monoculture plantations of *P. taeda* (LOBLOLLY PINE). *Pinus echinata* hybridizes with *P. taeda*.

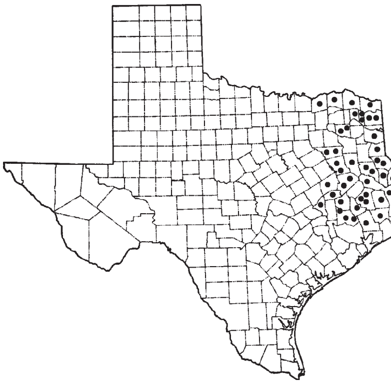
Recognition in the Field: needles 2(–3) per bundle, (5–)7–11(–13) cm long, yellowish-green to gray-green; terminal buds red-brown, 0.5–0.7(–1) cm long; seed cones 4–6(–7) cm long (the smallest of any East Texas pine).

WOOD



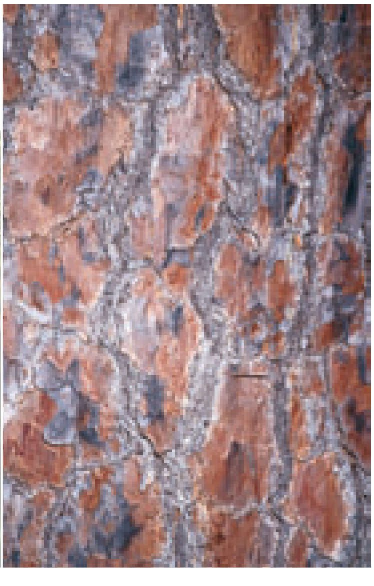
PINUS ECHINATA

LEAVES



SEEDLING

BARK



LEAVES AND SEED CONE

PINUS PALUSTRIS Mill. LONGLEAF PINE (PINACEAE, PINE FAMILY)

Other Common Names: FLORIDA PINE, LONGLEAF YELLOW PINE, SOUTHERN PINE, SOUTHERN YELLOW PINE, LONGSTRAW PINE, HILL PINE, PITCH PINE, HARD PINE, HEART PINE, SWAMP PINE

Form and Size: large tree to 47 m; trunk to 1.2+ m in diameter (e.g., a 61 inch diameter log was reported from Jasper Co.—see pages 81 and 82 in the introduction to this volume); crown open and irregular.

Leaves: needles 3 per bundle, (20–)25–45 cm long, lustrous yellow-green; bundle sheath 2–2.5(–3) cm long.

Buds: terminal buds 3–4 cm long, ovoid, silvery white.

Seed Cones: solitary or paired toward branchlet tips, 12–25 cm long, dull brown, usually sessile, the scales with a short reflexed prickle, with apophysis (= exposed, thickened, apical portion of each seed cone scale) dull, maturing in 2 years.

Pollen Cones: cylindrical, 30–80 mm long at time of pollen release, purplish.

Bark: orange-brown, relatively thin, with coarse, rectangular scaly plates; on small trunks, gray and rough.

Wood: sapwood nearly white to yellowish, orange-white, or pale yellow, thin to very thick; heartwood distinct, red-brown, heavy, hard, strong, resinous, with grain coarse and generally straight but uneven, with distinct growth rings, with a resinous odor.

Habitat: dry sandy uplands (e.g., Longleaf pine uplands), sandhills, and flatwoods (e.g., Pine savannah wetlands).

Range: southern part of the Pineywoods; Atlantic and Gulf coastal plains from VA south to FL west to TX.

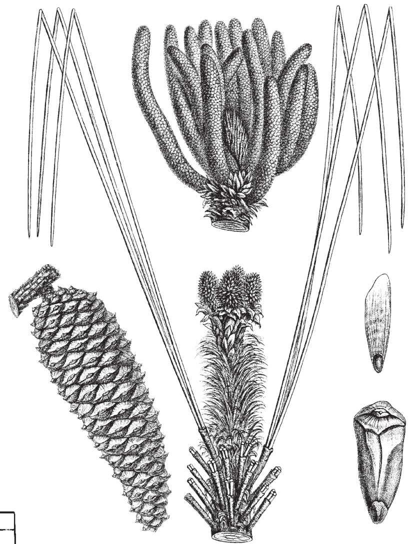
Principal Uses: a strong and durable wood with many uses, including poles, posts, structural beams, construction lumber, flooring, masts, and pulp.

Historical Uses: formerly the world's leading producer of turpentine, rosin, and tar (naval stores—so named because the resinous products were used in the past for waterproofing wooden sailing ships), obtained by tapping the trees for the oleoresin. Alabama-Coushatta Indians used the long needles to weave coil baskets and bowls.

Other Significant Information: recurrent low-intensity fire is critical for the maintenance of forests dominated by this deep-rooted, thick-barked, fire-tolerant species; it is shade intolerant, and unless there are periodic fires, hardwoods invade and shade the pine seedlings out. Even very young individuals can withstand fire. They pass through a "grass" stage lasting 3–25 years—called this because of the resemblance to a densely tufted perennial bunchgrass. During this stage, the taproot develops rapidly, the unbranched stem grows in diameter rather than height, and a thick tuft of needle-like leaves protects the meristem, located near ground level, from fire. At the end of the grass stage, the plant grows rapidly (several feet per year) until the meristem is above the typical scorch height of low-intensity fires. LONGLEAF PINES are also quite resistant to attack by bark beetles. The occurrence of LONGLEAF PINE has been greatly reduced by deforestation and modern forestry practices favoring LOBLOLLY PINE. In presettlement times, this species grew in extensive pure stands throughout the Atlantic and Gulf coastal plains. However, few or possibly no old-growth stands of LONGLEAF PINE currently exist in Texas, because of extensive harvesting and poor management in the past. Though much less common than previously, *P. palustris* is still a valuable timber species. LONGLEAF PINE forests, if periodically burned, have a rich understory of grasses and forbs and provide valuable habitat for numerous animals and plants. This species could be confused with *P. elliottii* Englem. (SLASH PINE); however, *P. elliottii* can be distinguished by the following characters: needles 2–3 per bundle, at least some 2, 15–20(–23) cm long, usually dark green and glossy; terminal bud silvery brown, 1.5–2 mm long; apophysis lustrous as if varnished.

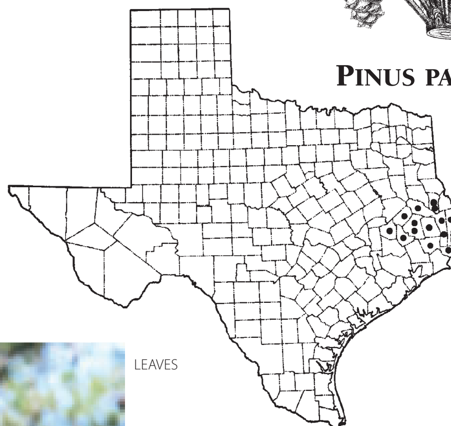
Recognition in the Field: needles 3 per bundle, (20–)25–45 cm long, lustrous yellow-green; terminal bud silvery white, 3–4 cm long; apophysis dull.

WOOD



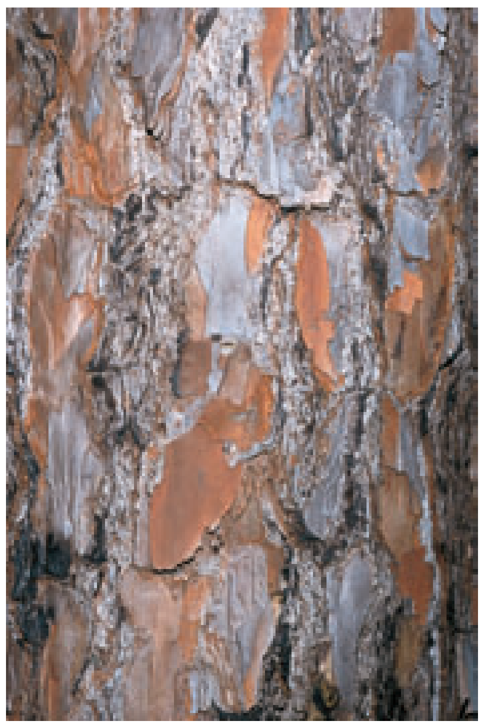
PINUS PALUSTRUS

YOUNG SEEDLING OR "GRASS STAGE"



LEAVES

BARK



PINUS TAEDA L. LOBLOLLY PINE (PINACEAE, PINE FAMILY)

Other Common Names: OLD-FIELD PINE, ROSEMARY PINE, BULL PINE, INDIAN PINE, LONGSTRAW PINE.

Form and Size: large tree to 46 m; trunk to 1.6 m in diameter; crown broadly conic to rounded.

Leaves: needles almost always 3 per bundle (very rarely 2), (10–)12–18(–23) cm long, deep yellow-green to gray-green, not glossy; bundle sheath 1–2.5 cm long.

Buds: terminal buds 1–1.2(–2) cm long, usually less than 1 cm broad, lance-cylindrical, pale red-brown.

Seed Cones: solitary or in small clusters, nearly terminal, 6–12 cm long, mostly dull yellow-brown including the apophysis (= exposed, thickened, apical portion of each seed cone scale), sessile to nearly sessile, the scales with a stout-based, sharp prickle, maturing in 2 years.

Pollen Cones: cylindrical, 20–40 mm long at time of pollen release, yellow to yellow-brown.

Bark: variable, on young trees scaly and nearly black, later with irregular, brownish blocks, or on old trees, red-brown, forming square or irregularly rectangular, scaly plates, without resin pockets.

Wood: sapwood nearly white to yellowish or orange-white or pale yellow, thin to very thick, often composing nearly half the trunk; heartwood distinct, ranging through shades of yellow and orange to reddish brown or light brown, weak (less durable than that of *P. palustris*), brittle, coarse-grained, with resinous odor and distinct growth rings.

Habitat: mesic lowlands and swamp borders to dry uplands, in presettlement times largely in association with hardwoods, but now typically in monoculture plantations.

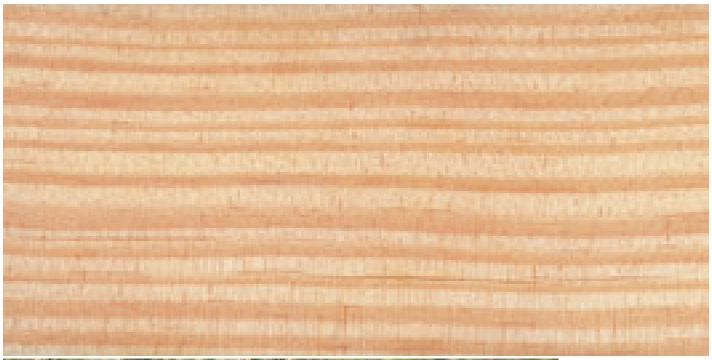
Range: native primarily to the Pineywoods with populations as far w as Lamar Co. in the Red River drainage and to Bastrop Co. ("Lost Pines") further south; cultivated widely, and escaped further west; widespread in the southeastern U.S. from DE south to FL west to OK and TX.

Principal Uses: lumber used for interior finish of buildings, general construction, and pulp for paper products. This is the most widely harvested and widely used species of tree in the southern United States. Most general construction lumber available today is LOBLOLLY PINE. It is also the principal softwood used to make paper. This species is the most commercially significant tree in Texas.

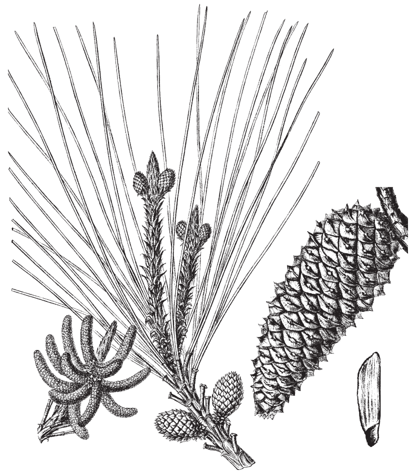
Historical Uses: bridges, freight cars, barrel shooks, boxes, crating, kindling (light'd knots), and tobacco hogsheads.

Other Significant Information: although inferior to *P. echinata* in hardness, *P. taeda* is by far the most important timber tree species in Texas and in the southern U.S. as a whole, primarily due to its fast growth rate, with trees attaining heights up to 75 ft. in 30 years—growing at 3.5 ft./yr when young. Commercial planting of this species has transformed much of the East Texas landscape into LOBLOLLY PINE monocultures. In contrast, prior to the coming of Europeans, *P. taeda* is thought to have rarely occurred in pure stands anywhere in the West Gulf Coastal Plain (LONGLEAF and SHORTLEAF PINE were much more abundant). Several genetically altered strains of LOBLOLLY PINE now exist which favor even faster growth and are resistant to rust fungi. This pine can be damaged or killed by the southern pine beetle (*Dendroctonus frontalis* Zimmermann). From the ecological standpoint, human-induced changes in species composition within forests have created conditions conducive for bark beetle outbreaks. The "Lost Pines," an area of ca. 70 square miles of loblolly pine-oak woodland isolated approximately 100 miles (162 km) west of the main body of East Texas pines, occurs in Bastrop County; this population is probably the remnant of a more extensive Ice Age forest persisting due to special soil conditions. The common name LOBLOLLY comes from one of the meanings of that word, "mud puddle," in reference to the sometimes wet habitat of this species. Hybrids are known between *P. taeda* and both *P. echinata* and *P. palustris*. *Pinus palustris* could be confused with *P. elliottii* Englem. (SLASH PINE), a species that occurs natively in the southeastern U.S. as far west as eastern LA (but is planted in TX); however, *P. elliottii* can be distinguished by the following characters: needles 2–3 per bundle, at least some 2, 15–20(–23) cm long, usually dark green and glossy; terminal bud silvery brown, 1.5–2 mm long; apophysis lustrous as if varnished.

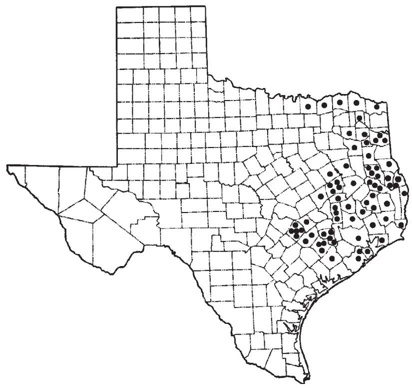
Recognition in the Field: needles almost always 3 per bundle, (10–)12–18(–23) cm long, deep yellow-green to gray-green, not glossy; terminal bud reddish brown, 1–1.2(–2) cm long, apophysis (= exposed, thickened, apical portion of each seed cone scale) dull.

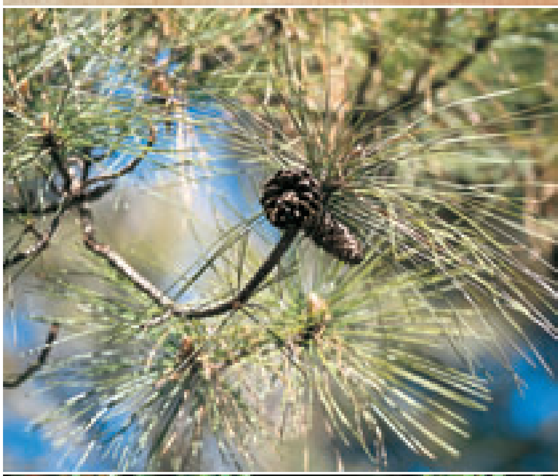


WOOD



PINUS TAEDA





LEAVES AND SEED CONES

LEAVES AND POLLEN CONES

BARK

PLATANUS OCCIDENTALIS L. AMERICAN SYCAMORE (PLATANACEAE, PLANE-TREE FAMILY)

Other Common Names: EASTERN SYCAMORE, BUTTONWOOD, PLANE TREE, AMERICAN PLANE TREE, BUTTONBALL TREE, WATER BEECH

Form and Size: large tree to 50+ m; trunk straight, tall or soon branching, becoming massive, to 3.5(–4+) m in diameter (one of the largest trees in the eastern deciduous forest); crown spreading at the top, broad, open, irregular.

Leaves: deciduous, simple, alternate, long-petioled, the petiole hollow at base and completely surrounding the axillary bud; leaf blades large, to ca. 20 cm long and 25 cm wide (larger on sucker shoots), broadest near the base and marginally with 3–5(–7) broad, shallow lobes along the margin, the lobes acute or acuminate, entire or coarsely toothed, the sinuses between lobes rounded, the blade surfaces at first coated with soft, whitish stellate (= star-shaped) hairs, becoming sparsely pubescent with age; stipules sometimes persisting, conspicuous, entire or toothed.

Buds: terminal bud usually absent, lateral buds 6–10 mm long, cone-shaped, smooth, shiny, covered by 3 brown scales, hidden in the petiole bases.

Flowers: unisexual, male and female flowers occurring on the same tree (plants monoecious), numerous, individually tiny, in stalked, globular, dense clusters/heads; sepals and petals minute; male flower clusters 7–10 mm in diameter, reddish to yellow, on branchlets of the previous year; female flower clusters 10–14 mm in diameter, greenish-red, on older branchlets.

Fruits: in conspicuously pendulous (on stalks 8–16 cm long), usually solitary(–rarely 2 together), brownish, ball-like heads ca. 2–4 cm in diameter, the heads consisting of numerous closely packed, long, narrow fruits, the individual fruits 7–10 mm long, indehiscent, single-seeded, surrounded at base by a tuft of tawny hairs (which aid in wind dispersal).

Bark: on young trees produced in small, thick scales, dark reddish-brown; on the upper part of the trunk and on older trees, the bark separates into large, thin, scales that resemble pieces of a jigsaw puzzle or mosaic and fall away to expose the smooth, strikingly lighter-colored, white to tan or greenish inner bark.

Wood: sapwood whitish to yellowish or reddish brown; heartwood light to dark brown or reddish brown when distinguishable; grain generally irregularly interlocked; growth rings distinct.

Habitat: stream banks, river and stream bottoms, floodplains, and moist ravines, typically on alluvial soils; though generally in areas with significant moisture and tolerant of poorly drained soils, this species cannot stand extended flooding during the growing season.

Range: Pineywoods and northern Gulf Prairies and Marshes west to East Cross Timbers and Edwards Plateau; widespread in the eastern U.S. west to NE and TX; also mountains of northeastern Mexico.

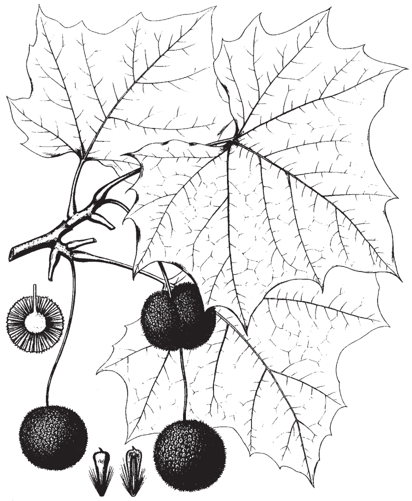
Principal Uses: chopping blocks, boxes, crates, pallets; also furniture, but tends to warp easily when sawn into lumber and is difficult to work; gives beautiful figure when quartersawn, but it has not been sufficiently recognized or widely used, probably because it is difficult to work with; also veneer and pulpwood.

Historical Uses: one of earliest uses was by farmers who would cut hollow trunks, saw them in lengths of three or four feet, and nail bottoms to one end for use as grain barrels, called gums or hogsheads. The resistance to splitting made it valuable for chopping blocks and buttons (hence the common name BUTTONWOOD). The wood was also used for slack cooperage (= barrels for storing dry goods; especially for sugar and flour barrels because it does not impart taste, odor, or stain), ox yokes, ox cart wheels, plug tobacco boxes, musical instruments, and saddle trees.

Other Significant Information: this is one of tallest angiosperms in North America, reaching 50+ m, and it has the greatest trunk diameter, attaining 4+ m. The species is being grown in the southeastern U.S. for fiber in intensively cultured "biomass farms." The ball-like fruit clusters break apart slowly, with some persisting on the leafless branchlets throughout the winter. The fruits were a favorite food of the now extinct Carolina parakeet. "In North America *Platanus* is usually called sycamore, a name apparently borrowed from the European sycamore maple, *Acer pseudoplatanus* Linneaus, which has similar leaves. That name in turn comes from the Middle Eastern sycomore fig, *Ficus sycomorus* Linnaeus, its specific epithet from the Greek *sykomoros*, mulberry" (Kaul 1997).

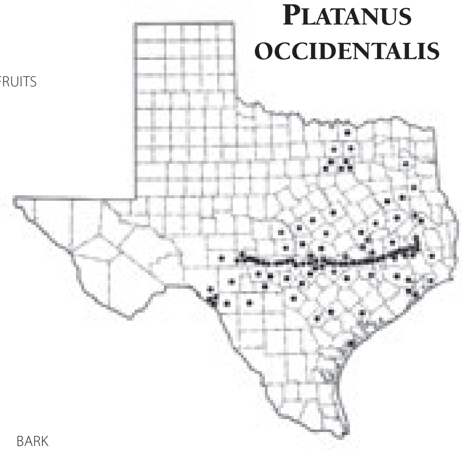
Recognition in the Field: *smooth, strikingly white, tan, and green, mottled bark* (and thus easily recognized at a distance); *large 3–5(–7)-lobed leaves* with petiole bases surrounding and completely *hiding axillary buds*; *fruits in dangling, ping-pong ball size clusters.*

WOOD



FRUITS

PLATANUS OCCIDENTALIS



BARK

HABIT

QUERCUS ALBA L. WHITE OAK (FAGACEAE, BEECH OR OAK FAMILY)

Other Common Names: STAVE OAK, RIDGE WHITE OAK, FORKED-LEAF WHITE OAK, EASTERN WHITE OAK

Form and Size: medium to tall tree to 25(–35) m; trunk tall, straight in the forest or short and soon branching in open fields, 0.6–1.5 m in diameter; crown broad and rounded.

Leaves: deciduous, simple, alternate, the blades (7.9–)12–10(–23) cm long, (4–)7–11(–16.5) cm wide, light gray-green and dull or glossy above, light green below, with numerous whitish or reddish erect hairs, these quickly shed as leaf expands, usually widest above the middle to almost uniformly wide along the sides, basally tapering, apically broadly rounded or ovate, marginally moderately to deeply lobed, the lobes often narrow, rounded distally, without bristle tips, the sinuses between lobes extending 1/3–7/8 distance to midrib; petiole stout, usually grooved above, (4–)10–25(–30) mm long.

Buds: ca. 3 mm long (terminal), dark reddish brown, ovoid, apically obtuse, glabrous.

Flowers: unisexual, male and female flowers produced separately on the current year's branchlets (plants monoecious), individually tiny and inconspicuous; male flowers numerous in drooping catkins 6.2–7.5 cm long; female flowers usually 2–4 on a short stalk in leaf axils.

Fruits: acorns, solitary or 2–3 together, maturing in 1 season, nearly sessile or with a short peduncle to 25(–50) mm long; cup enclosing 1/4 of nut; nut ovoid-ellipsoid or oblong, (12–)15–21(–25) mm long, 9–18 mm wide.

Bark: usually light ash gray or light gray, sometimes with a reddish-brown cast, with shallow to deep lengthwise fissures separating small scaly blocks or narrow rounded ridges.

Wood: sapwood whitish to light brown, thin or thick; heartwood rich light brown to dark brown; wood usually straight- and close-grained, heavy, hard, tough, strong, and durable (all of these characteristics make it valuable); historically this was one of the most important hardwoods of North America); growth rings distinct except in slow-grown stock.

Habitat: stream bottom woods, mixed forests on mesic lower slopes and terraces and mesic to dry-mesic uplands.

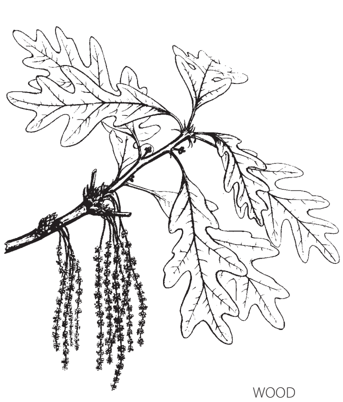
Range: Pineywoods and Post Oak Savannah, the species was historically collected as far west as Dallas; widespread in the eastern U.S. west to KS and TX.

Principal Uses: furniture, flooring (widely used because of hardness, resistance to abrasion, and ability to finish smoothly with an attractive figure), interior paneling, cabinets, barrels (used especially for wine and spirits—the wood is excellent for holding liquids because of the presence of tyloses, which are microscopic structures that decrease permeability—because of the extensive use in making barrel staves, this species is sometimes called STAVE OAK), railroad ties, firewood.

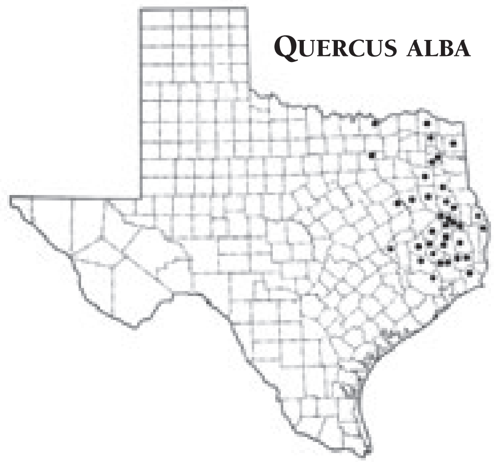
Historical Uses: principal oak species used for furniture, shipbuilding, mine timbers, poles, farm vehicles, planing-mill products, railroad cars, railroad ties, boxes, crates, pallets, caskets and coffins, barrel staves, handles, and firewood. It was used for shipbuilding by the first U.S. Navy and on ship decks until World War II. Some of the first objects made from WHITE OAK were casks called "pipes" for wine and other liquids.

Other Significant Information: the acorns are rich in fat and protein and were a staple of the American Indian diet. In the past *Quercus alba* was the most commercially important and valued hardwood species in North America and was used widely for furniture and shipbuilding. It has been largely replaced by various red oaks that are more common and have faster growth and greater yields. The red oaks lack tyloses and therefore are better suited for pressure treating with preservatives. WHITE OAK is a long-lived species, with some individuals up to 600 years old or even older.

Recognition in the Field: leaves simple, alternate, light gray-green, ± glabrous, *moderately to deeply lobed*, the lobes variable but often narrow, without bristle tips; fruits *acorns* with cup covering 1/4 of nut.



WOOD



LEAVES

BARK

QUERCUS FALCATA Michx. SOUTHERN RED OAK (FAGACEAE, BEECH OR OAK FAMILY)

Other Common Names: SPANISH OAK, THREE-LOBE RED OAK

Form and Size: medium to tall tree to 30 m; trunk straight, to 1.5 m in diameter; crown high and rounded in forests, much broader and open in clear areas.

Leaves: deciduous, simple, alternate, the blades 12–23(–30) cm long, 6–12 cm wide, dark shiny green above, gray-green and short hairy below, quite variable in shape, with 3–7 deep lobes to nearly entire with 3 broad apical lobes, though usually with long, turning brown in slender, falcate (= sickle-shaped), pointed lobes and deep, rounded sinuses, the terminal lobe usually elongated, the lobes with several bristle tips, basally rounded or U-shaped.

Buds: 4–8 mm long (terminal), light reddish brown, ovoid, puberulent.

Flowers: unisexual, male and female flowers occurring separately on the same tree (plants monoecious); individually tiny and inconspicuous; male flowers on drooping catkins 7.5–12.5 cm long; female flowers occurring singly or in pairs(–rarely many) on a short stalk.

Fruits: acorns solitary or in pairs, maturing in two seasons; cup covering 1/3–1/2 nut; nut nearly spherical, 9–16 mm long, 8–15 mm wide, sometimes with fine longitudinal lines or ridges.

Bark: dark brown to almost black, broadly ridged and fissured on old trunks, smoother and lighter on younger growth.

Wood: sapwood whitish to grayish or pale reddish brown; heartwood pinkish to light reddish brown, the flesh-colored cast generally pronounced, occasionally light brown; wood hard, strong, generally straight- and coarse-grained; growth rings very distinct.

Habitat: dry upland to mesic lower slopes and terraces to bottomland forests.

Range: Pineywoods and Post Oak Savannah, west in Red River drainage to Fannin County, also northern Gulf Prairies and Marshes; mainly southeastern U.S. from coastal NY s to FL w to OK and TX.

Principal Uses: mostly for general construction, boxes, crates, pallets, furniture, flooring, and firewood.

Historical Uses: the wood is not as high quality as that of a number of other oak species. It cracks and checks when not treated properly and rots in contact with soil; consequently it was not extensively used when other higher quality woods were readily available; telegraph poles, crates, boxes.

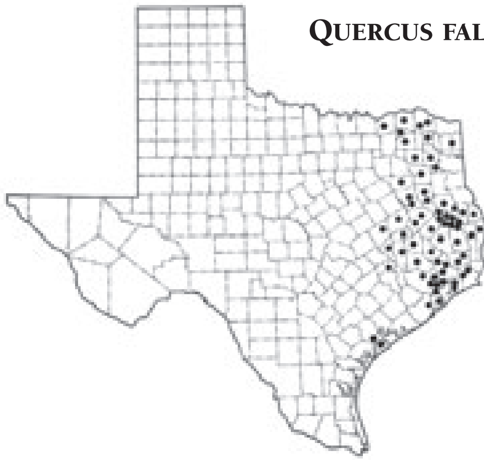
Other Significant Information: *Quercus falcata* is extremely variable, particularly in leaf blade shape, with the same tree often possessing several different forms. SOUTHERN RED OAK is by far the dominant oak in the Pineywoods region of East Texas. It is frequently used as a lawn or street tree. As with other oaks, seed dispersal is accomplished by squirrels which hoard and bury the acorns. Though many acorns are actually eaten and destroyed, some are forgotten until spring when they germinate. By having been buried, these acorns have avoided destruction by other seed predators or damage by the adverse climatic conditions of winter. While *Quercus pagoda* Raf. is sometimes recognized as a variety of *Q. falcata* (as var. *pagodifolia* Elliott), that species is here considered a distinct species. Like many oaks, *Quercus falcata* hybridizes with other species, including *Q. marilandica* (BLACKJACK OAK), *Q. nigra* (WATER OAK), *Q. pagoda* (CHERRYBARK OAK), *Q. phellos* (WILLOW OAK), *Q. shumardii* (SHUMARD'S OAK), and *Q. velutina* (BLACK OAK).

Recognition in the Field: leaves simple, alternate, basally rounded or U-shaped, *usually deeply lobed, the terminal lobe usually greatly elongated and much more prominent than the laterals*, but sometimes with only 3 shallow apical lobes, the lobes with several bristle tips; fruit an *acorn* with cup covering 1/3–1/2 of nut.

WOOD

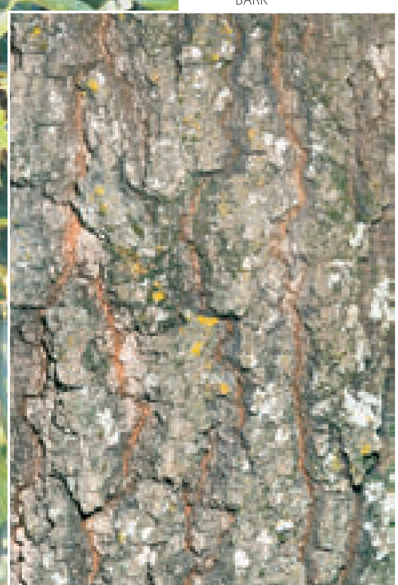
LEAF

QUERCUS FALCATA



LEAVES

BARK



QUERCUS NIGRA L. WATER OAK
(FAGACEAE, BEECH OR OAK FAMILY)

Other Common Names: POSSUM OAK, SPOTTED OAK, DUCK OAK, PUNK OAK

Form and Size: medium to tall tree to 30(–44.5) m; trunk straight, 0.3–1 m in diameter; crown rounded or cone-shaped.

Leaves: deciduous or tardily so, simple, alternate, the blades 3–12(–16) cm long, 1.5–6(–7) cm wide, dull green and smooth above, paler below, turning yellow to brownish in autumn, with tufts of hairs in the main junctions of veins on the lower surface, much broader apically than basally and definitely club-shaped but variable, unlobed and with one apical bristle tip or shallowly 3(–5)-lobed (occasionally pinnately lobed, particularly on sprouts) and the lobes with bristle tips; petioles stout, flattened, 2–9 mm long.

Buds: 3–6.5 mm long (terminal), dark reddish-brown, the scales hairy.

Flowers: unisexual, male and female flowers occurring separately on the same tree (plants monoecious), individually tiny and inconspicuous; male flowers numerous on slender dangling catkins 4–7.5 cm long; female flowers in few-flowered, short-stalked clusters in leaf axils.

Fruits: acorns usually solitary, maturing in two seasons; cup covering 1/4 of nut or less; nut broadly ovoid, 9.5–14 mm long, 9.5–14.5 mm wide.

Bark: very dark gray to grayish black, smooth and thin, later developing rough, wide scaly ridges.

Wood: similar to *Q. falcata*, sapwood and heartwood reddish-brown, heavy, strong; grain coarse.

Habitat: typically on moist alluvial and lowland sites such as stream bottom woods, but it can occur on a wide variety of soil types and in varying habitats including moist uplands.

Range: Pineywoods, northern Gulf Prairies and Marshes, Post Oak Savannah, and Blackland Prairie west to western margin of East Texas; mainly southeastern U.S. from NJ south to FL w to OK and TX.

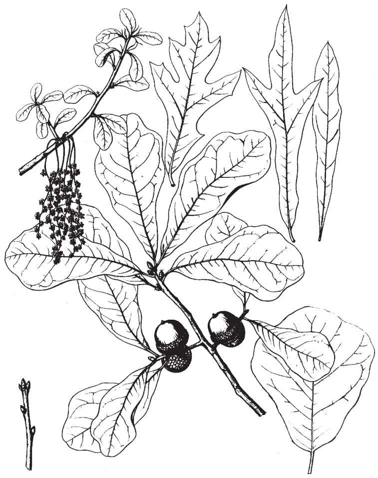
Principal Uses: mostly general construction, boxes, crates, fuel. The wood is inferior to that of other red oaks, but it is often sold as "red oak."

Historical Uses: the wood is not as high quality as that of a number of other oak species; consequently it was not extensively used when other higher quality woods were readily available.

Other Significant Information: this rapidly growing species is often planted as a street or shade tree. It is also often abundant as second growth in appropriate habitats on cutover lands. As is the case with many oaks, hybridization is well known. *Quercus nigra* hybridizes with almost every other species in section *Lobatae* (red or black oak group), including *Q. laurifolia* (LAUREL OAK), *Q. marilandica* (BLACKJACK OAK), *Q. phellos* (WILLOW OAK), *Q. shumardii* (SHUMARD'S OAK), and *Q. velutina* (BLACK OAK). Many interesting hybrids can be observed, and it is often difficult to distinguish between species in this complex in the field.

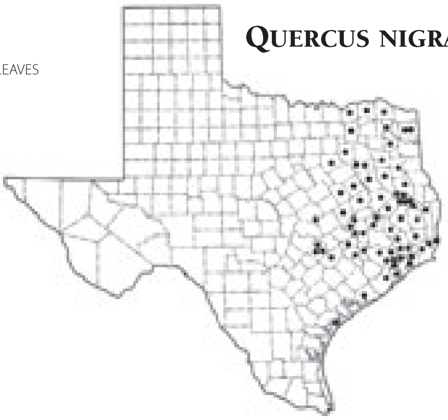
Recognition in the Field: leaves simple, alternate, much broader apically than basally, *definitely club-shaped*, and *unlobed or shallowly 3(–5)-lobed apically*; twigs and petioles glabrous or nearly so; fruit an *acorn* with cup covering 1/4 of nut or less.


WOOD



LEAVES

Quercus nigra



BARK

QUERCUS PHELLOS L. WILLOW OAK (FAGACEAE, BEECH OR OAK FAMILY)

Other Common Names: PIN OAK, PEACH OAK, SWAMP WILLOW OAK, WILLOW-LEAF OAK, POSSUM OAK, SPOTTED OAK, DUCK OAK, PUNK OAK

Form and Size: medium tall tree to 30 m; trunk straight, to 1.2 m in diameter; crown narrowly open or cone-shaped.

Leaves: simple, deciduous, alternate, the blades 5–12 cm long, 1–2.5 cm wide, light green and glabrous above, pale green below, glabrous, rarely softly pubescent, turning golden yellow in autumn; usually linear to narrowly elliptic, usually widest near the middle, unlobed, marginally entire with a single bristle at the apex, strongly revolute as they emerge; petiole 2–4(–6) mm.

Buds: 2–4 mm long (terminal), chestnut brown, ovoid, apically acute, glabrous.

Flowers: unisexual, male and female flowers occurring separately on the same tree (plants monoecious), individually tiny and inconspicuous; male flowers numerous on slender dangling catkins 2.5–7.5 cm long; female flowers in few-flowered clusters in leaf axils.

Fruits: acorns solitary or in pairs, maturing in 2 seasons; cup covering 1/4–1/3 nut; nut ovoid to hemispheric, 8–12 mm long, 6.5–10 mm wide.

Bark: dark gray and smooth, darkening with age, roughened into irregular, scale-covered plates when older.

Wood: similar to *Q. falcata*, strong and coarse- and straight-grained, often marketed as "red oak."

Habitat: alluvial soils of bottomland flood plains, stream banks, terraces, and poorly drained uplands.

Range: Pineywoods, northern Gulf Prairies and Marshes, and Post Oak Savannah, west in Red River drainage to Fannin County; mainly southeastern U.S. from coastal NY south to FL w to OK and TX.

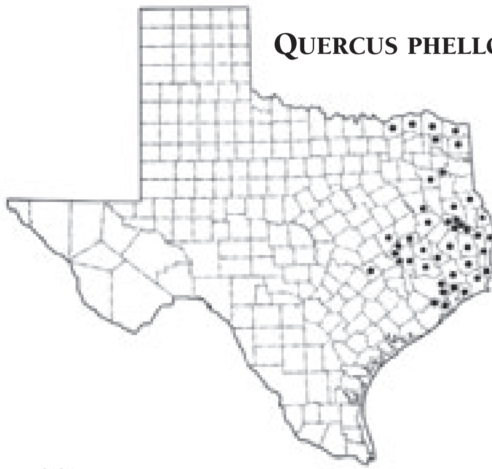
Principal Uses: pulp, general construction, pallets, interior finishes, furniture, railroad ties, and firewood.

Historical Uses: the wood is not as high quality as that of a number of other oak species; consequently it was not extensively used when other higher quality woods were readily available.

Other Significant Information: this tree has gained popularity as an ornamental and shade tree due to its relatively fast growth compared to other oaks; it is also long-lived and easy to transplant. It is being used in hardwood plantations because of its growth rate and the characteristics of its pulp. This species hybridizes with a number of related oaks, including *Q. falcata* (SOUTHERN RED OAK), *Q. marilandica* (BLACKJACK OAK), *Q. nigra* (WATER OAK), *Q. pagoda* (CHERRYBARK OAK), *Q. shumardii* (SHUMARD'S OAK), and *Q. velutina* (BLACK OAK).

Recognition in the Field: leaves simple, alternate, *willow-like*—linear to narrowly elliptic, at least 5 times as long as wide, *unlobed, entire except for 1 apical bristle*; fruit an *acorn* with shallow cup covering 1/4–1/3 of nut.

WOOD



QUERCUS PHELLOS

LEAVES

BARK

QUERCUS SHUMARDII Buckley SHUMARD'S OAK (FAGACEAE, BEECH OR OAK FAMILY)

Other Common Names: SHUMARD'S RED OAK, RED OAK, SWAMP RED OAK, SPOTTED OAK

Form and Size: medium to tall tree to 35 m; trunk tall, straight, to 1.6 m in diameter; crown broad, open and rounded.

Leaves: deciduous, simple, alternate, the blades 10–20 cm long, 6–15 cm wide, dark green, shiny and glabrous above, the lower surface pale green, with tufts of hairs in junctions of the main veins, turning red to orange-red or yellow to brown in autumn, basally usually obtuse to truncate, apically acute, marginally with 5–9 lobes and numerous bristle tips, the terminal lobe not much larger than the laterals, the lobes oblong or expanded distally; petioles 2–6 cm long.

Buds: 4–6(–8) mm long (terminal), gray to grayish-brown, ovoid or broadly ellipsoid, glabrous.

Flowers: unisexual, male and female flowers occurring separately on the same tree (plants monoecious), individually tiny and inconspicuous; male flowers numerous in slender dangling catkins, 8–18 cm long; female flowers solitary, paired, or few-clustered, in leaf axils.

Fruits: acorns, solitary or in pairs, maturing in 2 seasons; cup covering 1/4–1/3 of nut; nut ovoid to oblong, 14–30 mm long, 10–20 mm wide.

Bark: gray-brown to dark brown, smooth at first, developing shallow furrows with small, tight, interlacing ridges.

Wood: hard, heavy, strong, and straight-grained, the heartwood red-tinged to light-brown, the sapwood paler and thin; superior to that of many other red oak species.

Habitat: moist but often well-drained soils, stream bottoms, terraces, moist forests, drainage ways, and poorly drained uplands; the species is tolerant of high pH.

Range: Pineywoods west throughout East Texas and west to the Cross Timbers and Prairies; widespread in the southeastern U.S. west to KS and TX and also north in the Mississippi River Valley.

Principal Uses: furniture, flooring, veneer, interior finishes, cabinets, general construction, pallets, railroad ties, and firewood; often not distinguished from other red oaks.

Historical Uses: likely similar to present uses.

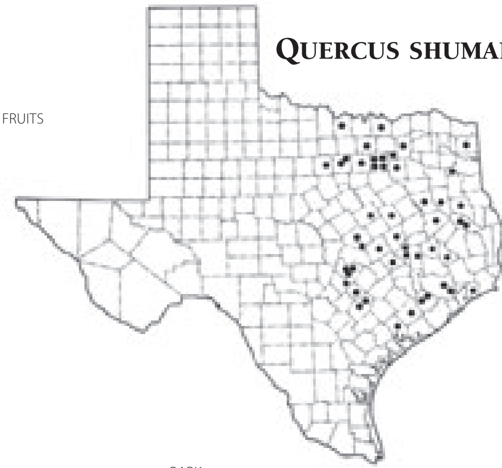
Other Significant Information: this is an important ornamental and shade tree, often developing beautiful red foliage in autumn. *Quercus shumardii* and the similar *Q. buckleyi* (occurring mainly from the Eastern Cross Timbers westward) hybridize along a narrow zone of overlap from the Cooke and Grayson County area near the Red River south to the vicinity of San Antonio (Bexar Co.). To the west of this hybrid zone "pure" individuals of *Q. buckleyi* can be found, while to the east "pure" *Q. shumardii* occurs. In the hybrid zone, specific determination is often not possible. *Quercus shummardii* is here treated as including var. *schneckii* (Britt.) Sarg., which differs in having more deeply rounded cups covering ca. 1/3 of the nut (vs. shallow cups covering ca. 1/4 of the cup). *Quercus shumardii* also hybridizes with a number of other related species including *Q. falcata* (SOUTHERN RED OAK), *Q. laurifolia* (LAUREL OAK), *Q. marilandica* (BLACKJACK OAK), *Q. nigra* (WATER OAK), *Q. phellos* (WILLOW OAK), *and Q. velutina* (BLACK OAK). Numerous Texas oaks, including *Q. shumardii*, are being killed by oak wilt, caused by the fungus *Ceratocystis fagacearum* (Bretz) J. Hunt. Live oaks and members of the red oak group (inculding *Q. shummardii*) are most susceptible. In the most susceptible red oaks, death can occur in a matter of weeks after initial symptoms are noted. Transmission seems to occur by root grafts and in some cases by insects (beetles). Appel and Billings (1995) gave detailed information on this disease. SHUMARD'S OAK exhibits "mast fruiting," a type of cyclical fruiting with years of heavy fruit production occurring irregularly (see also *Q. stellata*). The acorns are nevertheless an important wildlife food.

Recognition in the Field: leaves simple, alternate, *deeply lobed, the terminal lobe not much larger than laterals*, with the main lobes divided into several lobes, with main veins exserted as *bristle tips*; fruit an *acorn* with cup covering 1/3 of nut or less; terminal buds 4–6(–8) mm long, glabrous.

WOOD

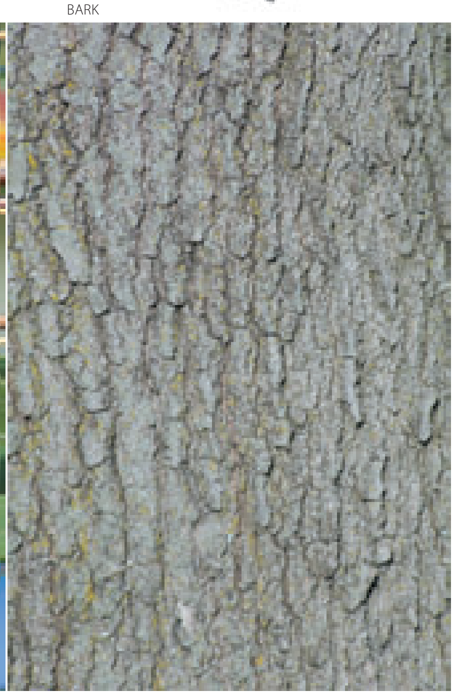
QUERCUS SHUMARDII

FRUITS



LEAVES AND FRUITS

BARK



QUERCUS STELLATA Wangenh. POST OAK (FAGACEAE, BEECH OR OAK FAMILY)

Other Common Names: IRON OAK, CROSS OAK

Form and Size: shrubby to small or medium-size tree to 20(–30) m; trunk straight to crooked, 0.3–1 m in diameter, often stunted in dryer western parts of East Texas and the adjacent Cross Timbers; crown broad and rounded.

Leaves: deciduous, simple, alternate, the blades 4–15(–20) cm long, 2–10(–12) cm wide, rather stiff in texture, dark green and shiny above, lower surface lighter and covered with minute, stellate (= star-shaped) hairs visible with moderate magnification, turning brownish or sometimes yellowish brown in autumn, basally rounded-attenuate to cordate, sometimes cuneate, marginally shallowly to usually deeply lobed, the typically 2–3 lobes on each side rounded to spatulate or with irregular shallow lobes, entire, usually the main lobe on each side rather large and perpendicular to midvein, giving the leaf a roughly cross-like appearance, without bristle tips; petiole 3–7(–30) mm long, with stellate hairs.

Buds: to ca. 4 mm long (terminal), reddish brown, ovoid, apically obtuse or acute, sparsely hairy.

Flowers: unisexual, male and female flowers occurring separately (plants monoecious), individually tiny and inconspicuous; male flowers numerous in slender, dangling catkins 5–10 cm long; female flowers stalkless, in 1–4-flowered clusters in the leaf axils

Fruits: acorns, often 1–3 clustered, maturing in 1 season; cup enclosing 1/4–2/3 nut; nut ovoid or globose, 10–20 mm long, 8–12(–20) mm wide.

Bark: light to dark gray, sometimes somewhat reddish brown, thin and scaly at first, developing deep lengthwise furrows separating the rounded, sometimes broad, scaly ridges.

Wood: sapwood whitish to light brown, thin or thick; heartwood rich light brown to dark brown; wood hard, heavy, durable, usually straight-grained; growth rings distinct except in slow-grown stock, nearly indistinguishable from other white oaks.

Habitat: Usually on dry sites, including dry sandy and gravely-silty uplands and ridges, often in association with BLACKJACK OAK. While POST OAKS are remarkably tough in natural situations (e.g., withstanding dry conditions and repeated droughts), they are extremely sensitive to disturbance of their roots and die quickly (e.g., in yard settings) when their root zone has been compromised (e.g., by compaction).

Range: occurring in all areas of Texas except the High Plains and Trans-Pecos and dominant in the Cross Timbers and Post Oak Savannah; widespread in the southeastern U.S. and adjacent areas west to KS, OK, and TX.

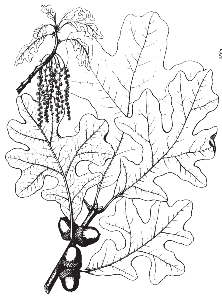
Principal Uses: limited use (commercially sold as WHITE OAK) in furniture, also flooring (widely used because of hardness, resistance to abrasion, and ability to finish smoothly), railroad ties, siding, planks, construction and mine timbers, trim molding, stairs, fence posts, pulp, veneer, particle boards, and fuel. The bark is a source of tannin.

Historical Uses: fence posts (since durable in contact with soil; hence the common name), railroad ties, flooring, lumber, fuel. The acorns of post oak, like those of other white oaks, are rich in fat, protein, and starch as well as being relatively low in tannins (compared to red oaks). Consequently, these acorns were used by Native Americans as food (when ground into meal) and by early settlers as forage for pigs.

Other Significant Information: POST OAK is the widest-ranging oak in Texas and the dominant tree in the sandy-soil areas of North Central and East Texas, where it dominates (sometimes in nearly pure stands) the Post Oak Savannah and Cross Timbers in the forest-prairie transition area. This is a slow growing, long-lived species. Tree-ring chronologies extending from about 200 to more than 300 years have been obtained from East Texas POST OAKS, with the oldest individual trees dating back to 1658 (D. Stahle, pers. comm.). In some areas, particularly the Cross Timbers, the stunted size and the poor quality of the wood obtainable from these ancient, often hollow and damaged trees have made them not worth cutting from the commercial standpoint. As a result, a number of old-growth areas of "Ancient Cross Timbers" still survive. Conservation efforts are underway to preserve these forests, which date back to presettlement times (see page 125 of the introduction to this volume). Though sensitive to disturbance of its roots (and very difficult to transplant), this species is sometimes used as a shade tree. It is also planted to stabilize dry rocky slopes where few other trees can grow. Like many oaks, POST OAK is a mast-fruiting species—in other words, it produces a heavy crop of fruits only at irregular intervals—this type of cyclical fruiting, with years of heavy fruit production occurring irregularly, is possibly an adaptation to reduce seed predation by making the seeds an unpredictable resource. Toxicity of oaks to cattle due to the presence of tannins can cause significant loss in some areas, particularly during drought years; mostly new foliage is involved, but mature leaves and acorns can also cause poisoning if eaten in large quantities; the compounds actually causing the toxic effects are apparently low molecular weight phenolic compounds produced as the result of biodegradation of more molecularly complex tannins. POST OAK is sometimes confusing to identify, due to its variable leaf shape and many different growth forms.

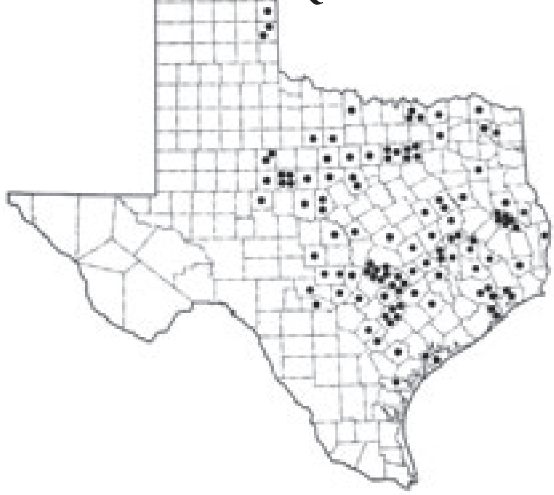
Recognition in the Field: leaves usually *cross-shaped and lacking bristle tips*; twigs and the lower surface of leaves with dense stellate (star-like) hairs; fruit an *acorn* with cup enclosing 1/4–2/3 of nut.

WOOD



LEAVES AND FRUIT

Quercus stellata



LEAVES

BARK

TAXODIUM DISTICHUM (L.) Rich. BALD-CYPRESS (CUPRESSACEAE, CYPRESS OR REDWOOD FAMILY)

Other Common Names: SOUTHERN BALD-CYPRESS, SOUTHERN-CYPRESS, SWAMP-CYPRESS, RED-CYPRESS, WHITE-CYPRESS, YELLOW-CYPRESS, GULF-CYPRESS, TIDEWATER RED-CYPRESS.

Form and Size: medium to large tree to 40(–50) m; crown sharply pointed on young trees, becoming broad and rounded or nearly flat-topped; trunk gradually tapering, usually to 1.5 m, rarely to 4 m in diameter, often with a strongly enlarged buttressed base, and if growing in or near water, the tree will have several conspicuous, cone-shaped "knees" produced by the roots and extending above the surface.

Leaves: deciduous (shed with deciduous twiglets), small, 2-ranked, linear to linear-lanceolate, flat, 5–17 mm long, laterally divergent, the free portion contracted and twisted basally, without an abaxial resin gland.

Buds: rounded, 2–4 mm in diameter, with several closely overlapping, pale brown scales.

Seed Cones: hanging, singly or 2–3 together, rounded to pear-shaped, to ca. 25(–40) mm in diameter, wrinkled and becoming woody, green turning brown or brownish purple at maturity; cone scales somewhat peltate (= shield-shaped), closely fitting one against another, with 2 seeds per scale; seeds irregularly 3-angled, 8–10 mm long, brown, with 3 narrow wings.

Pollen Cones: in dangling panicles usually 10–14 cm long.

Bark: moderately thin, light reddish-brown to light brown, with shallow furrows dividing the broad, flat ridges that sometimes separate into thin, fibrous scales.

Wood: sapwood pale yellowish white, merging more or less gradually into the heartwood; heartwood quite variable in color, ranging from yellowish to light or dark brown, reddish brown, or almost blackish; wood with a greasy feel (especially along the grain), often with a rancid odor (light colored wood sometimes odorless); grain generally straight and even or uneven, coarse textured; growth rings distinct.

Habitat: rivers, lake margins, and swamps, occasionally in slightly brackish water; saturated and seasonally inundated soils; the species is among the most tolerant of saturated soils with poor aeration. Though often seen growing in relatively shallow water considerable distances from the shore of lakes, seeds of the species will germinate only on moist but unflooded soil.

Range: Pineywoods and Post Oak Savannah west to Red River, Upshur, Brazos (possibly native), and Robertson cos. and southwestern portion of East Texas in Bexar, Bastrop, Bell, Comal, Hays, and Travis cos.; also Gulf Prairies and Marshes and eastern Edwards Plateau; primarily southeastern U.S. from DE s to FL west to OK and TX and up the Mississippi drainage to IL and IN.

Principal Uses: BALD-CYPRESS has one of the most variable woods in the U.S. in many respects, so major uses depend on the particular grade (particularly whether sapwood or heartwood). Most of the major uses rely on the wood's decay resistance and durability (particularly of old-growth wood) when exposed to conditions favorable to decay (e.g., the name "the wood eternal"). Such uses include siding, beams, posts, pilings, timbers in docks and bridges, and coffins. The wood is also used for millwork (doors, sash, and blinds, interior trim, and paneling), kitchen cabinets, shingles, boxes, and crates. BALD-CYPRESS is additionally used for railroad ties. High quality old-growth bald-cypress has, for commercial purposes, been exhausted.

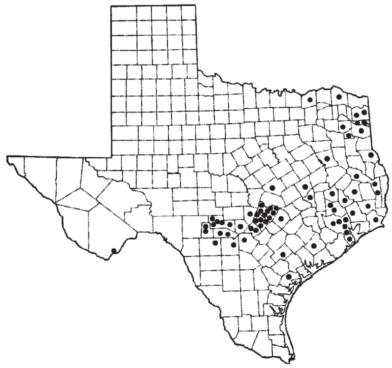
Historical Uses: tanks, vats, silos, containers for corrosive chemicals, laundry appliances, greenhouses, ship- and boatbuilding, stadium seats, shingles, cooperage (barrels).

Other Significant Information: BALD-CYPRESS has been growing in popularity as an ornamental tree for parks, large lawns, and urban settings. While extremely tolerant of flooding (and thus dominant in some East Texas habitats), the species does well in cultivation in upland situations and is reasonably drought tolerant (in natural settings it cannot compete with hardwoods in uplands). At one time there were large numbers of huge, old BALD-CYPRESSES in East Texas, but because of the value of the wood, almost all were cut for timber. A very few impressive, extremely old individuals escaped destruction and can still be seen in the Big Thicket National Preserve. Fortunately, second or third growth tracts do occur in state and federal parklands, forests, and preserves in Texas, especially in the Big Thicket National Preserve and at Caddo Lake. This species is extremely long-lived and individuals up to nearly 1,700 years old have been discovered in North Carolina, making it the longest lived tree species in eastern North America. While there have been various suggestions, the function or functions of the "knees" remains unclear. All trees in East TX are var. *distichum*. Two other varieties are known: *Taxodium distichum* var. *imbricatum* (Nutt.) Croom, POND-CYPRESS, native in the southeastern U.S. west as far as eastern Louisiana and *Taxodium distichum* var. *mexicanum* Gordon, MEXICAN or MONTEZUMA BALD-CYPRESS, which extends as far north as southern Texas. The seeds were an important food for the now extinct Carolina parakeet.

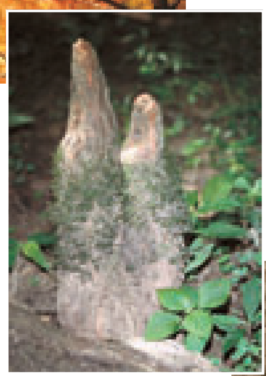
Recognition in the Field: typically *swollen-based trees* of wet habitats with nearly globose, *plum-sized, woody cones*, and when growing in or near water with distinctive *"knees"* (erect woody projections) from the roots; also with alternate, ± linear, flat leaves, and *deciduous* twiglets (and thus leaves which are borne on the twiglets).

WOOD

Taxodium distichum

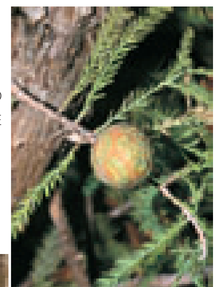


FALL LEAVES



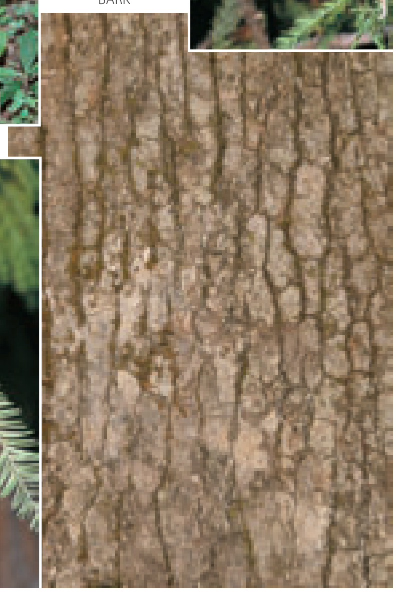
"KNEES"

SEED CONE



HABIT

BARK



LEAVES

ULMUS AMERICANA L. AMERICAN ELM (ULMACAEAE, ELM FAMILY)

Other Common Names: WHITE ELM, SOFT ELM, WATER ELM, GRAY ELM, COMMON ELM

Form and Size: medium to tall tree, 21–35(–40) m; trunk usually straight, to 1–3+ m in diameter, often soon branching, the branches sharply rising (giving rise to a "vase" shape); crown broadly rounded, sometimes with a weeping appearance.

Leaves: deciduous, simple, alternate, the blades 7–12(–14) cm long, mostly 1.5–2 times as long as wide, rounded and asymmetrical at base, apically tapering abruptly to a point, dark green, glabrous and smooth or slightly scabrous above, paler and glabrous to densely soft-pubescent beneath, marginally usually doubly serrate; petiole ca. 5 mm, glabrous to pubescent.

Buds: 4–6 mm long, broadest at the base and tapering to a sharp point, covered with tiny, reddish-brown, slightly hairy scales.

Flowers: bisexual (perfect), in fascicles of 3–4 produced on long (1–2 cm), slender, drooping, pedicels; petals absent; calyx slightly asymmetric, with 7–9 shallow lobes, the margins ciliate; stamens 7–9, the anthers red; pistil 1.

Fruits: in loose fascicles, drooping on elongate pedicels, dry, flattened, elliptic to ovate samaras ca. 1 cm long, the surfaces glabrous but ciliate marginally.

Bark: thick, ash-gray to grayish-brown, with deep somewhat irregular and intersecting furrows that separate the broad flat ridges/plates, the ridges composed of thin, closely pressed scales.

Wood: sapwood grayish white to light brown; heartwood thick, light brown to brown, frequently with a reddish tinge; wood with grain typically interlocked; growth rings distinct.

Habitat: bottomlands, floodplains, terraces, deciduous woodlands, fencerows, generally in areas with significant moisture.

Range: widespread in Texas except for the extreme south and extreme northwest; widespread in the eastern U.S. and southern Canada w to MT and TX.

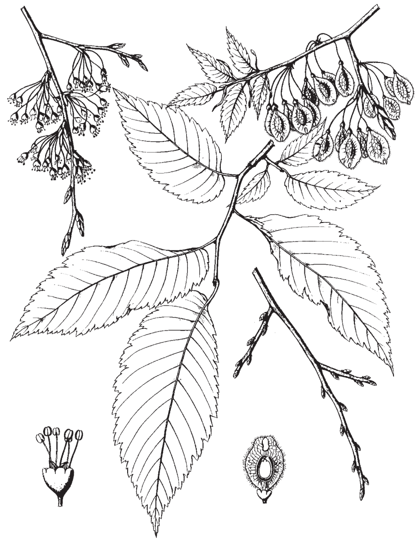
Principal Uses: boxes, crates, paneling, flooring; because of its good bending qualities it is used for the arching or curved parts of furniture; the interlocking grain makes it difficult to split (and thus useful for items like hockey sticks); because of the decline of this species due to Dutch Elm Disease, AMERICAN ELM wood is of limited importance today.

Historical Uses: because of its strength, the wood was used for things susceptible to wear such as wagon wheel hubs, ship decks, or mortars for grinding grain (by Native Americans). Other uses included slack cooperage (= barrels for storing dry goods; it was considered one of the best woods for barrel staves, due to its excellent bending properties and resistance to splitting), ship blocks, bark canoes (Native Americans), farm implements, construction and mining timbers, and railroad ties.

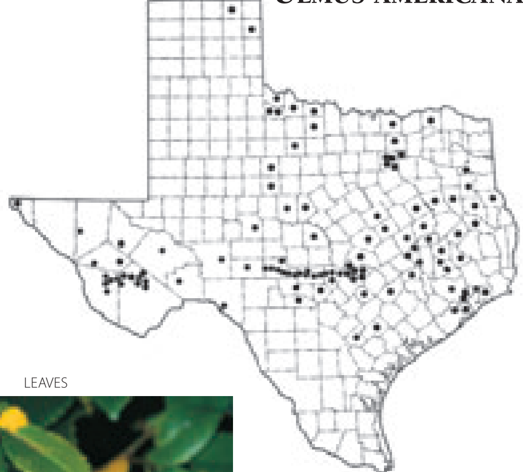
Other Significant Information: AMERICAN ELMS are moderately fast growing and generally do not flower and fruit significantly until they are 35–40 years old. This was once among the most popular ornamental trees in eastern North America, and it was well known for its beautiful "vase" shape (expanding ± evenly from a narrow base to a full crown). However, the wide spread of Dutch Elm Disease (thus named because it was discovered by scientists in the Netherlands) has greatly impacted this species. The disease is caused by an ascomycete fungus, *Ophiostoma ulmi* (Buisman) Nannf., that was introduced into the U.S. on diseased logs from Europe (though the fungus is thought to have originated in Asia). It was first discovered in North America in Colorado in the 1930s. This fungus, the spores of which are spread by bark beetles or through tree to tree root grafts, blocks the vascular tissue, thus killing infected trees. The loss of every tree on numerous elm-lined streets is a good lesson in the importance of planting a diversity of tree species (and avoiding monocultures).

Recognition in the Field: alternate, simple, large (> 7 cm long) leaves that are *asymmetrical at base, doubly toothed*, and have one main vein from the base; fruits small, flat, elliptic to ovate, *winged,* glabrous except for marginal cilia.

WOOD



ULMUS AMERICANA



LEAF SHOWING ASYMMETRICAL BASE

LEAVES

BARK

LIST OF SELECTED BOTANICALLY RELATED INTERNET ADDRESSES

The following list of internet addresses is intended to provide an entry point into what is a very large and constantly changing pool of information of interest to botanists; it is by no means an attempt at a comprehensive listing. Some of the addresses will soon be outdated, while others are likely to be constant for significant periods of time. One of the major advantages to botanists of this information explosion is that extensive information is accessible from one's desk even without access to major botanical libraries or institutions. This is particularly important to botanists at small colleges and universities. The addresses below have been obtained from the internet and also from unpublished lists by N.G. Miller, Jorge E. Arriagada, and Rahmona Thompson. Updates to this list can be found at:

artemis.austincollege.edu/acad/bio/gdiggs/inter.addresses.html

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I. BOTANICAL ORGANIZATIONS, PROJECTS, AND INSTITUTIONS

ALIEN PLANT WEBPAGE—THE ALIEN PLANT WORKING GROUP
www.nps.gov/plants/alien/

AMERICAN FORESTS
www.americanforests.org/

AMERICAN SOCIETY OF PLANT TAXONOMISTS (home page and to find addresses of members)
www.aspt.net/

THE ANCIENT CROSS TIMBERS CONSORTIUM
www.uark.edu/misc/xtimber/

BIOINFORMATICS WORKING GROUP—TEXAS A&M UNIVERSITY
csdl.tamu.edu/FLORA/tamuherb.htm

BIOTA OF NORTH AMERICA PROGRAM (BONAP)
www.bonap.org/

BOTANICAL RESEARCH INSTITUTE OF TEXAS (BRIT)
www.brit.org

BOTANICAL SOCIETY OF AMERICA
www.botany.org

CORNELL UNIVERSITY BOTANICAL GARDEN
www.plantations.cornell.edu/

COUNCIL ON BOTANICAL AND HORTICULTURAL LIBRARIES
www.cbhl.net/

EAST TEXAS ARBORETUM AND BOTANICAL SOCIETY
www.eastexasarboretum.org/

FLORA OF NORTH AMERICA
www.fna.org/FNA/

FOREST RESEARCH INSTITUTE-STEPHEN F. AUSTIN STATE UNIVERSITY
www.fri.sfasu.edu/

GENERIC FLORA OF THE SOUTHEASTERN UNITED STATES PROJECT
www.flmnh.ufl.edu/natsci/herbarium/genflor/

GRAY HERBARIUM OF HARVARD UNIVERSITY
www.huh.harvard.edu/

INTERNATIONAL ASSOCIATION FOR PLANT TAXONOMY
bgbm3.bgbm.fu-berlin.de/IAPT/default.htm

INTERNATIONAL ORGANIZATION FOR PLANT INFORMATION
plantnet.rbgsyd.gov.au/iopi/iopihome.htm
INVASIVE SPECIES INITIATIVE—THE NATURE CONSERVANCY
tncweeds.ucdavis.edu/
JEPSON AND UNIVERSITY OF CALIFORNIA AT BERKELEY HERBARIA
ucjeps.berkeley.edu/
LADY BIRD JOHNSON WILDFLOWER CENTER
www.wildflower.org/
MAST ARBORETUM-STEPHEN F. AUSTIN STATE UNIVERSITY
arboretum.sfasu.edu/
MISSOURI BOTANICAL GARDEN
www.mobot.org/default.asp
NATIONAL BIOLOGICAL INFORMATION INFRASTRUCTURE
www.nbii.gov/search/sitemap.html
NATURAL RESOURCES CONSERVATION SERVICE (USDA)
www.nrcs.usda.gov/
NATURAL SCIENCE COLLECTIONS ALLIANCE WEBSITE
www.nscalliance.org/
NEW YORK BOTANICAL GARDEN
www.nybg.org/
NORTH AMERICAN WEED MANAGEMENT ASSOCIATION
www.nawma.org/index.html
OHIO STATE UNIVERSITY MAIN PLANT PAGE
plantfacts.osu.edu/
ORGANIZATION FOR TROPICAL STUDIES (OTS)
www.ots.duke.edu/
PLANTS FOR THE FUTURE (a resource center for edible and other useful plants)
www.pfaf.org/
ROYAL BOTANIC GARDENS, KEW
www.rbgkew.org.uk
SIDA, CONTRIBUTIONS TO BOTANY
www.brit.org/sida/
SMITHSONIAN INSTITUTION BOTANY DEPARTMENT
www.nmnh.si.edu/botany/
TEXAS A&M UNIVERSITY TRACY HERBARIUM
www.csdl.tamu.edu/FLORA/taes/tracy/homeNF.html
TEXAS AGRICULTURAL EXPERIMENT STATION-COUNTY RESEARCH CENTERS (formerly part of the Texas Agricultural Extension Service)
agresearch.tamu.edu/r&ECenters.htm
TEXAS COOPERATIVE EXTENSION-COUNTY OFFICES (formerly the Texas Agricultural Extension Service)
county-tx.tamu.edu/
TEXAS DEPARTMENT OF PARKS AND WILDLIFE
www.tpwd.state.tx.us/
TEXAS FOREST SERVICE
txforestservice.tamu.edu/
TEXAS NATURE CONSERVANCY
nature.org/wherewework/northamerica/states/texas/
TREE OF LIFE (information about phylogeny and biodiversity)
tolweb.org/tree/phylogeny.html
UNIVERSITY OF CALIFORNIA MUSEUM OF PALEONTOLOGY (UCMP) WEB LIFT TO TAXA (general information on plant groups)
www.ucmp.berkeley.edu/help/taxaform.html

University of Texas at Austin Plant Resources Center
www.biosci.utexas.edu/prc/
University of Wisconsin-Madison, Department of Botany
www.botany.wisc.edu/
Useful Wild Plants Project-Useful plants of Texas and SE
www.usefulwildplants.org/

II. Plant Images

Agricultural Research Service Image Gallery (for plant images)
www.ars.usda.gov/is/graphics/photos/
Aquatic, Wetland, and Invasive Plant Line Drawings
aquat1.ifas.ufl.edu/linedr.html
California State University Stanislaus Botany Course Web Images
arnica.csustan.edu/botany/
Carnivorous Plant Images
www.omnisterra.com/bot/cp_home.cgi
Digital Flowers-from a systematics course at the University of Illinois
www.life.uiuc.edu/plantbio/digitalflowers/
Horticultural and Food Crop Images
pas.byu.edu/aghrt100/images.htm
Linnaean Herbarium Specimen Images
linnaeus.nrm.se/botany/fbo/welcome.html.en
Medical and Culinary Plant Images
www.ibiblio.org/herbmed/
Native Plant Information Network (Lady Bird Johnson Wildflower Center)
www.wildflower2.org/npin/gallery/gallery.html
Native Plants of Central Texas
www.sbs.utexas.edu/mbierner/bio406d/PlantPics_archive.htm
Missouri Botanical Garden Library-Rare Book Digitization Project
www.illustratedgarden.org/mobot/rarebooks/index.asp
Plant Image Gallery (The Noble Foundation)
www.noble.org/imagegallery/
Plant Images (Steve's Photos)
arnica.csustan.edu/photos/index.htm
Smithsonian Institution Botany Department (botanical images)
www.nmnh.si.edu/botany/images.htm
2bnthewild—images of plants of the southeastern U. S.
2bnthewild.com/
Vascular Plant Image Library (Texas A&M University)
www.csdl.tamu.edu/FLORA/gallery.htm
Virtual Foliage Home Page (plant images)
botit.botany.wisc.edu/

III. Tools Useful to Botanists

A. Databases Including Plant Names/Nomenclature

Alien Plant Database—Alien Plant Working Group
www.nps.gov/plants/alien/factmain.htm#pllists
Aquatic, Wetland, and Invasive Plant Database
aquat1.ifas.ufl.edu/

ARABIDOPSIS—THE DEFINITIVE WEBSITE
www.arabidopsis.org
BOTANICAL COLLECTORS DATABASE (information on plant collectors and authors)
brimsa.huh.harvard.edu/cms-wb/botanist_index.html
CHECKLIST (SYNONYMIZED) OF VASCULAR FLORA NORTH OF MEXICO (a checklist and more; BONAP/Kartesz data from 1998)
www.csdl.tamu.edu/FLORA/b98/check98.htm
DATABASES AT THE SMITHSONIAN INSTITUTION
www.mnh.si.edu/rc/db/databases.html
FAMILIES OF FLOWERING PLANTS (detailed family descriptions-geography, biochemistry, anatomy, pollination, etc.)
delta-intkey.com/angio/index.htm
FLORA EUROPAEA DATABASE
rbg-web2.rbge.org.uk/FE/fe.html
FLORA2K—BIODIVERSITY ON THE INTERNET (to access nomenclatural and family information)
www.csdl.tamu.edu/FLORA/kartesz/flora2ka.htm
FLOWERING PLANT GATEWAY (for plant family information)
www.csdl.tamu.edu/FLORA/tfp/vascdoc1.htm
GERMPLASM RESOURCES INFORMATION NETWORK (GRIN)
www.ars-grin.gov/cgi-bin/npgs/html/index.pl
GLOBAL WEED COMPENDIUM
www.hear.org/gcw/index.html
GRASS GENERA OF THE WORLD
delta-intkey.com/grass/
HARVARD UNIVERSITY DATABASES
blodeuwedd.huh.harvard.edu/databases/
INDEX HERBARIORUM (database of herbaria world wide)
sciweb.nybg.org/science2/IndexHerbariorum.asp
INDEX NOMINUM GENERICORUM
ravenel.si.edu/botany/ing//
INDEX NOMINUM SUPRAGENERICORUM PLANTARUM VASCULARIUM PROJECT
matrix.nal.usda.gov:8080/cgi-bin/starfinder/0?path=suprag.txt&id=anon&pass=&OK=OK
INTEGRATED TAXONOMIC INFORMATION SYSTEM DATABASE QUERY
www.itis.usda.gov/advanced_search.html
INTERNATIONAL ORGANIZATION FOR PLANT INFORMATION (database of plant databases)
plantnet.rbgsyd.gov.au/iopi/iopihome.htm
INTERNATIONAL PLANT NAME INDEX
www.ipni.org/ipni/query_ipni.html
INVASIVE SPECIES
www.invasivespecies.gov
NAMES IN CURRENT USE FOR EXTANT PLANT GENERA
www.bgbm.fu-berlin.de/iapt/ncu/genera/
NEW YORK BOTANICAL GARDEN (searchable databases)
www.nybg.org/bsci/online_pubs.html
PHYTOCHEMICAL AND ETHNOBOTANICAL DATABASES
www.ars-grin.gov/duke/index.html
PLANT CHROMOSOME NUMBERS DATABASE
mobot.mobot.org/Pick/Search/ipcn.html
PLANT-LINK (search engine for plant information)
www.dpw.wageningen-ur.nl/links/
PLANTS FOR THE FUTURE (a species database of useful plants)
www.pfaf.org/

PLANTS NATIONAL DATABASE (USDA)
plants.usda.gov/
ROYAL BOTANIC GARDENS, KEW DATABASES
www.rbgkew.org.uk/data/index.html
www.kew.org/searchepic/searchpage.do
TREEBASE—A DATABASE OF PHYLOGENETIC KNOWLEDGE
www.treebase.org/treebase/
TREE SPECIES RANGE MAPS
climchange.cr.usgs.gov/data/atlas/little/
TROPICOS (Worldwide Nomenclature Database-Missouri Botanical Garden)
mobot.mobot.org/W3T/Search/vast.html
UNIVERSITY OF MINNESOTA-PLANT INFORMATION ONLINE (Subscription required)
plantinfo.umn.edu/default.asp
VASCULAR PLANT FAMILY NAMES IN CURRENT USE
www.life.umd.edu/emeritus/reveal/pbio/fam.ncu.html
WORLD SPECIES INDEX
www.sp2000.org/

B. FLORAS

ARKANSAS VASCULAR PLANTS
www.csdl.tamu.edu/FLORA/arkansas/arkindex.htm
DIGITAL ATLAS OF THE VIRGINIA FLORA
www.biol.vt.edu/digital_atlas/
FLORA OF THE CAROLINAS, VIRGINIA, AND GEORGIA (online flora)
www.herbarium.unc.edu/flora.htm
FLORIDA VASCULAR PLANTS (Atlas)
www.plantatlas.usf.edu/
ILLUSTRATED FLORA OF NORTH CENTRAL TEXAS
artemis.austincollege.edu/acad/bio/gdiggs/NCTXpdf.htm
LOUISIANA GRASSES
www.csdl.tamu.edu/FLORA/lagrasses/lahome1.htm
NEW MEXICO VASCULAR PLANT NAMES (Working Index)
web.nmsu.edu/~kallred/herbweb/Working%20Index-title.htm
OKLAHOMA VASCULAR PLANTS DATABASE
www.biosurvey.ou.edu/atlasdesc.html
THE PULLEN HERBARIUM (MISS)
www.herbarium.olemiss.edu/
SOUTH CAROLINA PLANT ATLAS
cricket.biol.sc.edu/herb/
TENNESSEE VASCULAR PLANTS (Database)
tenn.bio.utk.edu/vascular/vascular.html

C. PLANT TAXONOMIC MATERIAL /RULES

AMERICAN SOCIETY OF PLANT TAXONOMISTS MEMBERSHIP LIST (to locate botanists)
www.aspt.net/
ANGIOSPERM PHYLOGENY
www.mobot.org/MOBOT/Research/APweb/welcome.html
AUTHORS OF PLANT NAMES (standard Brummitt & Powell abbreviations)
www.rbgkew.org.uk/web.dbs/authform.html
BIOLOGICAL NOMENCLATURE IN THE 21ST CENTURY
www.life.umd.edu/emeritus/reveal/PBIO/nomcl/delp.html

CODE BASED ON A PHYLOGENETIC (cladistic) THEME
www.ohiou.edu/phylocode/

DELTA (Descriptive Language for Taxonomy)
delta-intkey.com/

DRAFT BIOCODE (1997): THE PROSPECTIVE INTERNATIONAL RULES FOR THE SCIENTIFIC NAMES OF ORGANISMS
www.rom.on.ca/biodiversity/biocode/biocode1997.html

EXPERT CENTER FOR TAXONOMIC IDENTIFICATION (ETI)
www.eti.bio.uva.nl/

INTERNATIONAL CODE OF BOTANICAL NOMENCLATURE (Tokyo Code)
www.bgbm.fu-berlin.de/iapt/nomenclature/code/tokyo-e/

INTERNATIONAL CODE OF BOTANICAL NOMENCLATURE (St. Louis Code)
www.bgbm.fu-berlin.de/iapt/nomenclature/code/SaintLouis/0000St.Luistitle.htm

PLANT NAMES: CONSERVED AND REJECTED
persoon.si.edu/codes/props/

WORLD TAXONOMISTS DATABASE
www.eti.uva.nl/Database/WTD.html

WORLD WIDE PLANT FAMILY IDENTIFIER
www.colby.edu/info.tech/BI211/PlantFamilyID.html

D. SEARCHING THE BOTANICAL LITERATURE

AGRICOLA DATABASE—NATIONAL AGRICULTURAL LIBRARY (to search for journal articles, etc.)
agricola.nal.usda.gov/

INDEX TO AMERICAN BOTANICAL LITERATURE (excellent source for American botanical references)
www.nybg.org/bsci/iabl.html

KEW RECORD OF TAXONOMIC LITERATURE (excellent source of botany references going back to 1970)
www.rbgkew.org.uk/bibliographies/KR//KRHomeExt.html

IV. USEFUL NON-BOTANICAL TOOLS

AUSTIN COLLEGE ABELL LIBRARY—VIRTUAL LIBRARY
abell.austincollege.edu/Abell/

CAREERS IN BOTANY (Botanical Society of America)
www.botany.org/bsa/careers/

CARTOGRAPHIC LINKS FOR BOTANISTS
www.helsinki.fi/~rlampine/cartogr.html

CIA WORLD FACT BOOK (maps and information about countries worldwide)
www.odci.gov/cia/publications/factbook/index.html

ENVIRONMENTAL NEWS NETWORK
www.enn.com/

GEOGRAPHIC NAMES BROWSER
www.getty.edu/research/conducting_research/vocabularies/tgn/index.html

GEOGRAPHIC NAMES INFORMATION SYSTEM
geonames.usgs.gov/

GOVERNMENT WEBPAGES DATABASE (searches over 1.5 million government and military webpages)
www.firstgov.gov/

THE MAMMALS OF TEXAS—ONLINE EDITION
www.nsrl.ttu.edu/tmot1/Default.htm

MLA (Modern Language Association) (How to cite electronic sources)
www.columbia.edu/cu/cup/cgos/idx_basic.html

NATIONAL ATLAS OF THE UNITED STATES
www-atlas.usgs.gov/

Translation Service/AltaVista (to translate material to or from various languages)
babelfish.altavista.digital.com/
University of Texas Perry-Castaneda Library Map Collection
www.lib.utexas.edu/maps/

V. Links/Directories/Web Servers

Botanical Databases at the Smithsonian Institution
www.nmnh.si.edu/botany/database.htm
Botanical Society of America Botany Related WWW Sites
www.botany.org/bsa/www-bot.html
Botany Journals Webpage (links to journals on the web)
www.e-journals.org/botany/
Internet Directory for Botany
www.botany.net/IDB/
Major WWW and Internet botany addresses (numerous sites)
www.life.umd.edu/emeritus/reveal/pbio/pb250/weba.html
Natural Selection-links to websites on the natural world via query
nature.ac.uk/
Noxious Weed Webpage (links to many noxious weed web sites)
www.aphis.usda.gov/ppq/weeds/
Plant Systematics and Evolution Links
www.csdl.tamu.edu/FLORA/tfp/tfplinks.html
Search Engine for Plant related Questions
webgarden.osu.edu/
Scott's Botanical Links
www.ou.edu/cas/botany-micro/bot-linx/
Vegetation Maps from All Regions of the World
www.lib.berkeley.edu/EART/vegmaps.html
Virtual Library: Botany
www.ou.edu/cas/botany-micro/www-vl/
Virtual Library—Evolution (Biosciences)
mcb.harvard.edu/BioLinks/Evolution.html
Wildflower Links
www.wild-flowers.com/
World Species List (links to plant sites around the world)
species.enviroweb.org/

VI. Texas Botany

Benny Simpson's Native Texas Trees
aggie-horticulture.tamu.edu/ornamentals/natives/tamuhort.html
Bibliography of Texas Vascular Plants
www.csdl.tamu.edu/FLORA/ftc/dft/bibquery.htm
Big Thicket National Preserve
www.nps.gov/bith/
Carnivorous Plants of Texas
www.carnivorousplantsoftexas.org
Checklist of the Vascular Plants of Texas
www.csdl.tamu.edu/FLORA/taes/tracy/coverNF.html
Digital Flora of Texas
www.texasflora.org

ENDEMICS CHECKLIST FOR TEXAS
www.csdl.tamu.edu/FLORA/endemics/endemic1.htm
HERBARIUM SPECIMEN BROWSER (over 240,000 Texas herbarium specimens online)
www.csdl.tamu.edu/FLORA/tracy2/main1.html
ILLUSTRATED FLORA OF EAST TEXAS PROJECT
www.easttexasflora.org
ILLUSTRATED TEXAS FLORAS PROJECT
artemis.austincollege.edu/acad/bio/gdiggs/floras.html
NATIVE PLANT SOCIETY OF TEXAS
www.npsot.org/
SHINNERS & MAHLER'S ILLUSTRATED FLORA OF NORTH CENTRAL TEXAS
artemis.austincollege.edu/acad/bio/gdiggs/shinners.html
TEXAS BIG TREE REGISTRY
txforestservice.tamu.edu/shared/article.asp?DocumentID=476
TEXAS DEPARTMENT OF AGRICULTURE
www.agr.state.tx.us
TEXAS MINTS (some images and descriptions)
www.lib.utexas.edu/lsl/Mints/
THE VASCULAR FLORA OF MADISON COUNTY, TEXAS
biocourse.bio.tamu.edu/graduate-students/neilla/madhome.htm
WILDFLOWERS IN TEXAS (images)
www.rice.edu/armadillo/Wildflowers/Project/wild4.html

VII. GARDENING/HORTICULTURAL/AGRICULTURAL/PRACTICAL INFORMATION (APPLIED BOTANY)

AGGIE HORTICULTURE, TEXAS A&M UNIVERSITY
aggie–horticulture.tamu.edu
AMERICAN SEED AND NURSERY INDUSTRY
www.sil.si.edu/SILPublications/seeds/
COMMON NAMES WITH THEIR SCIENTIFIC NAMES
www.b-and-t-world-seeds.com/coma.htm
DISTRIBUTED NETWORK OF AGRICULTURAL-RELATED INFORMATION
laurel.nal.usda.gov:8080/agnic/
ENCYCLOPEDIA OF PLANTS (horticultural information)
www.botany.com/
FORESTEST SCIENCE (TEXAS A&M) INFORMATION AND LINKS
forest.tamu.edu/
PLANT TRIVIA TIMELINE
www.huntington.org/BotanicalDiv/Timeline.html
SEED RESOURCES
www.seedquest.com/
SILVICS OF NORTH AMERICA-U.S.D.A. HANDBOOK
www.na.fs.fed.us/spfo/pubs/silvics_manual/table_of_contents.htm
SOIL TAXONOMY-SOIL ORDERS
soils.ag.uidaho.edu/soilorders/orders.htm
TREE DESCRIPTIONS FOR 680 TREES
hort.ifas.ufl.edu/trees/family.htm
TREE BIOLOGY AND NEWS AROUND THE WORLD
www.dlarborist.com/treetrends/
WHAT ARE ALL THOSE DEAD PLANTS FOR, ANYWAY?
ucjeps.berkeley.edu/dead_plants.html

VIII. Conservation

Big Thicket Association
www.btatx.org
Biodiversity Worldmap
www.nhm.ac.uk/science/projects/worldmap/
Bionet-International—Global Network for Taxonomy in Developing Countries
www.bionet-intl.org
Caddo Defense
www.caddodefense.org/
Caddo Lake Institute Data Server
www.clidata.org/default.htm
Center for Biodiversity and Conservation Website
research.amnh.org/biodiversity/
The Conservation Fund
www.conservationfund.org/
Convention on Biological Diversity Website
www.biodiv.org/default.shtml
Endangered Species and International Trade
www.rbgkew.org.uk/conservation/cites-ind.html
Endangered and Threatened Species
endangered.fws.gov/
www.tpwd.state.tx.us/nature/endang/
Environmental Protection Agency
www.epa.gov/
Global Environmental Facility Website
www.gefweb.org
Globally Threatened Trees
www.wcmc.org.uk/trees/
Instituto Nacional de Biodiversidad Website—a Costa Rican Organization
www.inbio.ac.cr/es/default.html
National Library for the Environment
www.cnie.org/NLE/
National Register of Big Trees
www.americanforests.org/resources/bigtrees/
Native Prairies Association of Texas
www.texasprairie.org/
Naturserve-Connecting science with conservation
www.natureserve.org/
Natural Area Preservation Association
www.napa-texas.org/
Natural Resources Conservation Service, U.S. Department of Agriculture, Plant Materials Program
plant-materials.nrcs.usda.gov/
Natural Resources Conservation Service, U.S. Department of Agriculture, Plant Materials Program, East Texas Office
plant-materials.nrcs.usda.gov/etpmc/index.html
Nature Conservancy
nature.org/
Pineywoods Native Plant Center-Stephen F. Austin State University
pnpc.sfasu.edu/Default.htm

Plant Conservation Alliance

www.nps.gov/plants/

Sierra Club

www.sierraclub.org/

Society for Conservation Biology

conbio.net/

Texas Committee on Natural Resources

tconr.home.texas.net/

Texas Commission on Environmental Quality (formerly Texas Natural Resource Conservation Commission)

www.tceq.state.tx.us/index.html

Texas Nature Conservancy

nature.org/wherewework/northamerica/states/texas/

The Trust for Public Land

www.tpl.org/tier2_rl.cfm?folder_id=264

Virtual Library of Ecology and Biodiversity

conbio.net/vl/

Water Conservation

www.watersmart.org

World Conservation Monitoring Centre

www.unep-wcmc.org/

Worldwatch Institute

www.worldwatch.org

IX. Poisonous and Medicinal Plants

American Association of Poison Control Centers

www.aapcc.org/

www.1-800-222-1222.info/

Medicinal and Economic Botany Links

www.life.umd.edu/emeritus/reveal/PBIO/FindIT/ecmd.html

Medicinal Plants—Images, Classic Publications and Resources

www.all-natural.com/herbindx.html

Poisonous Plant Links

www.life.umd.edu/emeritus/reveal/PBIO/FindIT/popl.html

Poisonous Plants Information System-Canada

www.cbif.gc.ca/pls/pp/poison?p_x=px

Poisonous Plants Webpage—Cornell University

www.ansci.cornell.edu/plants/index.html

State Botanical Symbols

Information on state botanical symbols can be found in Texas Parks & Wildlife (1995), Tyrl et al. (1994), Jones et al. (1997), and Shearer and Shearer (1994).

Texas

Lupinus [Fabaceae], BLUEBONNET. All six *Lupinus* species which occur in the state are the **state flowers of Texas**. *Lupinus subcarnosus* was designated the state flower in 1901 and in 1971 the legislature extended state flower status to the other five *Lupinus* species native in Texas (Andrews 1986).

Carya illinoinensis (Wangenh.) K. Koch [Juglandaceae], PECAN, NOGAL MORADO, NUEZ ENCARCELADA. **State tree of Texas** as designated by the state legislature in 1919 (Jones et al. 1997).

Bouteloua curtipendula (Michx.) Torr. [Poaceae], SIDE-OATS GRAMA. **State grass of Texas** as designated by the 62nd Texas Legislature in 1971 (Jones et al. 1997).

Opuntia [Cactaceae], PRICKLY-PEAR. All members of subgenus *Opuntia* (with flat stems) are considered the **state plant of Texas**, while those of subgenus *Cylindroopuntia* (with cylindrical stems) are not—as designated by the 74th state legislature (Jones et al. 1997).

Citrus paradisi (L.) Macfad. [*C. maxima* × *C. sinensis*] (cultivar "Ruby" (redblush)) [Rutaceae], TEXAS RED GRAPEFRUIT. **State fruit of Texas** as designated in 1993; while this hybrid cultivar was developed in TX, the parents are introduced (Jones et al. 1997).

Capsicum annuum L. var. *annuum* [Solanaceae], JALAPEÑO. **State pepper of Texas** as designated by the 74th state legislature (Jones et al. 1997).

Capsicum annuum L. var. *glabriusculum* (Dunal) Heiser & Pickersgill [Solanaceae], BIRD PEPPER, CHILITEPÍN, CHILIPIQUÍN, CHILE PIQUÍN, BUSH REDPEPPER. **Native pepper of Texas** as designated by Texas House Concurrent Resolution 82 in 1997 (Andrews 1998).

Oklahoma

Gaillardia pulchella Foug. [Asteraceae], FIRE-WHEELS, INDIAN-BLANKET, ROSE-RING GAILLARDIA. **State wildflower of Oklahoma** (Tyrl et al. 1994).

Cercis canadensis L. [Fabaceae], REDBUD, JUDAS TREE. **State tree of Oklahoma** (Tyrl et al. 1994).

Sorghastrum nutans (L.) Nash [Poaceae], INDIAN GRASS, YELLOW INDIAN GRASS, INDIAN REED. **State grass of Oklahoma** (S. Barber, pers. comm.).

Phoradendron tomentosum (DC.) Engelm. ex A. Gray [Viscaceae], MISTLETOE, CHRISTMAS MISTLETOE, INJERTO, HAIRY MISTLETOE. **Official floral emblem of Oklahoma** as designated by the Assembly of the Territory of Oklahoma on 11 February 1893 (Tyrl et al. 1994).

Arkansas

Malus coronaria (L.) Mill. [Rosaceae], APPLE BLOSSOM. **State flower of Arkansas**. Adopted by the General Assembly of 1901. www.sosweb.state.ar.us/educational_history_facts.html (accessed 2/16/2005).
Shearer, B.E. and B.S. Shearer. 1994. *State Names, Seals. Flags, and Symbols: A Historical Guide Revised and Expanded*. Greenwood Press, Westport, CT.

Pinus L. [Pinaceae], PINE. **State tree of Arkansas** (species not designated). Adopted by the General Assembly of 1939. www.sosweb.state.ar.us/educational_history_facts.html (accessed 2/16/2005). Shearer, B.E. and B.S. Shearer. 1994. *State Names, Seals. Flags, and Symbols: A Historical Guide Revised and Expanded*. Greenwood Press, Westport, CT.

Solanum L. [Solanaceae], SOUTH ARKANSAS VINE RIPE PINK TOMATO (numerous varieties). **State fruit and vegetable of Arkansas**. Adopted as an official symbol on March 16, 1987. www.sosweb.state.ar.us/educational_history_facts.html (accessed 2/16/2005). Quasha, J. 2002. *How to Draw Arkansas' Sites and Symbols*. Rosen, New York.

LOUISIANA

Magnolia grandiflora L. [Magnoliaceae], SOUTHERN MAGNOLIA. **State flower of Louisiana**. Adopted as an official symbol on August 1, 1900. Shearer, B.E. and B.S. Shearer. 1994. *State Names, Seals. Flags, and Symbols: A Historical Guide Revised and Expanded*. Greenwood Press, Westport, CT.

Taxodium distichum (L.) Rich. [Cupressaceae], BALD CYPRESS. **State tree of Louisiana**. Adopted in 1963. Shearer, B.E. and B.S. Shearer. 1994. *State Names, Seals. Flags, and Symbols: A Historical Guide Revised and Expanded*. Greenwood Press, Westport, CT.

Iris giganticaerulea Small [Iridaceae], LOUISIANA IRIS. **State wildflower of Louisiana**. Adopted in 1990. www.sec.state.la.us/around/facts/facts-index.htm (accessed 2/16/2005). Shearer, B.E. and B.S. Shearer. 1994. *State Names, Seals. Flags, and Symbols: A Historical Guide Revised and Expanded*. Greenwood Press, Westport, CT.

Elray S. Nixon Publications

Scientific Journals and other Refereed Publications

Nixon, E.S. and E.M. Christensen. 1964. Observations on reproduction of bigtooth maple. Leafl. W. Bot. 10:97–99.

Nixon, E.S. and C. McMillan. 1964. The role of soil in the distribution of four grass species in Texas. Amer. Midl. Naturalist 71:114–140.

Nixon, E.S. 1964. Edaphic responses of *Lupinus texenis* and *Lupinus sabcarnosus*. Ecology 45:459–469.

Nixon, E.S. 1967. A vegetational study of the Pine Ridge of northwestern Nebraska. SouthW. Naturalist 12:59–66.

Nixon, E.S. 1967. A comparative study of the mountain brush vegetation in Utah. Great Basin Naturalist 27:59–66.

Johnson, K. and E.S. Nixon. 1967. The Rhopalocera of northwestern Nebraska. Amer. Midl. Naturalist 78:508–528.

Main, J.L. and E.S. Nixon. 1968. Distributional aspects of *Pinus ponderosa* in northwestern Nebraska. Great Basin Naturalist 28:24–29.

Nixon, E.S. 1969. An edaphic study of two *Spartina spartinae* locations in Texas. Texas J. Sci. 21:93–95.

Nixon, E.S. and L.K. Halls. 1969. Response of partridgepea to soil factors. Proceedings of the 23rd Annual Conference of the Southeastern Association of Game and Fish Commissioners. 6 pp.

Nixon, E.S., J.R. Sullivan, J.T. Brown, J.B. Lacey, and J.D. Freeman. 1970. Notes on the distribution of *Trillium gracile* and *Trillium recurvatum* (Liliaceae) in Texas. Sida 3:528–530.

Sullivan, J.R. and E.S. Nixon. 1971. A vegetational analysis of an area in Nacogdoches County, Texas. Texas J. Sci. 23:67–79.

Nixon, E.S., L.F. Chamblees, and J.L. Malloy. 1973. Woody vegetation of a Palmetto (*Sabal minor*) area in East Texas. Texas J. Sci. 24:535–541.

Stransky, J.J., E.S. Nixon, C.L. Burandt, Jr., and R.L. Willett. 1974. First year revegetation following timber harvest in East Texas. USDA Forest Service Research Note SO-173, Southern Forest Experiment Station, New Orleans, Louisiana. 7 pp.

Chambless, L.F. and E.S. Nixon. 1975. Woody vegetation-soil relations in a bottomland forest of East Texas. Texas J. Sci. 26:407–416.

Nixon, E.S. 1975. Successional stages in a hardwood bottomland forest near Dallas, Texas. SouthW. Naturalist 20:323–336.

Stransky, J.J., L.K. Halls, and E.S. Nixon. 1976. Plants following timber harvest: importance to songbirds. Texas Forestry Paper No. 28, School of Forestry, Stephen F. Austin State University, Nacogdoches, Texas. 13 pp.

Nixon, E.S. and J.A. Raines. 1976. Woody creekside vegetation of Nacogdoches County, Texas. Texas J. Sci. 27: 443–452.

Burandt, C.L., Jr., E.S. Nixon, and R.L. Willett. 1977. Woody vegetation of an inland heronry in East Texas. SouthW. Naturalist 21:475–486.

Nixon, E.S. et al. 1977. Analysis of stump vegetation in an East Texas pond. Texas J. Sci. 28:366.

Hoff, V.J. and E.S. Nixon. 1977. Extension of *Gaura demareei* into East Texas. SouthW. Naturalist 22:135.

Nixon, E.S. 1977. A mountain *Cercocarpus* population-revisited. Great Basin Naturalist 37:97–99.

Nixon, E.S., R.L. Willett, and P.W. Cox. 1977. Woody vegetation of a virgin forest in an eastern Texas river bottom. Castanea 42:227–236.

Nixon, E.S., K.L. Marietta, and M. McCrary. 1980. *Brachyelytrum erectum* and *Talinum rugospermum*, new species to Texas and notes on *Schoenolirion wrightii*. Sida 8:355–356.

Nixon, E.S., K.L. Marietta, R.O. Littlejohn, and H.B. Weyland. 1980. Woody vegetation of an American beech (*Fagus grandifolia*) community in eastern Texas. Castanea 45:171–180.

Nixon, E.S., J.W. Higgins, P.L. Blanchette, and F.A. Roth. 1980. Woody vegetation of a wet creek branch in East Texas. Texas J. Sci. 32:337–341.

Nixon, E.S. and J.R. Ward. 1981. Distribution of *Schoenolirion wrightii* (Liliaceae) and *Bartonia texana* (Gentianaceae). Sida 9:64–69.

NIXON, E.S., R.L. WILLETT, M.L. BUTTS, and C.L. BURANDT, JR. 1981. Early seral development following partial clearcutting in East Texas. Texas J. Sci. 33:25–32.

NIXON, E.S. and L.H. BRAGG. 1982. East Texas populations of *Prosopis* (Leguminosae). Texas J. Sci. 34:89–90.

NIXON, E.S. and J.R. WARD. 1982. *Rhynchospora miliacea* and *Scirpus divaricatus*, new to Texas. Sida 9:367.

MARIETTA, K.L. and E.S. NIXON. 1983. Vegetational analysis of a post oak/black hickory community in eastern Texas. Texas J. Sci. 35:197–203.

NIXON, E.S., R.L. EHRHART, S.A. JASPER, J.S. NECK, and J.R. WARD. 1983. Woody streamside vegetation of Prairie Creek in East Texas. Texas J. Sci. 35:205–213.

NIXON, E.S., J.R. WARD, and B.L. LIPSCOMB. 1983. Rediscovery of *Lesquerella pallida* (Cruciferae). Sida 10:167–175.

MARIETTA, K.L. and E.S. NIXON. 1984. Vegetation of an open, prairie-like community in eastern Texas. Texas J. Sci. 36:25–32.

NIXON, E.S., J. MATOS, and R.S. HANSEN. 1987. The response of woody vegetation to a topographic gradient in eastern Texas. Texas J. Sci. 39:367–375.

NIXON, E.S., S.C. DAMUTH, and M. MCCRARY. 1987. Five additions to the Texas flora. Sida 12:421–423.

NIXON, E.S. and J.R. WARD. 1988. Vegetation of a wet creek bottom site in eastern Texas. Texas J. Sci. 40:358–361.

GEORGE, R.J. and E.S. NIXON. 1990. The herbaceous flora of three Weches Formation outcrops in eastern Texas. Sida 14:117–127.

NIXON, E.S., G.A. SULLIVAN, S.D. JONES, G.D. JONES, and J.K. SULLIVAN. 1990. Species diversity of woody vegetation in the Trinity River Basin, Texas. Castanea 55:97–105.

NIXON, E.S., J.R. Ward, E.A. FOUNTAIN, and J.S. NECK. 1991. Woody vegetation of an old-growth creekbottom forest in north-central Texas. Texas J. Sci. 43:157–164.

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Special Recognition—Lynn R. Lowrey

IN MEMORIAM

Lynn R. Lowrey
1917–1997

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According to many of Lynn Lowrey's friends, he never met a plant he didn't like. Born in Mansfield, Louisiana, Lynn grew up among much of the same vegetation that he later found when he moved to Texas. His love and appreciation for those plants prompted him to encourage others to try them in their gardens, and by so doing, he became one of the first nurserymen to actively promote using native plants in both residential and commercial landscapes.


PHOTO COURTESY MIKE ANDERSON

In 1940, Lynn received his Bachelor of Science in Horticulture from Louisiana State University. In the early 1950s, he came to Houston and soon afterwards opened his own nursery. He later recalled that when he put out a sign advertising native azaleas, that "it must have brought in at least one car a week."

Not one to be discouraged, Lynn continued to "botanize" and to search for garden worthy plants. He enjoyed having a few friends to collect with and was soon botanizing with Robert Vines, Ed McWilliams and L.G. Marsters, Jr. in the Houston area. Moving westward, he enjoyed the company of Benny J. Simpson, Barton Warnock, and Carroll Abbott. Years later, Lynn wrote, "Plant hunting with Benny, Carroll Abbott, and Barton Warnock was like an expedition looking for gold nuggets."

Through the years, Lynn became friend and mentor to horticulturists across the state. At Lynn's memorial service, Scooter Cheatam described him as the "Pied Piper of the plant kingdom" and said that "once he started playing that flute," everyone would drop what they were doing to follow him on his plant collecting excursions. In Lynn's quiet manner, he taught and inspired everyone he encountered. He was widely respected for his knowledge and horticulturists literally from around the world came to visit him.

During the 1970s, Lynn relocated his nursery to Conroe, Texas and there published his Lowrey Nursery newsletters, offering numerous philosophical gems about using native plants. Although Lynn never published a book, he wrote both for his own newsletter and for other publications, including *The American Horticultural Magazine, Carroll Abbott's Texas Wildflower Newsletter, The Native Plant Society of Texas Newsletter,* and *The American Nurseryman.* He was ahead of his times in recognizing the need for biodiversity, using fruiting plants for wildlife, and using locally adapted strains for preservation.

Some of the East Texas plants Lynn recommended were *Acer saccharum*, *Cyrilla racemiflora, Itea virginica, Crataegus marshallii, Crataegus opaca, Fagus grandifolia, Ilex decidua, Bignonia capreolata,* and *Asimina triloba.* A yellow berried *Ilex vomitoria,* named "Saratoga Gold" was a significant native that he promoted.

He considered the Texas Pistache, *Pistacia texana,* and the Anacacho Orchid, *Bauhinia lunarioides*, two of the most rare plants in Texas. He propagated both and is largely responsible for introducing them to the horticultural trade. He loved collecting in Mexico and is known for his work on the Mexican oaks, particularly *Quercus polymorpha, Q. rysophylla* and *Q. canbyii*. He, along with Dr. Ray Jordan and Emmet Dodd, while on a trip to Mexico, discovered a new species of legume, subsequently named *Myrospermum sousanum.* Two perennials that Lynn promoted were *Ruellia brittoniana* var. *katie* and a pink form of *Scutellaria suffrutescens.*

During the last few years of his life, Lynn worked with his daughter and son-in-law, Patsy and Mike Anderson, at Anderson Nursery in Houston. His last horticultural work and contribution to society were with a little known Chinese plant, *Camptotheca acuminata.* His propagation material was donated to the Stehlin Foundation in Houston and to Xylomed Research in Monroe, Louisiana, for cancer research. In Lynn's honor, Dr. Li Shiyou, subsequently named another species *Camptotheca lowreyana.*

The seeds of knowledge planted by Lynn R. Lowrey will continue to flourish both far and wide.

Glossary

This glossary is modified from those of Shinners (1958) and Mahler (1988), with additional entries obtained or modified from a variety of sources including Lawrence (1951), Featherly (1954), Correll (1956), Gleason and Cronquist (1963), Radford et al. (1968), Correll and Johnston (1970), Gould (1975b), Lewis and Elvin-Lewis (1977), Benson (1979), Schmutz and Hamilton (1979), Fuller and McClintock (1986), Jones and Luchsinger (1986), Schofield (1986), Gandhi and Thomas (1989), Blackwell (1990), Isely (1990), Harris and Harris (1994), Spjut (1994), and Hickey and King (1997).

A

A- A prefix meaning without or not.

Abaxial Located on the side away from axis; e.g., lower leaf surface; contrasting with adaxial.

Aberrant Different from normal or typical condition.

Abortive Not developing or imperfectly developed; barren; defective.

Abscission Act or process of cutting off or shedding; e.g., the shedding or abscising of leaves.

Abscission layer Zone at base of petiole or other structure (e.g., pedicel) forming a layer of separation. This layer is important in the drop or shedding of leaves and fruits.

Acaulescent Stemless or apparently so; having leaves basal with stems not elongated.

Accessory fruit A fruit or assemblage of fruits with fleshy parts derived from organs other than the pistil; e.g., strawberry with fleshy receptacle with achenes (individual fruits) embedded in its surface.

Accrescent Enlarging after anthesis or with age, frequently in reference to the calyx.

Accumbent cotyledons Cotyledons lying face to face with the edges against the radicle.

Acerose (= Acicular) Needle-shaped or -like.

Achene Small, dry, indehiscent, one-seeded fruit with ovary wall free from seed.

Achlamydeous Lacking a perianth.

Achlorophyllus Lacking chlorophyll or apparently so; e.g., a number of non-green saprophytes or parasites.

Acicular (= Acerose) Needle-shaped or -like.

Acorn Fruit of a *Quercus* species (oak) composed of a nut and its cup or cupule made of fused bracts.

Acrid With sharp and harsh or bitterly pungent taste.

Acropetal Developing or maturing in succession from the base toward the apex.

Actinomorphic (= Regular) Radially symmetrical. The term usually refers to the arrangement of flower parts.

Acuminate Having a long, tapering point; longer tapering than acute.

Acute Forming a sharp angle of less than 90 degrees; less tapering than acuminate.

Ad- A prefix meaning to or toward.

Adaxial Located on side toward axis; e.g., upper leaf surface; contrasting with abaxial.

Adherent Touching or sticking together, when two organs or parts (typically dissimilar) touch each other but are not grown or fused together.

Adnate United or fused, when the fusion involves dissimilar structures; e.g., as in fusion of stamens and corolla.

Adpressed (= Appressed) Lying flat against a surface.

Adventitious Referring to structures or organs that develop in an unusual position; e.g., buds or roots that develop out of their usual place.

Adventive Not fully naturalized or established; of occasional occurrence.

Aerial Above ground level.

Aestival Appearing in or pertaining to the summer.

Aestivation Arrangement of young flower parts in the bud.

Agamospermy The production of seeds without fertilization.

Aggregate Crowded into a dense cluster or tuft.

Aggregate fruit A fruit formed by the clustering together of a number of separate pistils from a single flower; e.g., a blackberry is a cluster of druplets.

Aglycone The nonsugar component of a glycoside. Glycosides are composed of a sugar plus another compound (the aglycone); many aglycones are toxic.

Alate Winged.

Albidus White.

Albumen Nutritive material stored within the seed.

Alkaloid Any of a broad class (> 5,000 known alkaloids) of bitter, usually basic (alkaline), organic compounds that contain nitrogen and typically have a ring in their structure. They are often physiologically active in animals; many are poisonous; many affect the nervous system; there are a number of general types based on chemical structure including indole, isoquinoline, piperidine, purine, pyrrolidine, quinoline, and tropane alkaloids; well known examples of alkaloids include atropine, caffeine, cocaine, quinine, morphine, nicotine, theobromine, and strychnine.

Allelopathy, **Allelopathic** Harmful or detrimental chemical effect by one species upon another; e.g., a plant producing phytotoxic compounds that inhibit the germination or growth of other plants.

Allergen Substance capable of inducing an allergic response.

Allergenic Causing an allergic response or an allergy to become manifest.

Allergy Hypersensitivity of the body cells to specific substances as antigens and allergens, resulting in various types of reactions (e.g., anaphylaxis, contact dermatitis, hay fever).

Alliaceous Onion-like.

Alluvial Of or pertaining to alluvium (= organic or inorganic materials, including soils, deposited by running water).

Alternate Bearing one leaf or other structure at a node; having only one attached at a given point; contrasting with opposite or whorled.

Alveolate Honeycombed.

AMENT (= Catkin) A flexible often pendulous spike or spike-like raceme of small, inconspicuous, unisexual, apetalous, usually wind-pollinated flowers, the whole falling as one piece; e.g., male inflorescence of oaks or pecan.

AMENTIFEROUS Bearing aments.

AMETHYSTINE Violet-colored.

AMINO ACIDS Compounds containing both an amino group and a carboxyl group. They are the subunits (monomers) that are linked together by peptide bonds to form the polymers known as proteins; some nonprotein amino acids are found free in plants and are sometimes toxic; e.g., in *Lathyrus* (Fabaceae).

AMORPHOUS Without regular or definite form; shapeless.

AMPHITROPOUS OVULE Ovule that is half inverted so that the point of attachment is near the middle.

AMPLEXICAUL (= Clasping) With base of leaf or other structure (e.g., stipule) wholly or partly surrounding the stem.

AMPLIATE Enlarged.

ANASTOMOSING Net-like; with veins connecting by cross-veins to form a network.

ANATROPOUS OVULE Ovule that is completely inverted, the micropylar end being essentially basal.

ANDROECIUM Collective term for the stamens or male structures of a flower.

ANDROGYNOPHORE A stalk bearing both androecium and gynoecium; e.g., in many Passifloraceae.

ANDROGYNOUS Bearing staminate flowers above (= distal to) the pistillate in the same spike; e.g., in some Cyperaceae.

ANDROPHORE A support or column bearing stamens.

ANEMOPHILOUS, ANEMOPHILY Wind-pollinated.

ANGIOSPERM (= Flowering plant) Literally, "vessel seed"; a plant having its seeds enclosed in an ovary (= the proximal part of the carpel or "vessel"); a member of Division Magnoliophyta.

ANNUAL Plant or root system living only one growing season (year); completing the growth cycle within one year.

ANNULAR Arranged in a ring or circle.

ANNULATE With the appearance of rings; e.g., cross-ribbed or ringed spines of some Cactaceae.

ANNULUS A group or ring of thick-walled cells, on the sporangia of some ferns, that are involved in spore dehiscence.

ANTERIOR Describing the position of an organ located toward the front in relation to the axis; e.g., in a flower the side away from the axis and toward the subtending bract.

ANTHER That part of a stamen producing the pollen.

ANTHER-CELL (= Theca) One of the pollen-sacs or locules of an anther.

ANTHERIDIUM Male sexual organ; structure forming male gametes, typically found in less derived plants (e.g., ferns) but so reduced evolutionarily as to not be present in flowering plants.

ANTHESIS (a) Time or process of flower expansion or opening; (b) also descriptive of period during which a flower is open and functional.

ANTHOCARP A structure that includes a fruit united with the perianth or the receptacle; e.g., Nyctaginaceae.

ANTHOCYANIN A red, purplish, or blue water-soluble pigment found in most flowers. The color of these pigments is affected by pH (e.g., in *Hydrangea*); chemically, anthocyanins are phenolic.

ANTIPETALOUS Referring to stamens that are of the same number as, and borne in front of (= on the same radius as) the petals or corolla lobes.

ANTISEPALOUS Referring to stamens that are of the same number as, and borne in front of (= on the same radius as) the sepals or calyx lobes.

ANTRORSE Directed toward the summit, upward, or forward; e.g., pubescence directed up the stem, the free end of the hair above or distal to the attached end; contrasting with retrorse.

ANTRORSELY BARBED With barbs (= points) pointing upward toward the summit or apex.

APETALOUS Having flowers without petals.

APETALY The condition of being without petals.

APERTURE An opening.

APEX (pl. APICES) The tip or summit.

APHYLLOPODIC Lacking leaves at the base.

APHYLLOUS Leafless; e.g., Cuscutaceae.

APICAL At the tip or apex; relating to the apex.

APICAL BUD (= Terminal bud) Bud at the end (= apex) of a stem or branch.

APICULATE Having a small sharp point formed by blade tissue (of a leaf, sepal, or petal) rather than by projection of a rib or vein; with an abrupt tip or projection.

APOCARPOUS With the carpels separate or free from one another.

APOGAMOUS Forming a sporophyte without the union of gametes.

APOMIXIS A collective term for reproduction, including vegetative propagation, that does not involve sexual processes; any form of asexual reproduction.

APOPETALOUS (= Polypetalous) Referring to a corolla consisting of separate petals.

APOPHYSIS Swelling or enlargement of the surface of an organ.

APOSEPALOUS (= Polysepalous) Referring to a calyx consisting of separate sepals.

APPENDAGE Any attached structure that is supplementary or secondary.

APPENDICULATE With an appendage.

APPRESSED (= Adpressed) Lying flat against a surface.

APPROXIMATE Close together.

AQUATIC Living in water.

ARACHNOID, ARACHNOSE Cobwebby; cobweb-like, with entangled, slender, loose hairs; thinly pubescent with relatively long, usually appressed and interlaced hairs.

ARBORESCENT Tree-like or becoming tree-like.

ARCHEGONIUM Female sexual organ; structure forming female gametes, typically found in less derived plants (e.g., ferns) but so reduced evolutionarily as to not be present in flowering plants.

ARCUATE Curved or bent like a bow, often used in reference to curving veins.

ARENACEOUS Sand-like or growing in sand.

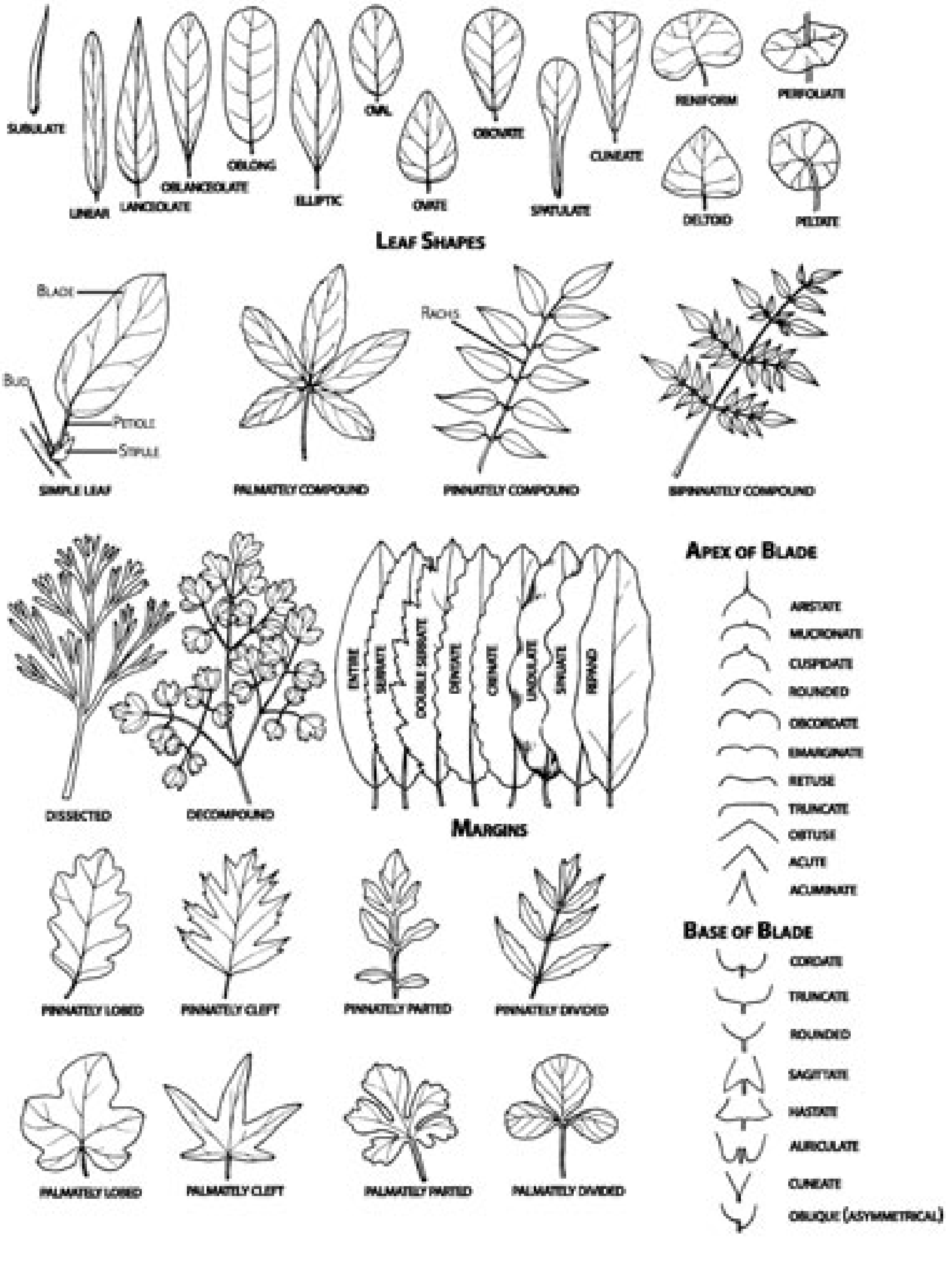
AREOLATE Divided into small angular spaces; marked with areolae.

AREOLE, AREOLA (pl. AREOLAE) (a) Small space marked out on a surface, usually referring to the space bounded by veinlets on the surface of a leaf; (b) the small spine-bearing areas on a cactus stem.

ARGILLACEOUS Clayey; growing in clay or clay-like material.

ARIL An appendage or covering on a seed, typically involved in dispersal by animals.

LEAF CHARACTERS



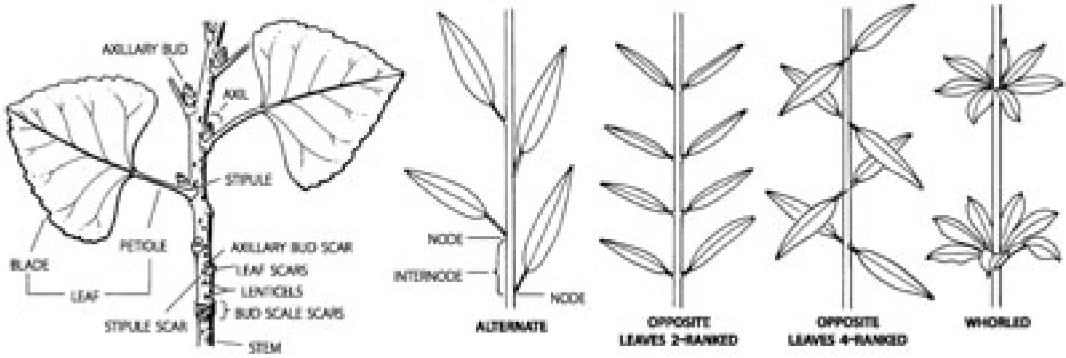
ADAPTED FROM MASON (1957); USED WITH PERMISSION OF UNIV. OF CALIFORNIA PRESS; ©1957.

Arillate With an aril.
Aristate Bearing a stiff awn or bristle.
Aristulate Diminutive of aristate.
Armed Possessing sharp projections; e.g., prickles, spines, or thorns.
Aromatic (a) Generally, having a fragrant odor; (b) chemically, containing or patterned after benzene rings, with or without fragrance.
Article The individual unit of a constricted or jointed fruit; e.g., in some Fabaceae such as *Desmodium*.
Articulate Jointed; joined.
Articulation A separation place; joint.
Ascending, **Ascendent** Rising at an oblique angle.
Asepalous Without sepals.
Asexual Without sex; reproducing without sex.
Asperous Rough to the touch.
Assurgent Ascending, rising.
Astylous Without a style.
Asymmetrical Without symmetry.
Atomiferous Bearing very fine glands.
Atrocastaneous Very dark chestnut-colored.
Atropurpureous Dark purple; purple-black.
Attenuate Gradually tapering to a very slender tip, the taper more gradual than in acuminate.
Atypical Not typical; deviating from the norm.
Auricle Earlobe-like lobe or appendage; e.g., at the base of some leaves, sepals, etc.
Auriculate With an auricle.
Autotrophic Descriptive of an organism capable of making its own food, usually through photosynthesis; free living, not parasitic or saprophytic; e.g., green plants.
Autumnal Associated with or occurring in the fall of the year.
Awl-shaped (= Subulate) Tapering from the base to a slender or stiff point; narrow and sharp-pointed.
Awn Terminal slender bristle or hair-like extension or projection; e.g., in grasses, the prolongation of the midnerve of the glumes or lemmas.
Awn column In certain grasses, a prominent narrowed beak at the apex of the lemma. The awns arise from this structure.
Axial Relating to the axis.
Axil Angle between two organs; e.g., upper angle formed by a leaf and a stem.
Axile or **Axillary Placentation** Placentation with the ovules attached to the central axis of the ovary.
Axillary In an axil; e.g., in the angle between a leaf and a stem.
Axis (pl. Axes) (a) The central stem from which organs arise; (b) a portion of a plant from which a series of organs arises radially; e.g., the axis of an inflorescence.

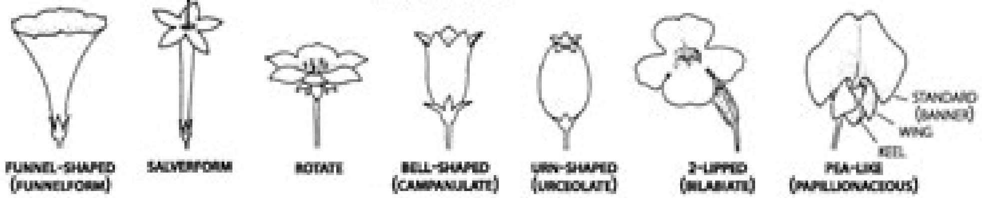
B

Baccate Resembling or having the structure of a berry; berry-like.
Ballistic Referring to fruits that are forcibly or elastically dehiscent, whose seeds are thrown catapult-like; e.g., *Phyllanthus* (Euphorbiaceae).
Banner (= Standard) Adaxial and typically largest petal of a papilionaceous flower.
Barbed With short reflexed points like a multi-pronged fishhook.
Barbellate Diminutive of barbed; with short, fine, stiff hairs.
Bark Outer (= external to vascular cambium) protective tissues on the stems or roots of woody plants.
Basal Located at the base of a plant or of an organ.
Basal rosette Cluster of leaves on or near the ground.
Basal style Style projecting from among the lobes of a deeply lobed ovary.
Basifixed Attached basally, typically referring to attachment of an anther to a filament; contrasting with either dorsifixed or versatile.
Basilaminar At base of blade of leaf or other structure.
Basipetal Developing or maturing in succession from the apex toward the base.
Basiscopic Directed toward the base.
Basionym The original epithet assigned to a species (or other taxon of lower rank) by its author.
Beak A long, prominent, and relatively thickened point; a tapering projection; e.g., projection on a fruit resulting from a persistent style.
Beaked Ending in a beak.
Beard A group of long awns or bristle-like trichomes; a zone of pubescence; e.g., on some corollas.
Bearded Bearing long or stiff hairs, typically in a line or tuft.
Berry Indehiscent type of fruit with the entire pericarp fleshy and lacking a stone, usually with several to many seeds; e.g., tomato, grape.
Betalains Reddish, nitrogen-containing pigments (characteristic of most Caryophyllidae) that derive their name from the genus *Beta* (beets).
Bi-, **Bis-** Latin prefix signifying two, twice, or doubly.
Bicolored Two-colored.
Biconvex Convex on both sides.
Bidentate Two-toothed.
Biennial Plant or root system living only two years (growing seasons), typically producing only leafy growth the first year, then flowering and dying the second.
Bifid Two-cleft, usually deeply so; with two lobes or segments.
Bifurcate Two-forked; e.g., some Y-shaped trichomes, stigmas, or styles.
Bilabiate Two-lipped, typically referring to corollas or calyces.
Bilateral Arranged on two sides; two-sided.
Bilaterally symmetrical With only one plane of symmetry; divisible into halves in one plane only.
Bilocular Having two cavities.
Binomial The combination of a generic name and a specific epithet given to each species.
Binomial nomenclature System of nomenclature where each species has a two-part name composed of a generic name and a specific epithet.
Bipartite Two-parted; divided into two parts nearly to the base.
Bipinnate (= Twice-pinnate or 2-pinnate) Descriptive of a leaf with leaflets pinnately arranged on lateral axes that are themselves pinnately arranged on the main axis; with the primary divisions (pinnae) themselves pinnate.
Bisected Completely divided into two parts.

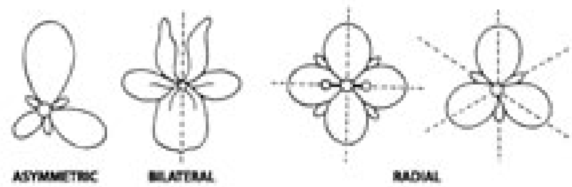
Leaf and Twig Structure and Arrangement



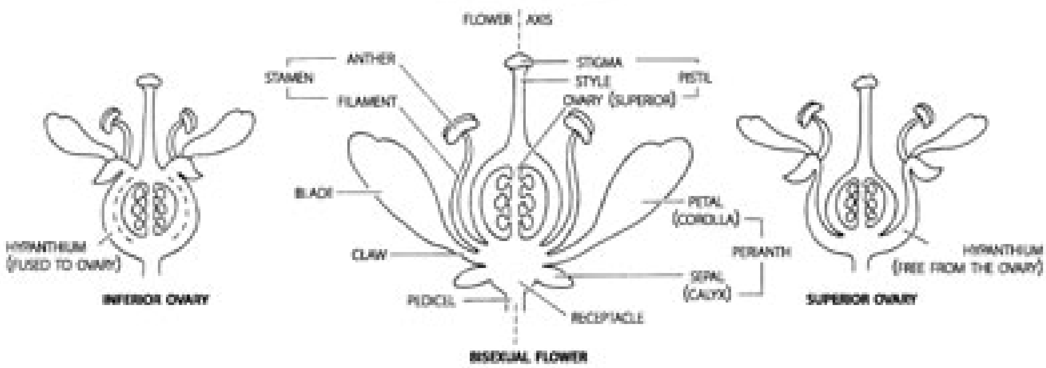
Flower Shape



Flower Symmetry



Flower Structure



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Biseriate In two whorls or cycles; e.g., a perianth with both calyx and corolla.

Bisexual flower Type of flower with both stamens and pistil(s) functional within the same flower.

Bivalvate Opening by two valves.

Bladder (a) A thin-walled, inflated structure; (b) a hollow, membranaceous appendage that traps insects; e.g., *Utricularia* (Lentibulariaceae).

Bladdery Thin-walled and inflated; like the bladder of an animal.

Blade Flat, expanded portion, as the main part of a leaf or petal.

Bloom (a) Flower or flowering; (b) coating of white wax or powder, as on plums or grapes.

Bole The main trunk or stem of a tree.

Boss A protrusion.

Brackish Somewhat salty.

Bract A modified reduced leaf typically subtending a flower or cluster of flowers. Bracts can vary from very leaf-like to scale-like or thread-like; in some cases they can be colorful and attract pollinators.

Bracteal Having the form or position of a bract.

Bracteate Having bracts.

Bracteolate Having bracteoles.

Bracteole, **Bractlet** A usually small bract borne on a secondary axis (e.g., on a pedicel).

Bracteose Having numerous or conspicuous bracts.

Branch A shoot or secondary stem growing from the main stem.

Branchlet The ultimate division of a branch.

Bristle Stiff, strong but slender hair or trichome.

Bristly Bearing bristles.

Broad (= Wide) Distance across a structure (equal to diameter if tubular); sometimes restricted to signify the width or diameter of three-dimensional structures.

Bryophyta Group containing the mosses, liverworts, and hornworts. The Bryophyta is not treated in this flora.

Bud (a) Undeveloped or unopened flower; (b) undeveloped, much-condensed shoots, containing embryonic (meristematic or growing) tissue, usually covered by scales or bracts. Such buds are usually found at the tips of stems or in the axils of leaves.

Bulb Underground structure composed of a short, disc-like stem and one or more buds surrounded by layers of thickened fleshy leaf bases or scales; e.g., an onion.

Bulbil Small bulbs produced in an inflorescence or in leaf axils; e.g., in *Allium* inflorescences.

Bulblet Small bulbs produced alongside a parent bulb; e.g., the numerous underground small bulbs produced by some garlics.

Bulbous, **Bulbose** Having bulbs or bulb-like structures.

Bullate Describing a surface with rounded elevations resembling blisters or puckers.

Bur, **Burr** A structure with a rough or prickly envelope or covering; e.g., sandbur.

Bush (= Shrub) A woody perennial usually branching from the base with several main stems.

C

Ca. Latin, circa; abbreviation meaning about, around, approximately.

Caducous Falling off early, quickly, or prematurely; e.g., the sepals in some Papaveraceae.

Caespitose (= Cespitose) Growing in clumps or tufts.

Calcarate With a spur.

Calcareous Containing an excess of available calcium, usually in the form of the compound calcium carbonate; containing limestone or chalk.

Caliche A crust of calcium carbonate formed on stony soils in arid regions.

Callosity (= Callus). A hard protuberance or thickened, raised area.

Callous Having the texture of a callus.

Callus (= Callosity). A hard protuberance or thickened, raised area; e.g., thickened, hardened, basal portion of some lemmas in the Poaceae.

Calycine Resembling or pertaining to a calyx.

Calyculate Calyx-like; e.g., describing bracts that by their size or position are suggestive of a calyx.

Calyptra A lid, cap, cover, or hood; e.g., the lid of certain fruits and moss spore cases.

Calyx (pl. Calyces, Calyxes) Collective term for the sepals; outer series of floral "leaves", often enclosing the other flower parts in bud. The calyx is typically green but can be corolla-like and showy.

Calyx lobe One of the free projecting parts of a synsepalous calyx; also referred to as a calyx tooth.

Calyx tube The basal or tubular portion of a synsepalous calyx, as opposed to the free, distal calyx lobes.

Cambium The thin layer of delicate, rapidly dividing, meristematic cells that forms wood internally and bark externally; also known as vascular cambium.

Campanulate Bell-shaped; rounded at base with a broad flaring rim.

Campylotropus ovule Ovule curved in its development, so that the morphological apex lies near the base.

Canaliculate Longitudinally channeled or grooved.

Cancellate Latticed.

Cane Stem, specifically, (a) floricane, the flowering stem of *Rubus* species (blackberries and dewberries); (b) primocane, first-year leafy stem of the same; (c) persistent woody stems of *Arundinaria gigantea*, giant cane.

Canescent With whitish or grayish-white appearance due to abundance of soft short hairs.

Cap A convex, lid-like, removable covering; e.g., the apical portion of a circumscissile capsule. The term calyptra is used for the cap of some fruits and moss spore cases.

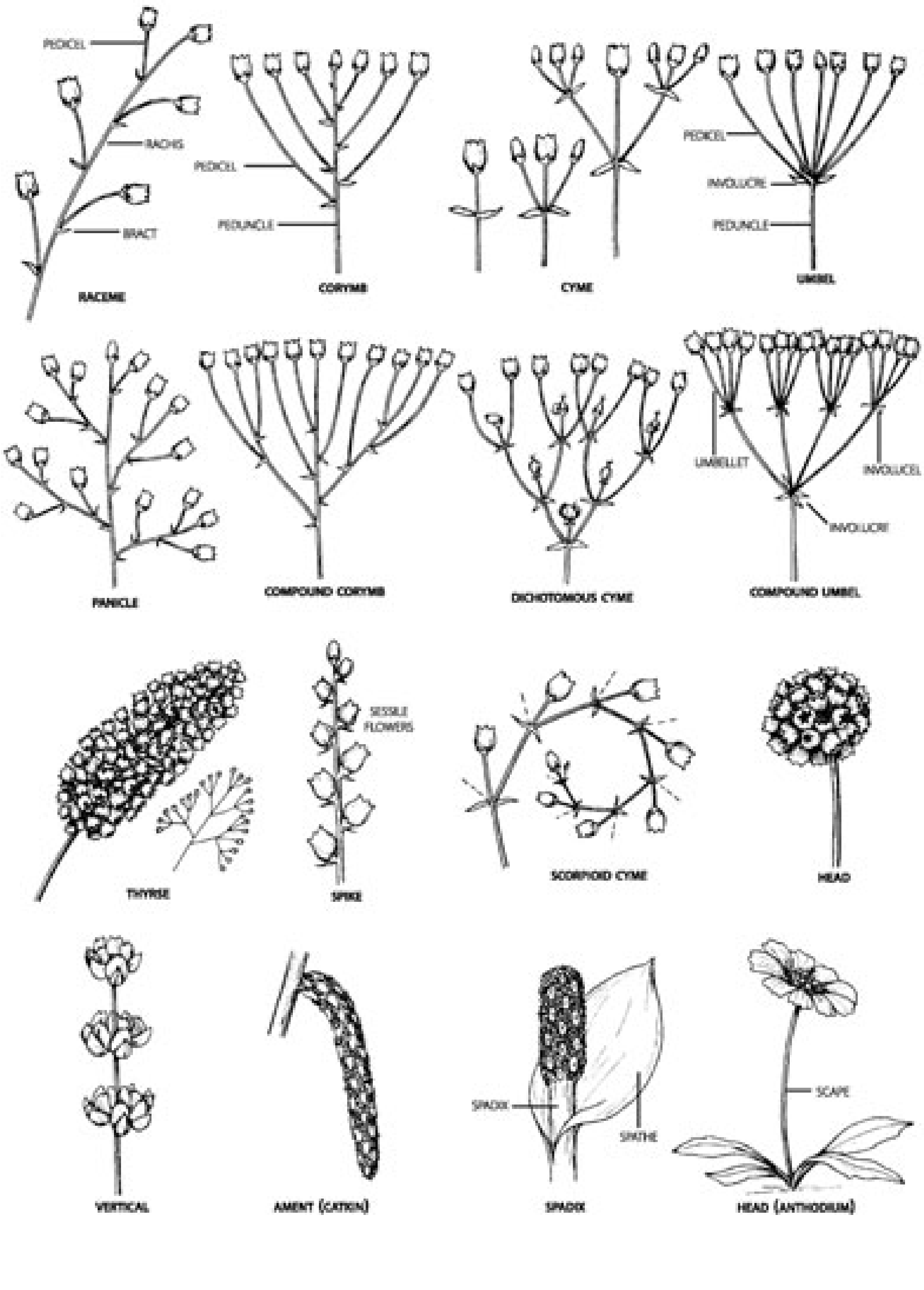
Capillary Hair-like; very slender.

Capitate (a) In heads, head-like, or head-shaped; aggregated into a dense or compact cluster; (b) referring to capitate hairs, like a pin-head on a stalk.

Capitellate Aggregated into a small, dense cluster; diminutive of capitate.

Capitulum (= Head) Dense cluster of sessile or nearly sessile flowers. This type of inflorescence is typical of the Asteraceae.

Types of Inflorescences



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CAPSULAR Having the structure of a capsule.

CAPSULE A dry dehiscent fruit developed from more than one carpel.

CARCINOGEN A substance potentially inducing cancer or malignancy.

CARDIAC GLYCOSIDE A glycoside (two-component molecule) that upon breakdown yields a heart stimulant as the aglycone (= non-sugar component). The aglycones are steroidal in structure and are typically poisonous; e.g., digoxin and digitoxin from *Digitalis*, used in treating heart trouble.

CARINA (= Keel) The two lower (= abaxial) fused petals of a papilionaceous flower (Fabaceae); (b) prominent longitudinal ridge, shaped like the keel of a boat.

CARINATE Keel-shaped; provided with a ridge or keel extending lengthwise along the middle. If more than one keel is present, the fact may be indicated by a numerical prefix.

CARNIVOROUS Referring to plants that digest animal (primarily insect) tissue to obtain nutrients such as nitrogen.

CARNOSE Fleshy; succulent.

CARPEL A modified leaf bearing ovules; a simple pistil or one unit of a compound pistil; female reproductive structure in flowering plants.

CARPELLATE Possessing carpels. The term is sometimes used with a numerical prefix to indicate the number of carpels.

CARPOPHORE The slender prolongation of the floral axis between the carpels that supports the pendulous fruit segments (= mericarps) in the Apiaceae.

CARTILAGINOUS Tough and hard but not bony; gristly; cartilage-like.

CARUNCLE Enlarged, somewhat spongy, seed appendage.

CARYOPSIS Achene-like, 1-seeded fruit with pericarp adnate to the seed coat; fruit typical of the Poaceae.

CASTANEOUS Chestnut-colored; dark brown.

CATKIN (= Ament) A flexible often pendulous spike or spike-like raceme of small, inconspicuous, unisexual, apetalous, usually wind-pollinated flowers, the whole falling as one piece; e.g., male inflorescence of oaks or pecan.

CAUDATE Having a tail or tail-like appendage.

CAUDEX (pl. CAUDICES) Woody stem base.

CAULESCENT With an evident leafy stem above ground.

CAULIFLOROUS Having flowers borne along the stems or trunks.

CAULINE Growing on or pertaining to the stem.

CELL (a) One of the living units of which a plant is composed; (b) (= locule) cavity or compartment containing the ovules in a carpel or the pollen in an anther.

CENTRIFUGAL Maturation of parts from the center toward the periphery.

CENTRIPETAL Maturation of parts from the periphery toward the center.

CERACEOUS Waxy.

CERIFEROUS Wax-bearing; waxy.

CERNUOUS Nodding or drooping.

CESPITOSE (= Caespitose) Growing in clumps or tufts.

CHAFF Thin, dry, or membranous scales or bracts, often used to refer to receptacular scales or bracts in many Asteraceae; see pale or palea.

CHAFFY Thin, dry, or membranous.

CHALAZA The basal part of the ovule where it attaches to the funiculus.

CHANNELED Deeply grooved.

CHARTACEOUS Stiffly papery.

CHASMOGAMOUS Referring to flowers that open at anthesis; with pollination after opening of flowers; contrasting with cleistogamous.

CHIROPTEROPHILY, **CHIROPTEROPHILOUS** Bat-pollination.

CHLOROPHYLL The light-capturing pigment giving the green color to plants. Because chlorophyll absorbs less green than other wavelengths of light (and thus reflects and transmits relatively more green), leaves appear green to the human eye.

CHORIPETALOUS Composed of or characterized by separate petals.

CHORISEPALOUS Composed of or characterized by separate sepals.

CHROMOSOMES Thread-like "colored bodies" occurring in the nuclei of cells and containing the genetic material.

CILIATE With a marginal fringe of hairs similar to eye lashes.

CILIOLATE Diminutive of ciliate.

CILIUM (pl. CILIA) Marginal hair or trichome.

CINCINNUS A curl; e.g., a helicoid (= curled or coiled) cyme, as in the Boraginaceae.

CINEREOUS Ash-colored; light-gray.

CIRCINATE Coiled, with the apex innermost, as the young fronds in some ferns.

CIRCUMSCISSILE Dehiscing by a regular transverse line around the fruit or anther, the top coming off like a lid.

CIRRHOUS Tendril-like; e.g., a leaf with a slender coiled apex.

CLADOPHYLL, **CLADODE** (= Phylloclade) A portion of a stem having the general form and function of a leaf; a flattened photosynthetic stem.

CLAMBERING Vine-like; growing over other plants often without the aid of tendrils or twining stems.

CLASPING (= Amplexicaul) With base of leaf or other structure (e.g., stipule) wholly or partly surrounding the stem.

CLASS The unit, category, or rank in classification made up of one or more orders; ending in -ae or -opsida; sometimes divided into subclasses which in turn are made of orders.

CLATHRATE Latticed; with a series of crossed members.

CLAVATE Club-shaped; becoming gradually enlarged apically.

CLAVELLATE Diminutive of clavate.

CLAW Stalk-like basal portion of some petals or sepals.

CLAWED Having a claw.

CLEFT (a) Cut 1/2 or more the distance from the margin to midrib or from the apex to base; (b) generally, any deep cut.

CLEISTOGAM A small flower that does not open and is necessarily self-pollinating.

CLEISTOGAMOUS, **CLEISTOGAMIC** Referring to flowers not opening at anthesis and thus self-pollinating; with pollination prior to opening of flowers. Such flowers frequently have reduced or incompletely formed parts (e.g., petals).

CLESITOGAMY The self-pollination of flowers that do not open.

CLONE A group of individuals of the same genotype, usually propagated vegetatively.

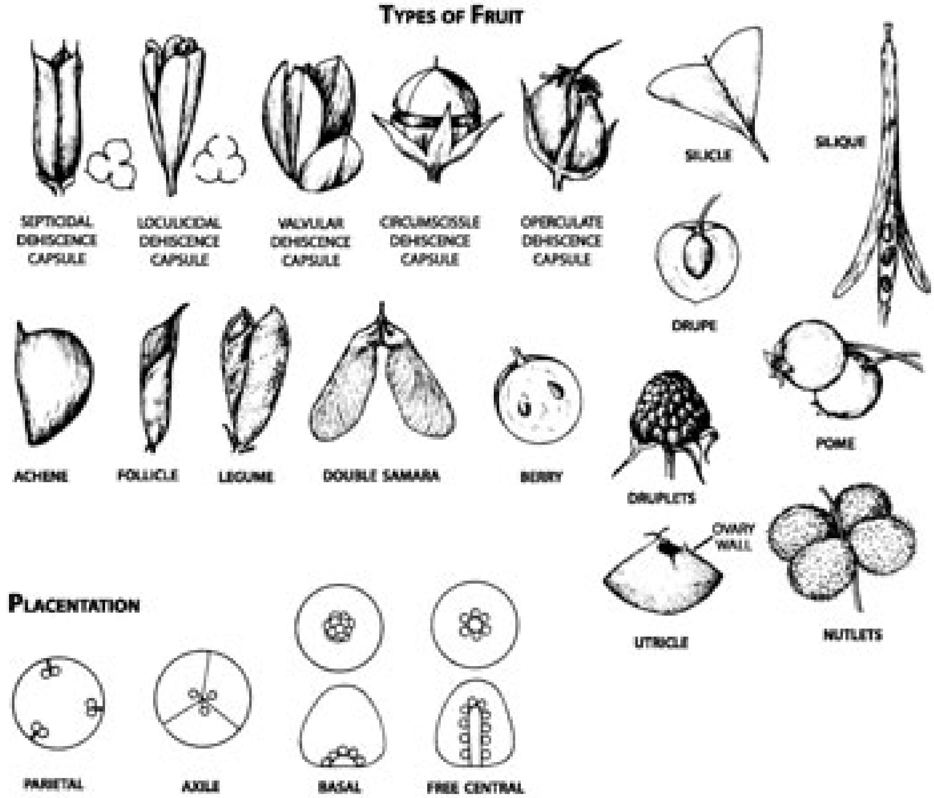
CLUMP A single plant with two to many, more or less crowded stems arising from a branched rootstock or short rhizome.

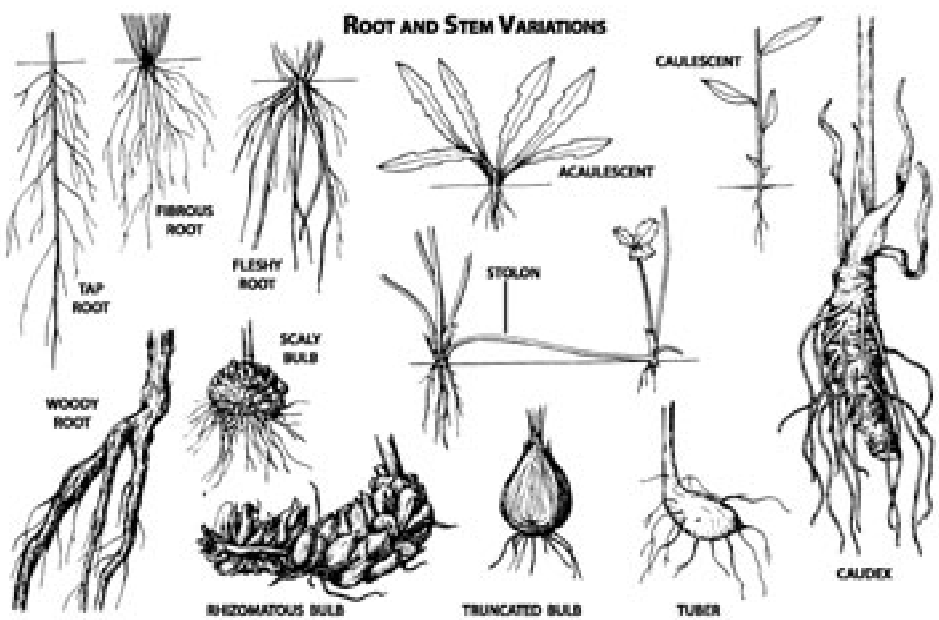
CM Centimeter; 10 mm; 1/100 of a meter; ca. 2/5 of an inch.

COALESCENT Referring to organs of one kind that have grown together.

COARCTATE Crowded together.

Types of Fruits and Root and Stem Variations





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Cob Rachis or central stalk of the pistillate inflorescence of corn.

Coccus (pl. Cocci) (a) A berry; (b) one of the parts of a lobed or deeply divided fruit with 1-seeded sections.

Cochleate Coiled like a snail shell; spiral.

Coetaneous At the same time or of the same age; e.g., flowers and leaves appearing at the same time.

Coherent Descriptive of the close association of two similar structures without fusion.

Collar The outer side of a grass leaf at the junction of the blade and sheath.

Collateral Located side by side; e.g., ovules located side by side; e.g., accessory buds located on either side of a lateral bud.

Colonial Forming colonies usually by means of underground rhizomes, stolons, etc. The term is commonly used to describe groups of plants with asexual reproduction.

Colony A stand, group, or population of plants of one species, spreading vegetatively, or from seeds, or both.

-colpate A suffix referring to pollen grains having grooves (= colpi).

-colporate A suffix referring to pollen grains having grooves and pores.

Columella The persistent central axis around which the carpels of some fruits are arranged.

Column (a) United style and filaments in Orchidaceae; (b) united filaments in Malvaceae and Asclepiadaceae; (c) basal differentiated portion of the awn(s) in certain grasses.

Columnar Column-shaped.

Coma (a) A tuft of soft hairs or trichomes, as at the apices or bases of some seeds; (b) tuft of structures projecting from something (e.g., tuft of bracts projecting from heads of some *Eryngium* species).

Comate, **Comose** Resembling or provided with a coma.

Commisure The surface where organs are joined; e.g., the face by which one carpel joins another.

Complanate Flattened.

Complete With all of the usual parts; e.g., a flower with all four flower parts: sepals, petals, stamens, and pistils.

Complicate Folded together.

Composite (a) (= Compound) made up of several distinct parts; (b) common name for species of the Asteraceae.

Compound (= Composite) Made up of several distinct parts.

Compound inflorescence One having two or more degrees of branching; e.g., a compound umbel is one whose branches bear branchlets rather than ending directly in flowers.

Compound leaf A leaf that is cut completely to the base or midrib into segments (= leaflets) resembling miniature leaves; a leaf with two or more leaflets.

Compound ovary Ovary developed from two or more united carpels, as evidenced by the presence of two or more locules, valves, placentae, styles, or stigmas.

Compound pistil Pistil composed of two or more united carpels.

Compressed Flattened.

Concave Hollow; with a depression on the surface.

Concolor, **Concolorous** Of a uniform color.

Conduplicate Folded together lengthwise.

Cone (= Strobilus) A usually globose or cylindrical structure involved in reproduction and composed of an axis with a spiral, usually dense aggregation of sporophylls, bracts, or scales (these bearing spores, pollen, or seeds).

Confluent Blending of one part into another.

Congested Crowded together.

Conglomerate Densely clustered.

Conical, **Conic** Cone-shaped.

Coniferous Cone-bearing.

Conjugate Jointed in pairs.

Connate United or fused, when the fusion involves two or more similar structures; e.g., as in fusion of stamens into a tube.

Connate-perfoliate Both connate and perfoliate; e.g., two leaves grown together and completely encircling a stem; e.g., in *Eupatorium perfoliatum*.

Connective The tissue connecting the pollen-sacs of an anther. In certain plants the connective is prolonged at its base or apex.

Connivent Converging or nearly or quite in contact, but not fused; e.g., connivent stamens in *Solanum*.

Conserved Term applied to a scientific name whose use, even though illegitimate according to nomenclatural rules, is allowed by the International Code of Botanical Nomenclature; e.g., many family names long in use, such as Cactaceae and Caryophyllaceae, have been conserved to prevent confusion.

Conspecific Of the same species.

Constricted Tightened or drawn together or narrowed.

Contact dermatitis Inflammation of the skin due to contact with poisons, irritants, or sensitizers. In some individuals it can be caused by even the slightest contact; caused by a variety of plants including poison-ivy (*Toxicodendron radicans*).

Contiguous Touching but not fused.

Continuous Not interrupted; not articulated; not jointed.

Contorted Twisted or distorted.

Contracted Narrowed or shortened; reduced in size.

Contrary In an opposite direction or at right angles to.

Convergent Coming together or approaching.

Convex Rounded or bulged on the surface.

Convolute Rolled or twisted together when in an undeveloped stage.

Coralloid Coral-like.

Cordate, **Cordiform** (a) Heart-shaped; with a notch at the base and ovate in outline (the words apply specifically to flat surfaces and to solid shapes, respectively); (b) often referring only to the notched base of a structure; e.g., leaf base.

Coriaceous With texture like leather; tough; leathery.

Corm Bulb-like usually subterranean stem base, solid instead of with layers of modified leaves as in a true bulb.

Cormous Having a corm.

Corneous Horny in texture.

Corniculate Bearing a small horn or horns.

Cornute Horned or spurred.

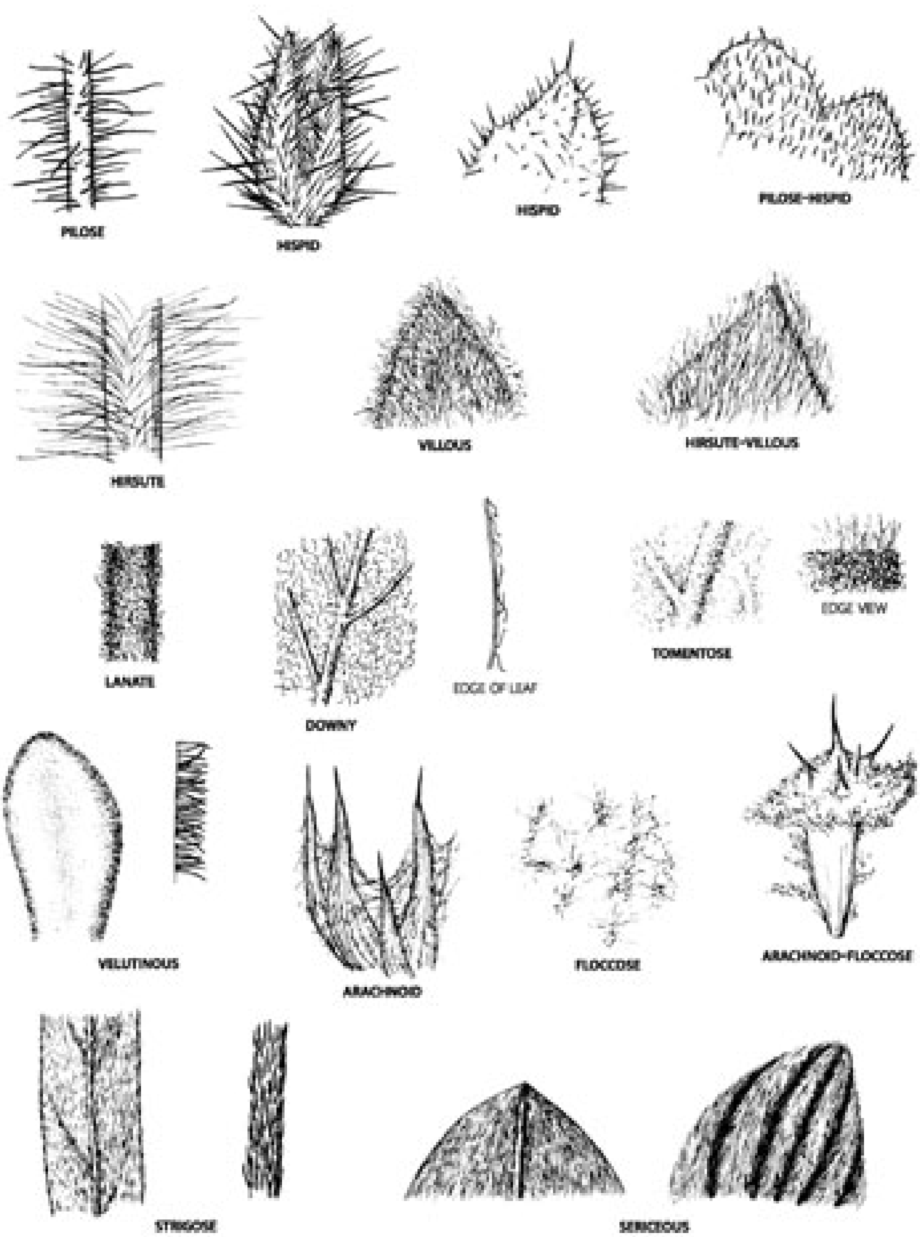
Corolla Collective term for the petals; the inner series of floral "leaves". Corollas are typically but not always colorful and showy.

Corolla lobe A free projecting part of a synsepalous corolla; also referred to as a corolla tooth.

Corolla tube The basal or tubular portion of a synsepalous corolla, as opposed to the free, distal, corolla lobes.

Corona (= Crown) Projection or outgrowth of a corolla, perianth,

Types of Pubescence



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or anthers, in the form of a fringe, cup, or tube, sometimes greatly resembling an extra corolla or perianth.

Coroniform scales Membranous scales broader than long.

Corpusculum In Asclepiadaceae, the gland-like clip connecting the two bands (= filament-like retinacula) attached to the pollinia; part of the translator.

Corrugate Having wrinkles or folds.

Cortex (a) The tissue between the stele and epidermis of a stem; (b) bark or rind.

Corymb A more or less flat-topped inflorescence (resulting from lower branches being longer than upper) that is indeterminate (i.e., with the outer flowers opening first); inflorescence superficially similar to an umbel but with the branches arising at different points rather than one.

Corymbiform Shaped like a corymb.

Corymbose In corymbs or corymb-like inflorescences (i.e., flat-topped).

Costa (pl. Costae) A rib; the midvein of a leaf.

Costate Longitudinally ribbed.

Costules Midveins of the pinnules.

Cotyledon Seed leaf; main leaf or leaves of the embryonic plant.

Coumarin glycoside A glycoside (two-component molecule) that upon breakdown yields coumarin as the aglycone (= non-sugar component). Coumarin can be converted to dicoumarin, a toxic compound which prevents blood-clotting; e.g., in *Melilotus*.

Crateriform In the shape of a saucer; shallow and hemispherical.

Creeping Growing along the surface of the ground and emitting roots at intervals, usually from the nodes.

Crenate Scalloped with rounded teeth; shallowly round-toothed or with teeth obtuse.

Crenulate Diminutive of crenate; with small rounded teeth.

Crest An elevated ridge, process, or appendage on the surface of an organ or structure.

Crested Having a crest.

Crispate, **Crisped** Irregularly curled or twisted.

Cross-section A slice cut across an object; e.g., a slice of bread.

Crown (a) An irregular perennial or over-wintering stem or stem-root structure from which new growth arises; (b) (= Corona) projection or outgrowth of a corolla, perianth, or anthers, in the form of a fringe, cup, or tube, sometimes greatly resembling an extra corolla or perianth.

Crozier A young coiled leaf of some ferns.

Cruciate, **Cruciform** Cross-shaped.

Cruciferous (a) Cross-bearing; (b) specifically descriptive of cross-like arrangement of petals of members of the Brassicaceae (Cruciferae).

Crustaceous, **Crustose** With a brittle, hard texture.

Cryptogams An old term for plants that reproduce without flowers or seeds. Cryptogams typically reproduce by spores.

Crystalline Crystal-like.

Cucullate Hood-like.

Culm Stem of Poaceae and Cyperaceae.

Cultigen A plant known only in cultivation.

Cultivar A variety or race of a cultivated plant; abbreviated cv.

Cuneate, **Cuneiform** Wedge-shaped; triangular with tapering, straight-sided, narrow base.

Cup, **Cupule** The cup-like structure at the base of a fruit; e.g., acorn.

Cupuliform, **Cupulate** Cup-shaped.

Curvi- A prefix to denote curved or bent.

Cusp A sharp, abrupt, and often rigid point.

Cuspidate Bearing a cusp or strong sharp point.

Cut A general term for any dissection of a leaf or petal deeper than a lobe.

Cuticle The waxy, more or less waterproof coating secreted by the cells of the epidermis. The cuticle prevents water loss.

Cyanogenic glycoside A glycoside (two-component molecule) that upon breakdown yields hydrocyanic (prussic) acid (HCN) as the aglycone (= non-sugar component). Hydrocyanic acid is extremely dangerous, causing cyanide poisoning; e.g., amygdalin in cherry and peach leaves or apple seeds (Rosaceae).

Cyathiform Cup-shaped.

Cyathium (pl. Cyathia) (a) Cup-shaped structure producing unisexual flowers; (b) specifically, the units of the inflorescence in *Euphorbia*. In this case the cup contains a single pistillate flower and a number of staminate flowers, each consisting of a single stamen; on the rim of the cup there are glands and these often have a petal-like appendage; the whole structure superficially resembles a single flower.

-cyclic A suffix referring to the circles of different parts in a flower, commonly used with a numerical prefix; e.g., a *Verbascum* flower with sepals, a corolla, stamens, and an ovary is four-cyclic; compare with -merous.

Cylindrical, **Cylindric** Elongate, circular in cross-section; having the form of a cylinder.

Cymbiform Boat-like or boat-shaped.

Cyme A broad, flattish or convex, determinate inflorescence with the central flowers maturing first.

Cymose With the flowers in cymes; having an inflorescence type with the oldest flowers in the center.

Cymule A small or few-flowered cyme.

Cypsela Achene derived from an inferior ovary and adnate to the enclosing floral tube; e.g., in Asteraceae.

Cystolith A stone-like mineral concretion, usually of calcium carbonate.

D

DC. De Candolle, name of a distinguished family of Swiss botanists; specifically Augustin Pyramus, who sponsored early botanical exploration in Texas by Berlandier, and named many Texas species; A. DC.: Alphonse, son of the preceding.

Deciduous Falling away; not persistent over a long period of time.

Declinate, **Declined** Bent forward or downward.

Decompound More than once compound.

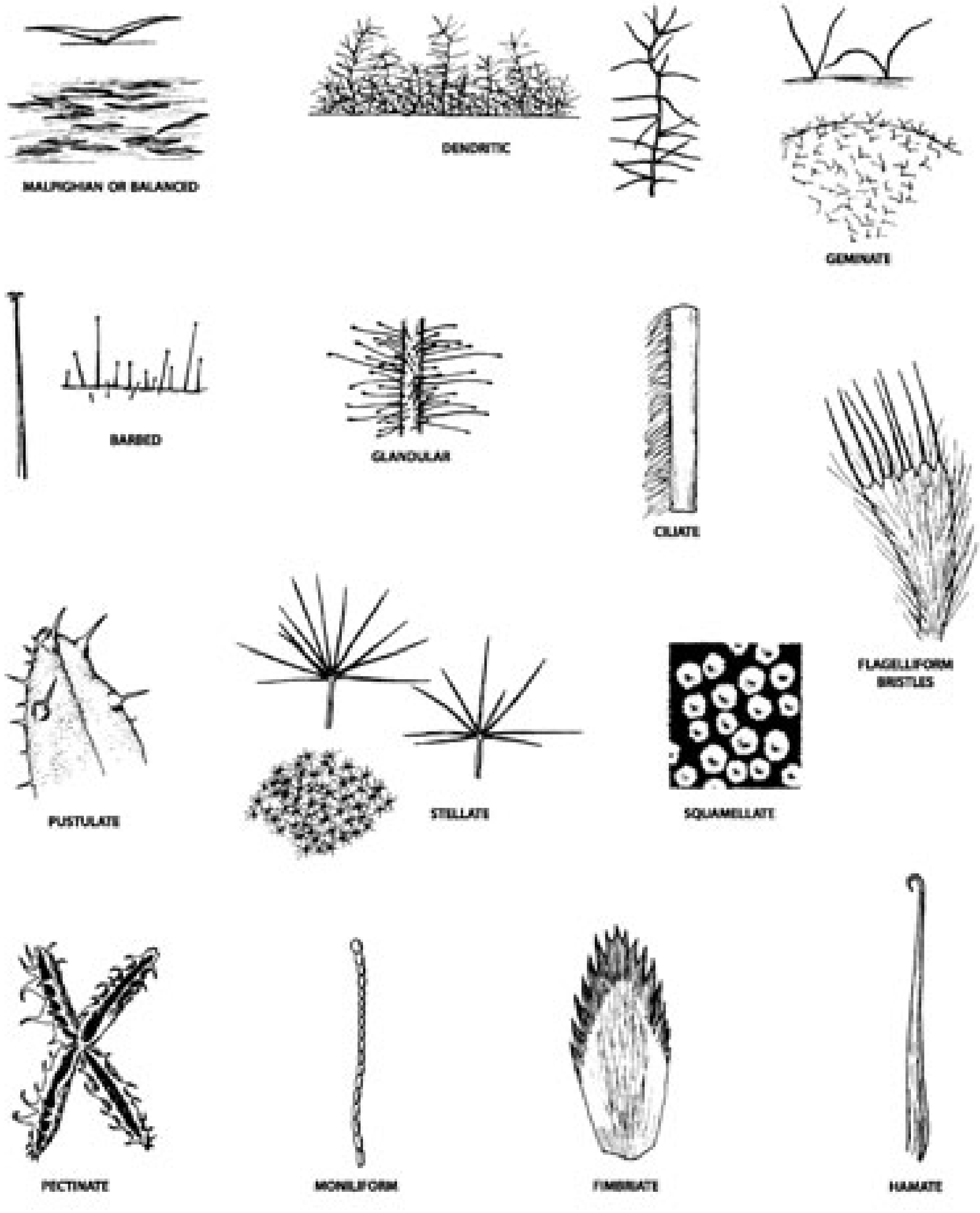
Decumbent Lying flat or reclining with terminal shoots or stem tips ascending.

Decurrent Extending down the stem and united with it, as in the continuation of leaf bases down the stem as wings.

Decurved Curved downward.

Decussate Arranged oppositely in pairs, each successive pair at

Types of Hairs and Processes



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right angles to the preceding one (resulting in the appearance of four rows), typically referring to arrangement of leaves.

Deflexed Bent downward.

Defoliate To shed or remove leaves.

Dehisce, **Dehiscent** To open at maturity to discharge the contents; e.g.; fruit releasing seeds or anther releasing pollen.

Dehiscence The process or act of opening.

Deliquescent Softening, dissolving, melting away, or wasting away; e.g., ephemeral petals of *Tradescantia*.

Deltate, **Deltoid** Shaped like an equilateral triangle, like the Greek letter delta (Δ).

Dendritic Tree-like, as in branching.

Dentate With sharp teeth not directed forward.

Denticulate Minutely dentate.

Depauperate Smaller than the usual natural size; short of the usual development; stunted; impoverished.

Depressed Low as if flattened.

Dermatitis Inflammation of the skin due to exposure to poisons, irritants, or sensitizers. It can be caused by a number of plants including poison ivy.

Descending With a gradual downward tendency.

Determinate Descriptive of an inflorescence whose flowers begin to open first at the top or center, progressing downward or outward; with the number of flowers fixed or limited in number; contrasting with indeterminate.

Di-, **Dis-** Greek prefix meaning two or double.

Diadelphous With filaments united so as to form two groups of stamens. The most common situation is nine in a group and a tenth separate; e.g., numerous Fabaceae.

Diandrous Having two stamens.

Diaphanous Transparent.

Diaphragm Dividing membrane or partition.

Dichasial With or in the form of a dichasium.

Dichasium A cyme with lateral branches on both sides of the main axis.

Dichotomous Forking regularly into two equal or nearly equal branches.

Dicotyledons (abbreviated Dicots) Flowering plants having two cotyledons, mostly net venation, and flower parts usually in 4s or 5s; one of the two classes of flowering plants, which, depending on the system of classification, is known as Dicotyledonae or Magnoliopsida. The dicots are now considered to be a paraphyletic group.

Didymous Developed in or occurring in pairs; twin.

Didynamous Having four stamens, two longer and two shorter.

Diffuse Loosely branching or spreading; of open growth; widely spread.

Digitate Fingered; with a number of structures attached at one point, like fingers on a hand.

Dilated Widened, flattened, broadened, or enlarged.

Dimidiate Halved, as if one half is missing.

Dimorphic, **Dimorphism** Occurring in two forms.

Dioecious With staminate flowers on one plant (staminate plant) and pistillate flowers on a different plant (pistillate plant); literally, "two houses."

Diploid Possessing two sets of chromosomes in each nucleus; twice the haploid number typical for gametes.

Diplostemonous The stamens in two series, those of the outer series alternating with the petals.

Dipterophily, **Dipterophilous** Pollination by dipterans (members of the insect order Diptera—flies, gnats, mosquitoes, and their relatives).

Disarticulating Separating; coming apart or falling apart.

Disc, **Disk** (a) A more or less fleshy or elevated development of the receptacle or of coalesced nectaries or staminodes about the pistil; (b) the central part of an Asteraceae head.

Disc floret (= Disk flower) In Asteraceae, small flower with tubular corolla, in disk (disc) portion of head; contrasting with ray (= ligulate) floret.

Disciform (a) Shaped like a disc; (b) in Asteraceae, in reference to a head with disk florets in center and marginal florets with ligule reduced or lacking.

Disclimax The condition where succession is indefinitely arrested or altered due to factors such as persistent disturbance (e.g., overgrazing).

Discoid (a) Shaped like a disc; (b) in reference to disc (disk) florets of an Asteraceae head; (c) in reference to the head of some Asteraceae with disk florets in center and marginal florets with ligule reduced or lacking; (d) without ligulate flowers.

Discoid head In Asteraceae, a head with only disk (disc) florets.

Discolorous Having the two surfaces of a structure dissimilar in color.

Discrete Separate.

Disjunct (a) Outside the main range of a species; (b) being divided into separate groups; disconnected.

Disk flower (= Disc floret) In Asteraceae, small flower with tubular corolla, in disk (disc) portion of head; contrasting with ray (= ligulate) florets.

Disparate Dissimilar; unequal.

Dissected Divided into numerous narrow or slender segments, the divisions usually deeper than lobes.

Distal Located at or toward the apex of a plant or organ; the terminal portion; the end opposite the attachment; contrasting with proximal.

Distant In reference to similar parts remote from one another; contrasting with approximate.

Distichous In two vertical rows or ranks, not spirally arranged; e.g., leaves occurring in two rows on opposite sides of a stem.

Distinct (= Free) Separate, not united or fused.

Disturbed Referring to a habitat that has been altered or modified but not completely destroyed.

Diurnal Occurring during the daytime.

Divaricate Very widely spreading.

Divergent Spreading, but less broadly than divaricate.

Divided (a) Cut 3/4–completely the distance from margin to midrib or from apex to base; (b) generally, cut deeply.

Division The highest rank, category, or taxon in the plant kingdom; made up of classes; ending in -phyta; equivalent to the rank of phylum in the animal kingdom.

dm Decimeter; 10 cm.

Doctrine of signatures Ancient belief that a plant structure that resembles a portion of the human body (a sign or signature) gives clues to its use. Some people believed that a creator had placed such signs to indicate the plant's value as a remedy for ailments of those body portions; e.g., *Hepatica*, named for its lobed, liver-shaped leaves, possibly useful for liver problems.

Dolabriform (a) Referring to pubescence where the hairs are attached near the middle or towards (but not at) one end and are thus 2-forked; (b) having the form of an ax or hatchet.

Dormant Not active.

Dorsal Referring to the back or outer surface of an organ; the side away from the axis; the lower or abaxial surface; contrasting with ventral.

Dorsifixed Attached by the back or dorsal edge, often in reference to the attachment of an anther to a filament; contrasting with either basifixed or versatile.

Dorsiventral Differentiated into upper and lower surfaces distinct in appearance or structure.

Double fertilization Process essentially unique to the angiosperms in which an egg unites with a sperm, forming a zygote, and a second sperm often unites with two nuclei resulting in a triploid endosperm. Double fertilization is also known in the small gymnosperm group the Gnetophyta.

Double flower (a) One with more than the normal number of petals (anywhere from a few more to many times the usual number); (b) in Asteraceae, double can refer to a head with more than the normal number of ray (= ligulate) florets.

Doubly serrate With coarse serrations bearing minute teeth on their margins, the teeth angled toward the apex of the structure.

Downy Closely covered with short, weak, soft hairs.

Drooping More or less erect at base but with upper part bending downward.

Drupaceous Pertaining to, or of the nature of a drupe.

Drupe One-seeded indehiscent fruit with a stony endocarp, the middle part fleshy or juicy, and an outer skin; e.g., plum or cherry.

Drupelet A small drupe; one drupe from an aggregate fruit composed of many drupes; e.g., a blackberry is an aggregate fruit composed of drupelets.

Duplex Double, as in pubescence composed of two kinds of hairs.

E

e East.

E-, **Ex-** Latin prefixes denoting without, that parts are missing.

Ebeneous Black, ebony-like.

Ebracteate Without bracts.

Echinate Prickly.

Eciliate Without cilia.

Ecological indicator An organism that is sensitive to pollution or some other environmental problem and can therefore be used as an indicator or gauge of the condition of an ecosystem.

Ecotone Transition zone between two biological communities; e.g., much of nc TX is an ecotone between the eastern deciduous forest and the central North American grassland.

Ecotype Those individuals adapted to only one of the kinds of environment occupied by a widespread species.

Edaphic Pertaining to soil conditions.

Edentate Without teeth.

Egg A female gamete or sex cell, in flowering plants contained in an ovule.

Eglandular Without glands.

Elaiosome An oily appendage on the seeds of some plants. These structures have apparently evolved to attract ants that act as dispersal agents.

Elimbate Referring to a corolla without a limb.

Ellipsoid A solid that is elliptic in outline.

Elliptic Shaped like an ellipse, with widest part at the middle; in the form of a flattened circle usually more than twice as long as wide.

Elongate Lengthened; stretched out.

Emarginate With a notch in the usually rounded apex.

Embryo The new plant in a seed.

Emersed, **Emergent** Raised above and out of the water.

Emetic A substance that causes vomiting.

Enation Outgrowth on the surface; epidermal outgrowth.

Endemic Confined geographically to or native to a single area.

Endocarp Innermost layer of pericarp or fruit wall.

Endogenous Produced deep within another body.

Endosperm The food reserve of many angiosperm seeds.

Ensiform Sword-shaped; e.g., leaves of an *Iris*.

Entire With smooth margins; without teeth.

Entomophilous, **Entomophily** Pollinated by insects.

Epappose Without pappus.

Ephemeral Lasting for a brief period; e.g., for only one day.

Epi- Greek prefix meaning upon or on.

Epicalyx A whorl or involucel of sepal-like bracts just below the true sepals; e.g., Malvaceae.

Epicarp (= Exocarp) The outermost layer of the pericarp or fruit wall.

Epicotyl The portion of the embryo just above the cotyledon(s); the young stem.

Epidermal Relating to the epidermis.

Epidermis The cellular covering of plant tissue below the cuticle.

Epigeous Growing upon or above the ground.

Epigynous Borne on the ovary; indicating a flower in which the hypanthium or the basal parts of the perianth are adnate to the ovary, the perianth and stamens thus appearing to rise from the summit of an inferior ovary.

Epigyny The state of being epigynous.

Epipetalous Descriptive of stamens in which the filaments are adnate to the corolla for all or part of their length; borne upon or arising from the petals or corolla.

Epiphyte A plant growing on another plant for physical support only and not parasitic; e.g., many Bromeliaceae including *Tillandsia* species.

Epiphytic Having the character of an epiphyte.

Equidistant Of equal distance.

Equitant Overlapping in two ranks; folded lengthwise and distichous; e.g., leaves folded around a stem in the manner of the legs of a rider around a horse.

Eradiate Lacking ray (= ligulate) florets; e.g., discoid heads in Asteraceae.

Erect (a) Growing essentially in a vertical position (e.g., whole plant); (b) a structure perpendicular to the object to which it is attached.

Ergot An alkaloid producing fungus, *Claviceps purpurea* (and related species).

Ergotism A sometimes lethal poisoning due to a number of alkaloids (e.g., lysergic acid hydroxyethylamide—LSD-like, egrotamine—vasoconstrictive) produced by ergot fungi, *Claviceps purpurea* (Fr.) Tul., *C. paspali* Stev. & Hall, and related species, which sometimes infect the inflorescences of members of the grass family (e.g., *Secale*—rye). Symptoms resulting from eating ergot-contaminated grain can include hallucinations, psychosis, convulsions, and gangrene of the extremities (due to vasoconstriction); referred to in ages past as Saint Anthony's Fire. The reference to fire resulted from the assumption that the burning sensations and blackened (gangrenous) limbs were retribution for sins. Saint Anthony, supposedly with special powers to protect against fire, infection, and epilepsy, was often prayed to for help by those with the condition. Large scale epidemics of ergotism in Europe prior to 1800, from eating bread made with contaminated grain, resulted in 1,000s of deaths; isolated instances still occur where grain purity is not controlled; ergotism is blamed by some for the hysteria that resulted in the Salem witch trials in 17th century Massachusetts. See treatment of *Secale* (Poaceae) for references.

Erose With ragged margin, as if nibbled or chewed.

Escape A cultivated plant not purposely planted but found growing as though wild.

Escarpment A steep slope.

Essential oils Fragrant (often pleasantly so) substances that are typically rather simple terpenoid compounds (monoterpenes, sesquiterpenes). They are responsible for the fragrance of many flowers and other plant tissues and are currently used in aromatherapy; e.g., in mint family and citrus family.

Estipellate Without stipels.

Estipulate Without stipules.

Etiolate Lengthened and deprived of color by absence of light.

Evanescent Of short duration; quickly lost.

Even-pinnate Descriptive of a compound leaf with terminal leaflet absent; with an even number of leaflets.

Evergreen Remaining green through the winter.

Exalate Without wings.

Exalbuminous In reference to seeds without endosperm.

Excentric Not having the axis placed centrally.

Excurrent Extending beyond the tip or margin.

Excurved Curved outward or away from a central part.

Exfoliate To peel off or come off in scales, flakes, plates, layers, or shreds; e.g., some types of bark.

Exocarp (= Epicarp) The outermost layer of the pericarp or fruit wall.

Exotic Foreign; not native; from another geographic area.

Explanate Spread out flat.

Explosively dehiscent Descriptive of a fruit that suddenly and forcibly dehisces its seeds, with the seeds being thrown away from the plant; e.g., *Impatiens*.

Exserted Projecting out or beyond (e.g., stamens projecting beyond the corolla); contrasting with included.

Exstipulate Lacking stipules.

Extant Still existing; contrast with extinct.

Extinct No longer in existence; descriptive of a species for which living representatives no longer exist. Locally extinct refers to extinction in a given geographic region.

Extrafloral Outside the flower; e.g., extrafloral nectaries.

Extrorse Facing outward, away from the axis, typically used to refer to manner of anther dehiscence.

Exudate Material coming out slowly through small pores or openings.

Eye (a) The marked or contrastingly colored center of a flower; (b) a bud on a tuber; e.g., on potatoes.

F

f. (a) After an author's name: abbreviation of *filius*, the son, or "jr."; (b) abbreviation of forma or form (see next page).

Facet One of a set of small plane surfaces.

Facultative Not necessary or essential; optional; contrasting with obligate.

Falcate Sickle-shaped, with the tip curved to one side.

Fall Outer, spreading, often recurved, and commonly bearded perianth segment in *Iris*.

Family The unit, category, or rank in classification made up of one or more genera; ending in -aceae; sometimes divided into subfamilies, which in turn are made up of genera.

Farinaceous Mealy in texture.

Farinose Covered with a whitish mealy powder or mealiness.

Fasciated With an abnormal widening and flattening of the stem as if several stems had grown together.

Fascicle A condensed or close bundle or cluster.

Fasciculate Congested in bundles or clusters.

Fastigiate In reference to branches, close together and nearly parallel.

Fenestrate Perforated with holes, openings (windows), or translucent areas.

Feral Wild; not cultivated.

Ferrugineous Rust-colored.

Fertile Capable of normal reproductive functions, as a fertile stamen producing pollen, a fertile pistil producing ovules, or a fertile flower normally producing fruit (although it may lack stamens); e.g., used to describe Asteraceae flowers capable of maturing achenes, irrespective of ability to produce pollen.

Fertilization Union of two gametes (e.g., egg and a sperm) to form a zygote.

Fetid With a disagreeable odor.

Fibrillose Having small fibers or appearing finely lined.

Fibrous Resembling or having fibers.

Fibrous root system One with several roots about equal in size and arising from about the same place; contrasting with taproot.

-fid A suffix meaning deeply cut.

Filament (a) The thread-like stalk supporting an anther; (b) a thread or thread-like structure.

Filamentous, Filamentose Composed of filaments or threads; thread-like.

Filiferous With coarse marginal threads.

Filiform Slender; having the form of a thread; filamentous.

Fimbriate Fringed; with narrow or filiform appendages or segments along the margin.

Fimbrillate With a minute fringe.

First glume Lowermost of the two glumes in a grass spikelet.

Fissured Cracked or fractured.

Fistulose Hollow; lacking pith.

Flabellate, Flabelliform Fan-shaped; broadly wedge-shaped.

Flaccid Lax, weak, floppy, not rigid.

Flagelliform Whip-like.

Flange A rim-like structure.

Flavescent Yellowish or becoming yellow.

Fleshy Succulent, juicy, or pulpy.

Flexuous Zigzag; bending or curving alternately in opposite directions.

Floccose Covered with tufts of soft woolly hairs.

Flocculent Minutely floccose.

Flora (a) Collective term for the plants of an area; (b) a taxonomic work on the plants of an area.

Floral bract Reduced leaf subtending a flower in the inflorescence.

Floral envelope The calyx or corolla; the floral "leaves."

Floral tube, **Floral cup** Tube or cup formed by union of sepals, petals, and stamen bases. The structure can be either adnate to or free from the ovary; in some cases it is synonymous with hypanthium.

Floret (a) Small flower in a dense cluster; (b) in reference to individual flowers of Asteraceae and Poaceae; (c) in grasses referring to the lemma and palea together with the enclosed reproductive structures.

Floricane Flowering stem of the genus *Rubus* (dewberries and blackberries).

Floriferous Bearing or producing flowers.

Flower An axis bearing stamen(s), pistil(s), or both, and, in addition, often floral envelopes (= calyx and corolla); the reproductive structure of an angiosperm.

Fluted With alternating ridges and grooves.

Foliaceous Leaf-like.

Foliage Collective term for the leaves of a plant.

Foliate With leaves.

Foliolate With leaflets.

Foliose Leafy.

Follicle Dry, one-carpellate fruit dehiscing along one suture only.

Forb A herbaceous, non-grass-like plant.

Forked Dichotomous; divided into two equal or nearly equal branches.

Forma, **Form** (abbreviated f.) A taxon below the rank of variety used to refer to minor variations without distinctive geographic occurrence; e.g., occasional albinos or seasonal growth forms. This category is generally ignored in this book.

Fornices Internal appendages in the upper throat of a corolla; e.g., in some Boraginaceae.

Fovea (pl. Foveae). A pit or depression.

Foveate Pitted.

Foveolate Minutely pitted.

Free (= Distinct) Separate from one another.

Free-central placentation Placentation with the seeds attached to a central column and surrounded by a single continuous locule.

Frond The leaf of a fern, often compound or decompound.

Fructiferous Producing or bearing fruit.

Frugivore Animal that feeds on fruits.

Fruit A mature, ripened pistil or ovary. In the case of accessory "fruits" other tissues may be involved.

Fruticose Shrubby or bushy in sense of being woody.

Fugacious Falling or disappearing early, usually in reference to parts of a flower.

Fulvous Tawny, brownish yellow.

Funicle, Funiculus The stalk attaching an ovule or seed to the ovary wall or placenta.

Funnelform (= Infundibuliform) Funnel-shaped; gradually widening upward.

Furrowed With longitudinal channels or grooves.

Fuscous Grayish-brown.

Fused United by normal growth.

Fusiform Spindle-shaped; with broadest diameter at middle tapering to each end.

G

Galea The helmet-like or hood-like upper lip of a bilabiate corolla or calyx, especially one that is strongly concave.

Galeate Hooded, hood-like, or helmet-like.

Gamete A sex cell; an egg or sperm.

Gametophyte The gamete-producing, typically haploid generation alternating with the sporophyte (= spore-producing, typically diploid); the stage in the life-history of a plant that produces male or female cells (= gametes); the dominant generation in mosses and liverworts. In ferns and fern allies it is green and autotrophic, although small; in all flowering plants it is microscopic and develops within the tissues of the sporophyte.

Gamo- A prefix meaning united; e.g., gamopetalous or gamosepalous.

Gamopetalous (= Sympetalous) With petals united, at least basally, forming a tube.

Gamosepalous (= Synsepalous) With sepals united, at least basally, forming a tube.

Gastroenteritis Inflammation of the stomach and intestines. It can be caused by a number of plant materials.

Geminate In pairs; twin.

Gemma An asexual propagule sometimes appearing as, but not homologous with, a vegetative bud.

Geniculate Bent abruptly, like a knee.

Genus (pl. Genera) The unit, category, or rank in classification between family and species; composed of one or more closely related species; sometimes divided into subgenera, which in turn are made up of species.

Gibbous Swollen basally on one side.

Glabrate, **glabrescent** Becoming hairless with age.

Glabrous Without hairs.

Gladiate Sword-shaped.

Gland A secreting part or appendage, often protruding or wart-like.

Glandular Having or bearing secreting organs, glands, or trichomes.

Glandular-pubescent With gland-tipped, pinhead-like hairs.

Glandular-punctate With glands recessed in depressions.

Glaucescent Becoming glaucous.

Glaucous With waxy substances forming a whitish or gray-silvery covering or bloom.

Globose Nearly spherical or rounded.

Glochid (pl. Glochidia) An apically barbed bristle or hair; e.g., in many Cactaceae.

Glomerate In a dense cluster or glomerule.

Glomerulate Arranged in small dense clusters.

Glomerule A dense cluster of two or more structures.

Glucoside A glycoside with glucose as the sugar.

Glumaceous With greenish bracts or petals similar in appearance to the glumes in grass spikelets.

Glume One of a pair of bracts at the base of a grass spikelet.

Glutinous Sticky, gluey, or resinous.

Glycoside Complex, two-component chemical compound that can break down or hydrolyze under certain conditions, yielding a sugar plus another compound (= aglycone) that can be physiologically active including poisonous. Types of glycosides include cardiac, coumarin, cyanogenic, mustard oil, steroidal, and saponic; the term glucoside refers to those in which the sugar molecule is glucose.

Glycosinolate (= Mustard oil glycoside) A complex molecule that upon breakdown yields a sugar, a sulfate fraction, and isothiocyanates (= mustard oils); e.g., in the Brassicaceae or mustard family.

-gonous A suffix meaning angled; e.g., trigonous means three-angled.

Graduated Referring to a sequence in shape or size; e.g., leaves becoming narrowed up a stem.

Grain The 1-seeded fruit typical of cereal crops; often used synonymously with caryopsis.

Granular, **Granulose**, **Granulate** Covered with minute, grain-like particles.

Grit cell (= Stone cell) A sclerotic or hardened cell, as in the flesh of pears.

Gymnosperms Literally, "naked seed"; a polyphyletic assemblage of plants without flowers, the seeds "naked," (= not enclosed in a special structure), often on the surface of thick or thin, sometimes woody cone scales.

Gynecandrous The pistillate flowers above (= distal to) the staminate of the same spike; e.g., in some Cyperaceae.

Gynobasal, **Gynobasic** Referring to or having a gynobase.

Gynobase An enlargement of the receptacle at the base of the ovary.

Gynodioecious Basically dioecious, but with some flowers perfect and others pistillate.

Gynoecium The pistil or pistils of a flower considered collectively; collective term for the female parts of a flower.

Gynomonoecious Having female and bisexual flowers on the same plant.

Gynophore Prolonged stipe (= stalk) of a pistil.

Gynostegium (a) Sheath or covering of the gynoecium; (b) in Asclepiadaceae, the columnar or disk structure made up of the connate stamens, style, and stigma.

Gypsiferous, **Gypseous** Containing gypsum (= calcium sulfate).

H

Habit Style or arrangement of growth; general appearance.

Habitat Type of locality in which a plant grows; e.g., prairie.

Hair An epidermal appendage that is usually slender, sometimes branched, not stiff enough to be called a spine, not flattened as a scale; often used synonymously with trichome.

Halberd-shaped (= Hastate). Arrowhead-shaped but with the two basal lobes turned outward.

Hallucinogen A material capable of causing the perception of imaginary sights, sounds, or objects through effects on the nervous systems. Various plant products, including certain alkaloids, are capable of such effects.

Halophyte A plant tolerant of salty or alkaline soils.

Hamate Hooked.

Haploid Having the reduced number of chromosomes typical of gametes; usually with a single set of chromosomes in each nucleus.

Hastate (= Halberd-shaped). Arrowhead-shaped but with the two basal lobes turned outward.

Haustorium (pl. Haustoria) Sucker-like attachment organ of parasitic plants by which they draw their food supply from the host-plant.; e.g., in Cuscutaceae and some Scrophulariaceae.

Hay fever Respiratory allergy, frequently due to plant substances or microstructures such as pollen; e.g., *Ambrosia* (ragweed) pollen is a well-known cause of hay fever.

Head (= Capitulum) Dense cluster of sessile or nearly sessile flowers; the type of inflorescence typical of the Asteraceae.

Heartwood The innermost and oldest wood, often with materials (e.g., toxins) giving it different characteristics from sapwood (e.g., more durability or resistance to rotting).

-hedral A suffix signifying surface, usually preceded by a number and then indicating the number of sides, as a tetrahedral spore.

Helicoid, **Helical** Coiled or spiraled, usually in reference to inflorescences.

Heliophyte A plant adapted to grow in or tolerate full sun.

Hemi- Greek prefix meaning half.

Hemiparasitic (= Semiparasitic) Descriptive of a plant that carries out photosynthesis but obtains some of its food, mineral nutrition, or water needs from another living organism (the host).

Herb A vascular plant lacking a persistent woody stem and typically dying back to the ground each season.

Herbaceous (a) Referring to the aerial shoot of a plant that does not become woody; typically dying back to the ground each year; (b) of a soft texture, as green leaves.

Herbage Collective term for the green or vegetative parts of a plant.

Herbarium (pl. Herbaria) A collection of dried pressed plants prepared for permanent preservation (see Appendix eight for further details).

Herbicidal Having the ability to kill plants.

Hermaphroditic With stamens and pistils in the same flower; bisexual.

Hesperidium A specific type of fruit usually associated with the citrus family; a berry developed from a pistil with numerous carpels, pulpy within, and externally covered with a hard rind; e.g., orange.

Hetero- Greek prefix meaning other, various, or having more than one kind.

Heterocarpous With more than one kind of fruit.

Heterochlamydeous With the perianth differentiated into a calyx and a corolla.

Heterogamous (a) With more than one kind of flower; (b) in Asteraceae, with each head composed of more than one kind of flower.

Heterogeneous Not uniform in kind.

Heterophyllous Having more than one form of leaf.

Heterosporous Having two spore types; e.g., *Selaginella*.

Heterostylous Having styles of different lengths.

Hexagonal Six-angled.

Hexaploid Having six sets of chromosomes.

Hilum Scar or mark on a seed indicating where the seed was attached by a funiculus (= stalk) to the ovary wall or placenta. The hilum is the "eye" of a bean or other large seeds.

Hip The "fruit" of a rose; actually a fleshy hypanthium or floral cup with the true fruits (= achenes) inside.

Hippocrepiform Horseshoe-shaped.

Hirsute With straight, moderately stiff hairs.

Hirsutulous Diminutive of hirsute.

Hirtellous Minutely hirsute.

Hispid Resembling hirsute but the hairs stiffer, ± bristly, feeling rough to the touch.

Hispidulose Minutely hispid.

Hoary Covered with a fine, white, whitish, or grayish white pubescence.

Holophyletic A term used to describe a group consisting of a common ancestor and all of its descendants. The term monophyletic is sometimes used in the same sense.

Holotype The one specimen used or designated by the author of a species or other taxon as the nomenclatural type in the original publication. The holotype is the specimen to which the scientific name is permanently attached; it is not necessarily the most typical or representative element of a taxon.

Homo- Greek prefix meaning all alike, very similar, same, or of one sort.

Homochlamydeous With a perianth of tepals undifferentiated into calyx and corolla.

Homogamous (a) With only one kind of flower; (b) with anthers and stigmas maturing simultaneously.

Homogeneous Of the same kind or nature; uniform; contrasting with heterogeneous.

Homosporous With spores all of one type.

Hood (a) A segment of the corona in Asclepiadaceae; (b) a hollow arched structure.

Hooded Descriptive of an organ with the lateral margins more or less inrolled and the apex more or less inflexed; helmet-like; shaped like a hood.

Honey-leaf Petal-like perianth part producing nectar; e.g., in some Ranunculaceae.

Horn An exserted tapering appendage resembling a cow's horn; e.g., appendage on the hood in some Asclepiadaceae.

Horny Hard or dense in texture.

Host Organism from which a parasite obtains nourishment.

Humic Consisting of or derived from humus (= organic portion of soil).

Humistrate Laid flat on the soil.

Humus Decomposing organic matter in the soil.

Husk The outer covering of some fruits, typically derived from the perianth or bracts.

Hyaline Thin, membranous, and transparent or translucent.

Hybrid (a) A cross between two unlike parents; (b) specifically, the offspring resulting from a cross between two species.

Hydathode An epidermal structure, usually marginal or terminal, that excretes water.

Hydrophily, **Hydrophilous** Water-pollination; water-mediated pollination; using water as the mechanism of transferring pollen; e.g., in some Callitrichaceae; see Philbrick (1991).

Hydrophyte A plant typically growing partially or wholly immersed in water; contrasting with mesophyte and xerophyte.

Hygroscopic Susceptible of expanding, shrinking, twisting, or untwisting on the application or removal of water or water vapor.

Hymenopterophily, **Hymenopterophilous** Pollination by hymenopterans (= members of the insect order Hymenoptera—bees, wasps, and their relatives).

Hypanthium (pl. Hypanthia) Cup-shaped or tubular structure formed by (a) fusion of the sepals, petals, and stamens; or (b) enlargement of the receptacle so that the perianth and androecium are attached above the gynoecium. A hypanthium may be adnate to ovary (resulting in epigyny) or free from ovary (perigyny); formerly referred to as calyx tube.

Hypocotyl Axis of an embryo below the cotyledons.

Hypogeous Below the ground.

Hypogynium A structure below the ovary, as in *Scleria* (Cyperaceae).

Hypogynous Referring to a flower having floral organs attached below the ovary. Hypogynous flowers have superior ovaries.

I

Illegitimate name Name unacceptable as the accepted scientific name because it is not the earliest one given to the plant in question, or published without description, or violating some other specific requirement of the International Code of Botanical Nomenclature.

Imbricate Overlapping like shingles on a roof.

Immaculate Not spotted.

Immersed (= Submerged, Submersed) Growing under water.

Imparipinnate Unequally or odd-pinnate, with a single terminal leaflet.

Imperfect In reference to a flower having either functional stamens or functional pistils, but not both; unisexual.

Incanous Gray or hoary.

Incipient Beginning to be; coming into being.

Incised Cut rather deeply and sharply; intermediate between toothed and lobed.

Included Not exserted; within; not projecting beyond the surrounding organ.

Incomplete Referring to a flower lacking one or more of the flower parts: sepals, petals, stamens, or pistils.

Incomplete veins In *Carex*, referring to veins that do not extend the entire length of the perigynium body.

Incurved Curved inward.

Indehiscent Referring to a fruit that does not open at maturity; contrasting with dehiscent.

Indeterminate Inflorescence whose flowers begin to open first at bottom or outside, progressing upward or inward with the number of flowers not pre-determined at the beginning of flowering; growth of inflorescence not stopped by opening of the first flowers; contrasting with determinate.

Indigenous Native to an area; not introduced.

Indument, **Indumentum** Surface coating such as hairs, roughening, bloom, or glands.

Induplicate Folded or rolled inward.

Indurate Hardened.

Indusium (pl. Indusia) Epidermal outgrowth covering the sori or sporangia on fern fronds.

Inferior Descriptive of an ovary fused to the hypanthium or to the lower parts of the perianth and therefore appearing to be located below the rest of the flower; an ovary positioned below the point of attachment of the floral organs. This type of ovary is found in epigynous flowers.

Infertile (a) Incapable of normal reproductive functions; (b) specifically used to describe Asteraceae flowers incapable of maturing achenes, irrespective of presence of functional stamens.

Inflated With an internal air space; bladdery.

Inflexed Bent inward.

Inflorescence (a) Term commonly used to refer to the flowering structure of a plant; (b) a flower cluster; (c) arrangement of flowers on the floral axis; (d) manner of bearing flowers.

Infra- Latin prefix meaning below.

Infraspecific Within the species; referring to a unit of classification below the species; e.g., subspecies, variety, form.

Infructescence An inflorescence in the fruiting stage.

Infundibuliform (= Funnelform) Funnel-shaped; gradually widening upwards.

Innocuous Harmless, unarmed, spineless.

Innovation A basal shoot of a perennial grass.

Inrolled Rolled inward.

Insectivorous Consuming insects; referring to plants that digest insect tissue to obtain nutrients such as nitrogen.

Inserted Attached to another part or organ.

Insertion The place or mode of attachment of an organ.

Integument The covering of an organ; e.g., of the ovule.

Inter- Latin prefix meaning between.

Intercalary Medial in position.

Intercostal Located between the ribs or costae.

Interlacunar Between air spaces.

Internode Area of stem or other structure between two nodes.

Interrupted Not continuous or regular.

Interspecific Between different species.

Interstitial Referring to the space intervening between one thing and another.

Intra- Prefix used to denote within.

Introduced Brought from another geographic region; not native.

Introgression, **Introgressive hybridization** Successive crosses, first between plants of two species, then between the offspring of this cross and plants of one parent species, followed by further interbreeding between mongrels of varying percentage of impurity with purebreds of the parent line. This eventually leads to whole populations of one parent species being contaminated with genes derived from the other.

Introrse Facing inward, toward the axis, typically used to refer to manner of anther dehiscence.

Intruded Projecting inward or forward.

Invaginate To enclose in a sheath.

Involucel Diminutive of involucre; a secondary involucre; e.g., the bracts subtending the secondary umbels in Apiaceae or the whorl of bracts subtending a flower in Malvaceae.

Involucellate With an involucel.

Involucral, **Involucrate** Pertaining to or having an involucre.

Involucre The whorl of bracts subtending a flower cluster or flower; e.g., involucre of bracts (= phyllaries) subtending a head in Asteraceae or small involucre (= involucel) subtending a flower in many Malvaceae (specifically called an epicalyx).

Involute With margins or edges rolled inward toward the upper side.

Irregular (a) Structures not similar in size or shape; asymmetrical; (b) descriptive of a flower without any plane of symmetry; contrasting to regular and zygomorphic.

-ish Suffix meaning "slightly," often used with color terms.

Isodiametric Of equal dimensions.

Isolateral Equal-sided.

Isothiocyanate (= Mustard oil) Organic compound containing nitrogen and sulfur that has a pungent odor and taste and is irritating to the skin and mucous membranes. Isothiocyanates are toxic and can cause liver and kidney damage, as well as other problems; e.g., in the Brassicaceae or mustard family.

Isotype A specimen of the type collection other than the holotype; an extra or duplicate specimen made at the same time and place as the holotype.

J

Jointed With or apparently with nodes or points of articulation; e.g., jointed hairs of *Physalis* (Solanaceae).

Juvenile leaves In plants with more than one leaf type (e.g., leaf dimorphism), the leaves on new growth, often quite different in appearance from adult leaves; e.g., found in *Juniperus*, *Hedera*.

K

Keel (a) (= Carina) The two lower (= abaxial) fused petals of a papilionaceous flower (Fabaceae); (b) prominent longitudinal ridge, shaped like the keel of a boat.

Keeled With a ridge or keel.

Knees Erect woody projections; e.g., found in *Taxodium* (bald-cypress).

L

L. Linnaeus, Swedish naturalist who established the binomial system of nomenclature; L. f., his son.

Labellum (= Lip) In Orchidaceae, the enlarged upper petal that appears to be the lowest petal because of twisting of the pedicel.

Labiate Lipped; differentiated into an upper and a lower portion.

Lacerate Irregularly cleft as if torn.

Laciniate Cut into long, narrow, ± equal divisions or segments.

Lactiferous, **Lactescent** With milky sap.

Lacuna (pl. Lacunae) A space, hole, cavity, or areole.

Lacunose Perforated, with holes, cavities, or depressions.

Laevigate Smooth as if polished.

Lamella A flat, thin plate.

Lamellate Made up of flat, thin plates.

Lamina The blade or expanded part of an organ.

Laminate In plates or layers.

Lanate, **Lanose** Woolly; covered with dense, long, entangled hairs resembling wool.

Lanceolate Lance-shaped; several times longer than wide, tapering at both ends, widest about a third above the base.

Lanuginose With a cottony or woolly appearance, the hairs shorter than in lanate.

Latent Dormant.

Lateral Belonging to or borne on the sides.

Lateral bud Bud in a leaf axil; contrasting with terminal or apical bud.

Latex A water insoluble mixture of organic compounds, predominantly hydrocarbons, produced in specialized cells called laticifers and often milky in color. The latex of some species has elastic properties (e.g., *Hevea brasiliensis*, rubber) while that of others contain compounds such as alkaloids (e.g., *Papaver somniferum*, opium poppy).

Laticiferous Latex-bearing.

Latisept With broad partitions in the fruits; e.g., Brassicaceae.

Latrorse Dehiscing laterally and longitudinally; e.g., some anthers.

Lax (a) Spread apart, loose, distant; (b) not rigid.

Leaf The primary photosynthetic organ of most plants, usually composed of an expanded blade and a stalk-like petiole.

Leaf scar The mark or scar left on the stem by the fall of a leaf.

Leaf trace A vascular bundle, one or more in number, extending from the stem into the leaf.

Leaflet A single, expanded segment or division of a compound leaf.

Lectins Certain plant proteins that cause linking or agglutination between cells. They can be toxic or mitogenic (= capable of stimulating mitosis); they apparently function in the binding of symbiotic nitrogen-fixing bacteria to roots and in protecting against pathogenic bacteria; often found in members of the Fabaceae.

Lectotype A specimen or other material selected by a later worker from the original material studied by the author of the species (or other taxon) to serve as the nomenclatural type when a holotype was not originally designated or was lost or destroyed.

Legume (a) Fruit type with a single carpel typically dehiscent along both sutures (= margins); (b) a member of the Fabaceae; (c) any fruit type within the Fabaceae.

Lemma The outer (= lowermost) of the two bracts enclosing the reproductive structures in the grass floret.

Lenticel A small corky pore or spot on the bark of young twigs found in many trees and shrubs and allowing gas exchange.

Lenticular Two-sided; lens-shaped.

Lepidote Covered with small scales; scurfy.

Lepidopterophily, **Lepidopterophilous** Pollination by lepidopterans (= members of the insect order Lepidoptera—butterflies and moths).

Liana, **Liane** A woody climber (e.g., grape vine). Lianas are common in the tropics.

Ligneous Woody.

Lignescent Somewhat woody or becoming woody.

Ligulate Tongue-shaped; strap-shaped.

Ligulate floret (= Ray floret) Flower, with corolla expanded into a ligule, typical of many Asteraceae.

Ligulate head Head having only bisexual flowers with strap-shaped corollas.

Ligule (a) A strap-shaped limb or body; (b) strap-shaped part of ray (= ligulate) corolla in Asteraceae; (c) membranous or hairy appendage on adaxial surface of the leaf at junction of blade and sheath in Poaceae.

Liguliform Strap-shaped.

Limb (a) In a corolla of united petals, the main expanded portion, as distinguished from a basal tube; (b) expanded part of an organ.

Limbate With limb present.

Linear Resembling a line, long and narrow, with margins parallel to one another.

Lingulate Tongue-shaped.

Lip (a) Either of the principal lobes of a bilabiate or strongly zygomorphic corolla or calyx (e.g., Lamiaceae); (b) (= Labellum) the enlarged upper petal in Orchidaceae that appears to be the lowest petal because of twisting of the pedicel.

Lithophyte Plant that grows on rocks but derives its nourishment from the atmosphere and from accumulated humus.

Littoral Of a shore, particularly of the seashore.

Loam Soil consisting of a mixture of sand, clay, silt, and organic matter.

Lobate Having lobes.

Lobe A usually rounded segment or division of a leaf, petal, or other organ.

Lobed Having deep or coarse indentations of the margin, larger than mere teeth. (However, there is no sharp distinction between large teeth and small lobes.)

Lobulate Having small lobes.

Locular Having one or more locules.

Locule, **Loculus** The cavity, compartment, or cell containing the ovules in a carpel or the pollen in an anther.

Loculicidal Descriptive of a capsule dehiscing along the middle of the back of each locule or chamber (= along the midrib of each carpel).

Lodicule One of the two or three minute scales at the base of the ovary in most grasses, thought to be a rudiment of a perianth part. They swell and thus open the lemma and palea, allowing the reproductive parts to be exposed.

Loment, **Lomentum** An indehiscent fruit separating into one-seeded segments at maturity.

Longitudinal Lengthwise; along the long axis.

Lumper A taxonomist who in general has the tendency to lump segregates into larger groups; contrasting with splitter.

Lunate Crescent-shaped; half-moon-shaped.

Lurid Dirty, dingy.

Lustrous Shining.

Lutescent Becoming yellow.

Lyrate Lyre-shaped; pinnately lobed with the terminal lobe the largest.

M

m Meter; 10 decimeters; 39.37 inches.

Macro- Greek prefix denoting large or long.

Macrospore (= Megaspore) A large spore giving rise to the female gametophyte; the larger of two kinds of spores produced by heterosporous plants; a female spore.

Maculate With a spot or spots.

Malodorous Foul-smelling.

Malpighian Describing hairs lying parallel to a surface and attached by their middle; with two branches and almost no stalk; appearing to be an unbranched hair attached at the middle.

Mammiform Breast-shaped; conical with rounded apex.

Mammillate Having nipple-like structures.

Marbled With irregular streaks or blotches of color.

Marcescent Withering, but the remains persistent; e.g., the corollas of most *Trifolium*.

Margin Edge; the outer portion of a blade or other structure.

Marginal Attached to the edge or pertaining to the edge.

Marginate Distinctly margined; with a distinctly different margin.

Marsh Wet or periodically wet, treeless area.

Medial, **Median** Central, middle.

Medullary Pertaining to the pith.

Mega- Greek prefix meaning very large.

Megaphyll Leaf with branched veins.

Megasporangium Sporangium in which megaspores are formed.

Megaspore (= Macrospore) A large spore giving rise to the female gametophyte; the larger of two kinds of spores produced by heterosporous plants; a female spore.

Megasporophyll A sporophyll (= spore-bearing leaf) bearing one or more megaspores.

Membranaceous, **Membranous** Having the nature of a membrane, thin, somewhat flexible, translucent.

Mentum A projection near the base of some flowers in the Orchidaceae.

Mephitic Having an offensive odor.

Mericarp The individual, separated carpels of a schizocarpic fruit; e.g., one of the fruit segments in the Apiaceae or one of the "nutlets" in the Boraginaceae.

Meristem Embryonic or undifferentiated tissue, capable of developing into various organs.

Meristematic Pertaining to or with the nature of a meristem.

-merous Greek suffix used to refer to the number of parts (or multiples of such) in each circle of the floral organs, usually with a numerical prefix (e.g., a 3-merous perianth would mean there are three petals and three sepals or some multiple of three). The term often refers to the perianth only.

Mesa A flat-topped hill with abrupt or steeply sloping side or sides.

Mesocarp The middle layer of the pericarp or fruit wall.

Mesophyte Plant that grows under medium moisture conditions; contrasting with hydrophyte and xerophyte.

Micro- Greek prefix meaning small.

Microphyll A relatively small leaf with a single unbranched vein, typical of the Lycopodiophyta and Equisetophyta.

Microphyllous Having small leaves.

Micropyle A minute opening through the integuments into the ovule through which the pollen-tube usually enters and often distinguished in the mature seed as a slight depression.

Microsporangium Sporangium in which microspores are produced. In angiosperms, the microsporangium is equal to the pollen sac and there are typically four microsporangia per anther.

Microspore A small spore giving rise to the male gametophyte; the smaller of two kinds of spores produced by heterosporous plants; a male spore.

Microsporophyll The sporophyll (= spore-bearing leaf) upon which microspores are produced.

Microtuberculate Minutely tuberculate.

Midrib The central or main rib or vein of a leaf or other similar structure.

Mitriform Shaped like a miter or bishop's hat.

Mixed inflorescence One in which the parts are not consistent in being all determinate or all indeterminate.

mm Millimeter; 1000 microns or 1/1000 of a meter.

Monadelphous With all filaments united into a single tube surrounding the pistil.

Monandrous Having a single stamen.

Moniliform Like a string of beads.

Mono- Greek prefix meaning one or of one.

Monocarpic (a) Descriptive of a plant that flowers only once before dying; (b) having a single carpel.

Monocephalous, **Monocephalic** Bearing only a single head.

Monochasium A cyme with lateral branching on only one side of the main axis.

Monochlamydeous Having only one set of floral envelopes; having perianth of a single series.

Monocolpate With a single furrow; e.g., on a pollen grain.

Monocotyledons (abbreviated Monocots) Flowering plants having one cotyledon (= seed leaf), mostly parallel venation, and flower parts usually in threes; one of the two classes of flowering plants, which, depending on the system of classification, is known as Monocotyledonae or Liliopsida.

Monoecious Plants with staminate flowers and pistillate flowers on the same plant but lacking perfect flowers.

Monomorphic One form; contrasting with polymorphic.

Monophyletic A term previously used to describe a group of organisms with a common ancestor; more recently it has been used to describe a group consisting of a common ancestor and all of its descendants. Some authorities believe that a different term, holophyletic, should be used for a group consisting of a common ancestor and all of its descendants.

Monopodial With an evident single and continuous axis.

Monotypic Having a single type or representative; e.g., a genus with only one species.

Montane Pertaining to or living in mountains.

Mostly A quantitative term meaning "most of them."

Mucilaginous Slimy; with mucilage.

Mucro A short and small abrupt tip, as with the midrib extending as a short point.

Mucronate With a mucro.

Mucronulate Diminutive of mucronate.

Multi- Latin prefix for many.

Multicipital Literally, "many-headed"; descriptive of a crown of roots or a caudex from which several stems arise.

Multifid Divided into many narrow segments or lobes.

Multiflorous Many-flowered.

MULTIPLE FRUIT (= Syncarp) A single "fruit" formed by the coalescence of several fruits from separate flowers; e.g., *Morus* (mulberry), *Maclura* (bois d'arc), *Ananas* (pineapple).

MURICATE With numerous minute short points; roughened.

MURICULATE Diminutive of muricate.

MUSTARD OIL (= Isothiocyanate) Organic compound containing nitrogen and sulfur, which has a pungent odor and taste and is irritating to the skin and mucous membranes. Mustard oils are toxic and can cause liver and kidney damage, as well as other problems; e.g., in the Brassicaceae or mustard family.

MUSTARD OIL GLYCOSIDE (= Glycosinolate) A complex molecule that upon breakdown yields a sugar, a sulfate fraction, and an irritating mustard oil or isothiocyanate; e.g., in the mustard family.

MUTICOUS Blunt, lacking a point.

MYCORRHIZA (pl. MYCORRIHIZAE) A mutually beneficial, symbiotic association of a fungus and the root of a plant. Mycorrihizal relationships are characteristic of most vascular plants.

MYCORRHIZAL Pertaining to mycorrhiza.

N

N North.

NAKED Lacking various coverings, organs, or appendages, almost always referring to organs or appendages present in other similar plants; e.g., a naked flower lacks perianth.

NAPIFORM. Turnip-shaped; e.g., roots.

NASCENT In the act of being formed.

NATANT Floating underwater; immersed.

NATURALIZED Referring to an introduced foreign plant that has become part of the spontaneous, self-perpetuating flora of a region.

NAVICULATE, **NAVICULAR** Boat-shaped.

NECTAR A sugar-rich solution secreted by plants, typically produced in nectaries. Nectar production has apparently evolved to attract insects or other animals for pollination or other purposes.

NECTAR-GUIDE A line or other marking leading insects to the nectary; e.g., contrastingly colored lines on many corollas.

NECTARIFEROUS Having or producing nectar.

NECTARY A specialized nectar-secreting structure or area; there can be floral nectaries (in the flowers) or extra-floral nectaries (not associated with the flowers).

NEEDLE Linear, often stiff leaf as in *Pinus* (Pinaceae).

NEOTYPE A specimen selected by a later worker to serve as the nomenclatural type of a taxon when all material studied by the original author has been lost or destroyed.

NERVE A simple vein or slender rib of a leaf, bract, or other structure.

NERVED Having nerves.

NET-VEINED With veinlets branching irregularly and not uniformly angular, forming a net-like pattern.

NEUTER Sexless, as a flower that has neither functional stamens nor pistils.

NEUTRAL FLOWER A sterile flower; flower with a perianth but without functional sexual organs.

NIGRESCENT Turning black.

NITID Smooth and clear, lustrous, glittering.

NITRATES Nitrogen containing compounds that can be accumulated in plant tissues and cause toxicity in animals if ingested. During digestion, nitrates are converted to nitrites that are toxic due to their ability to render hemoglobin incapable of transporting oxygen.

NOCTURNAL Occurring at night or lasting for only one night.

NODAL Located at or pertaining to a node.

NODE Area of stem or axis at which branches, leaves, bracts, or flower stalks are attached; joint of a stem.

NODDING Hanging down.

NODOSE Nodular, knotty, with semispheroid protuberances.

NODULOSE Diminutive of nodose; having small, knobby nodes or knots.

NUT Hard-shelled and indehiscent fruit with a single seed.

NUTANT Nodding.

NUTLET (a) Diminutive of nut; (b) used to refer to any small, dry, nut-like fruit or seed, thicker-walled than an achene; (c) seed-like sections into which the mature ovary breaks in Boraginaceae, Labiatae, and most Verbenaceae, each section consisting of one seed with extra coat formed from ovary wall or partitions, making it technically a fruit.

O

OB- Latin prefix indicating the reverse or upside-down, as obcordate, meaning cordate or ovate with wider end at top or away from point of attachment.

OBCONIC, **OBCONICAL** Inversely cone-shaped, with attachment at the small end.

OBDELTOID Inversely deltoid; triangle-shaped with base pointed.

OBDIPLOSTEMONOUS Describing a flower with two circles of stamens, in which those of the outer circle are borne in front of (= on the same radius as) the petals.

OBLANCEOLATE Lanceolate with broadest part above the middle and tapering toward the base.

OBLATE Nearly spherical but flattened at the poles.

OBLIGATE Necessary or essential; contrasting with facultative.

OBLIQUE Slanting; unequal-sided.

OBLONG Longer than wide with sides nearly parallel.

OBOVATE Egg-shaped with attachment at narrow end; inversely ovate.

OBOVOID Inversely ovoid; a solid that is obovate in outline.

OBPYRIFORM Pear-shaped with attachment at narrow end.

OBSOLESCENT Nearly or becoming obsolete; rudimentary; referring to structures that are not or are only slightly evident.

OBSOLETE Not apparent or evident; rudimentary; vestigial; extinct.

OBTUSE Forming a blunt or rounded angle of more than 90 degrees; not pointed.

OCHRACEOUS Ochre-colored, yellow with a tinge of red.

OCHROLEUCOUS Yellowish-white, buff.

OCREA (pl. OCREAE) Tube formed by fused, sheathing stipules; e.g., in Polygonaceae.

OCREATE With an ocrea.

OCREOLA (pl. OCREOLAE) Secondary sheath; sheath surrounding a fascicle of flowers; e.g., in the Polygonaceae.

ODD-PINNATE Compound leaf with terminal leaflet present; with an odd number of leaflets.

OFFSET A short lateral shoot, arising near the base of a plant, primarily propagative in function and thus can give rise to a new plant.

Oligo- Greek prefix signifying few.

Olivaceous Olive-green.

Ontogeny The developmental cycle of an individual organism.

Opaque Impervious to light.

Operculate Having an operculum.

Operculum Literally, "a small lid"; term applied to the terminal portion (= lid or cap) of a circumscissile fruit or other organ.

Opposite Arranged two at each node, on opposite sides of the axis.

Orbicular, **Orbiculate** With round, approximately circular outline.

Order The unit, category, or rank in classification made up of one or more families; ending in -ales; sometimes divided into suborders or superfamilies, which in turn are made up of families.

Orifice An opening.

Ornithophily, **Ornithophilous** Pollination by birds.

Ortho- Greek prefix signifying straight.

Orthotropous ovule An erect ovule, with the micropylar end at the summit.

Oval Broadly elliptic.

Ovary Basal, ovule-containing portion of the pistil in angiosperms, developing into the fruit.

Ovate Egg-shaped with widest part at the base.

Ovoid Solid oval or solid ovate.

Ovulate Bearing ovules.

Ovule An immature or unfertilized seed; the megasporangium of a seed plant; the egg-containing unit of the ovary.

Oxalates Salts of oxalic acid, a carboxylic acid that can occur in plant tissue either as the free acid (e.g., rhubarb leaves) or as salts in the form of calcium oxalate, potassium oxalate, or sodium oxalate. Ingestion of the soluble oxalates by animals results in the formation of calcium oxalate crystals, which when deposited in the kidneys and other organs can cause serious mechanical damage; calcium deficiencies can also result; calcium oxalate also occurs in some plant tissues in the form of raphides or needle-like crystals; e.g., in Araceae.

P

Palate The raised portion within the throat of a bilaterally symmetrical corolla.

Pale (= Palea) A chaffy scale or bract on the receptacle of many Asteraceae, often subtending the fruit; see chaff.

Palea (a) In Poaceae, the inner (= uppermost) bract of a floret, often partly enclosed by the lemma; (b) (= pale) the receptacular scale or bract in Asteraceae; see chaff.

Paleaceous Chaffy; with small membranaceous scales.

Pallid Pale in color.

Palmate Attached or radiating from one point, as leaflets in a palmately compound leaf, veins in some leaf blades, or fingers of a hand.

Palmately compound With the leaflets attached at one point at the apex of the petiole, like the fingers all attached to the palm of a hand.

Palmately trifoliolate Having three leaflets with the terminal leaflet unstalked, sessile.

Palmatifid Cut so as to appear nearly palmately compound.

Paludal Growing in marshes.

Pandurate, **Panduriform** Fiddle-shaped; obovate with a contraction on each side.

Panicle A branched usually elongate (not flat-topped) inflorescence with flowers on the branches of the primary axis; a compound racemose inflorescence. Panicles are indeterminate.

Paniculate Resembling a panicle.

Paniculiform Having the form and appearance but not necessarily the structure of a panicle.

Pannose Having the texture or appearance of woolen cloth or felt.

Papilionaceous, **Papilionoid** Descriptive of a flower having a bilaterally symmetrical corolla composed of a banner (= standard), two lateral wing petals, and a keel of two fused petals; descriptive of flowers characteristic of many Fabaceae in the subfamily Papilionoideae.

Papilla (pl. Papillae) Small pimple-like or nipple-like projection.

Papillate, **Papilliform**, **Papillose** Shaped like or bearing papillae.

Pappus The crown of bristles, awns, scales, etc. at the apex of the achene of most Asteraceae, thought to be the modified calyx.

Papyraceous Papery.

Parallel-veined With main veins parallel to each other. Such leaves are typical of many monocots.

Paraphyletic A term used to describe a taxonomic group consisting of an ancestral species and some but not all of its descendants. Paraphyletic groups can give an inaccurate view of phylogeny but are often useful in classification; see Appendix 6 for discussion.

Parasite A plant that derives its food, mineral nutrition, and/or water wholly or chiefly from another plant (the host) to which it is attached; contrasting with epiphyte, saprophyte, or autophyte.

Parasitic Deriving food, mineral nutrition, water, or any combination from another living organism (the host).

Parietal Located on the inner side of the exterior wall of the ovary.

Parietal placentation Placentation with ovules attached to the ovary wall instead of the axis.

Paripinnate Referring to a pinnately compound leaf with an even number of leaflets or pinnae.

Parted (a) Cut nearly but not quite the distance from the margin to midrib or from the apex to base; (b) more generally, any deep cut; (c) as a suffix can be combined with a numerical prefix to indicate the number of segments.

Parthenogenetic Developing without fertilization.

-partite A suffix synonymous with -parted.

Patelliform Disk-shaped; circular with narrow rim.

Patent Spreading.

Pauci- Latin prefix denoting few.

Pectinate With narrow closely set segments or units similar to the teeth of a comb.

Pedate Palmately divided with the lateral segments again divided.

Pedicel (a) Stalk supporting a single flower of an inflorescence; (b) in grasses the stalk supporting a single spikelet.

Pedicellate, **Pediceled**, **Pedicelled** Borne on a pedicel; contrasting with sessile.

Peduncle Stem or stalk of an inflorescence, flower cluster, or of the only flower in an inflorescence.

Peduncular Pertaining to or on a peduncle.

Pedunculate With a peduncle.

Pellicle A thin skin or filmy covering.

Pellucid Clear, almost transparent.

Peltate Shield-shaped, with stalk attached on the undersurface away from the margin or base (sometimes attached at the middle like the axis of an umbrella).

Pendent, **Pendulous** Hanging down or suspended.

Penicillate Like a brush, usually referring to a tuft of hairs.

Pentagonal Shaped like a pentagon; five-sided or -angled.

Pentamerous Having the parts in fives.

Pepo A specific type of fruit usually associated with the Cucurbitaceae; a many-seeded fruit with a hard rind; e.g., gourd.

Perennating Surviving from growing season to growing season.

Perennial Root system or plant living at least three growing seasons (years); lasting from year to year.

Perfect flower One with both functional stamens and pistils; a bisexual flower.

Perfoliate Referring to a sessile leaf or bract whose base completely surrounds the stem, the latter seemingly passing through the leaf or with two leaves basally united around the stem.

Perforate Having translucent dots that look like small holes, or pierced through.

Peri- Greek prefix denoting around, enclosing.

Perianth Collective term for the corolla and calyx, often used when corolla and calyx are not well differentiated.

Pericarp Fruit wall; structure enclosing the seeds in angiosperms. The pericarp can be subdivided into endocarp, mesocarp, and exocarp.

Perigynium Urn-shaped, sac-like or pouch-like structure surrounding the pistil in *Carex* (Cyperaceae).

Perigynous Having floral organs united forming a tube (= floral tube) surrounding but not adnate to the pistil, the floral organs thus borne around (versus above or below) the ovary.

Peripheral On or near the margin.

Perisperm The nutritional material of a seed surrounding the embryo and formed outside the embryo sac.

Perisporium, **Perispore** A thin envelope enclosing a spore.

Pernicious Highly hurtful or harmful.

Persistent Remaining attached; not falling off; contrasting with deciduous.

Personate Referring to a strongly two-lipped corolla with the throat closed by a palate.

Petal One of the next-to-outermost whorl of parts in a complete flower; a segment of the corolla; the inner series of floral "leaves." The petals are collectively referred to as the corolla.

Petaliferous Bearing petals.

Petal-like (= Petaloid) Having the character or appearance of a petal, usually showy.

Petaloid (= Petal-like) Having the character or appearance of a petal, usually showy.

Petiolar Pertaining to or located on the petiole.

Petiolate With a petiole.

Petiole Stalk of a leaf supporting the blade.

Petiolulate Having a petiolule.

Petiolule Stalk supporting a leaflet.

Phanerogam A seed plant or spermatophyte; contrasting with cryptogam.

Phenolic, **Phenol** An aromatic alcohol; more technically, a substance with an alcohol (= hydroxyl) group attached to an aromatic (= benzene or phenyl) ring structure. Plant phenolics are sometimes toxic; a number of plant resins or resinoids are phenolic in nature; e.g., urushiol from poison ivy, tetrahydrocannabinol (THC) from marijuana; other phenolic compounds include vitamin E and anthocyanins.

Phenology Study of the times at which various events occur in the life of a plant or a flower.

Phloem The food-conducting tissue in a plant.

Photodermatitis Skin inflammation resulting from increased sensitivity to sunlight, often caused by exposure to certain plants or plant-derived materials.

Photosynthesis The process by which plants convert carbon dioxide and water into carbohydrates in the presence of light.

Phyllary (= Involucral bract) One of the bracts subtending a head in the Asteraceae.

Phylloclade (= Cladophyll, Cladode) A portion of stem having the general form and function of a leaf.

Phyllode, **Phyllodium** An expanded bladeless petiole; a leaf reduced to a flattened petiole. These structures typically serve the photosynthetic function of a blade.

Phyllodial Having the character of a phyllode.

Phyllotaxy Arrangement of the leaves on their axis.

Phylogeny The evolutionary history of a group.

Phytophotodermatitis Plant-induced skin inflammation resulting from increased sensitivity to sunlight.

Phytotoxic Term used to describe materials that are toxic to plants.

Phytotoxin (a) General term for a plant-derived toxin; (b) more typically used to refer to toxic plant proteins or toxalbumins; e.g., ricin from *Ricinus*.

Pilose With long, soft, ± straight hairs; softer than hirsute, not flexuous or curved as in villous.

Pilosulous Diminutive of pilose.

Pinna (pl. Pinnae) A primary division of a compound leaf. A pinna can be simple (and thus equivalent to a leaflet) or compound and divided into leaflets. The term is frequently used in describing fern leaves—here the term is used for any primary division of a leaf (e.g., a leaflet or a leaf division divided into leaflets). In flowering plants the term is generally used to describe a primary division of a decompound leaf (a pinna is thus divided into leaflets).

Pinnate, **Pinnatley compound** Descriptive of a compound leaf with leaflets distributed along both sides of an elongate axis; feather-like. Bipinnate or 2-pinnate leaves have the leaflets distributed along a secondary axis; tripinnate or 3-pinnate leaves have the leaflets along a tertiary axis, etc.

Pinnately trifoliate Referring to trifoliate leaves in which the terminal leaflet is extended beyond the other two by having a distinct petiolule.

Pinnatifid Pinnately divided into stalkless segments, but the segments not distinct leaflets (i.e., not divided all the way to the midrib).

Pinnatisect Pinnately divided to the midrib.

PINNIPALMATE Descriptive of a leaf exhibiting a combination of pinnate and palmate arrangements of the leaflets.
PINNULE A secondary pinna; division of a pinna or a leaflet.
PISIFORM Pea-shaped.
PISTIL The female reproductive organ of a flower consisting of the ovary, stigma, and style. Pistils can be either simple (of one carpel) or compound (with > one carpel); the pistils are collectively referred to as the gynoecium.
PISTILLATE With only the female reproductive structures being functional or with female reproductive structures only.
PISTILLODE, **PISTILLODIUM** A rudimentary or vestigial pistil.
PITH The soft spongy center of a stem.
PITTED Having little depressions or cavities.
PLACENTA (pl. PLACENTAE) Place of attachment of the ovule(s) within an ovary.
PLACENTATION Arrangement of placentae and thus ovules in an ovary.
PLAIT A lengthwise fold or pleat.
PLAITED (= Plicate) Folded like a fan.
PLANE With a flat even surface.
PLANO- A suffix denoting flat.
PLEATED Folded.
PLICATE (= Plaited) Folded like a fan.
-**PLOID** A suffix used in genetics, prefixed by a term indicating number, to denote the number of sets of chromosomes in the nucleus.
PLUMOSE Feathery; descriptive of a long hair with long, slender, lateral hairs.
POD A legume or, more generally, a dry dehiscent fruit; sometimes loosely synonymous with capsule.
POLLEN, **POLLEN GRAIN** The microscopic spheroidal structures that produce the male cells and borne within the anther of a flowering plant or on the microsporophyll of a gymnosperm; technically microgametophytes develop from microspores.
POLLEN SAC A microsporangium containing pollen. In angiosperms there are typically four pollen sacs per anther.
POLLEN TUBE The slender tube that develops from a pollen grain, penetrates the tissue of the ovary, and enters the ovule.
POLLINATE To transfer pollen from a stamen to a stigma.
POLLINATION The act or process of pollinating.
POLLINIUM (pl. POLLINIA) A mass of coherent pollen, as developed in Asclepiadaceae and Orchidaceae.
POLY- Greek prefix meaning many.
POLYADELPHOUS With several groups of stamens.
POLYGAMO-DIOECIOUS Descriptive of dioecious plants having some perfect flowers; bearing on one plant flowers partly perfect and partly pistillate, on another plant flowers partly perfect and partly staminate.
POLYGAMO-MONOECIOUS Descriptive of monoecious plants having some perfect flowers; bearing partly perfect, partly unisexual flowers.
POLYGAMOUS Bearing unisexual and bisexual flowers on the same plant.
POLYMORPHIC Of various forms; with three or more forms.
POLYPETALOUS (= Apopetalous) With corolla of separate petals; contrasting with gamopetalous.
POLYPHYLETIC A taxonomic group having species derived from more than one common ancestor, the species having been placed in the same group because of similarities due to convergent or parallel evolution. Polyphyletic taxa give an inaccurate view of phylogeny.
POLYPLOID A plant with three or more basic sets of chromosomes.
POLYSEPALOUS (= Aposepalous) Composed of or possessing separate sepals.
POLYSTICHOUS Arranged in several longitudinal rows.
POME A fleshy indehiscent fruit developing from a compound inferior ovary embedded in receptacular or floral cup tissue; e.g., apples or pears.
PORE A small aperature or opening; e.g., opening at end of anther in *Solanum* species.
PORICIDAL Opening by pores.
PORULUS Somewhat porous (= pierced with small round holes).
POSTERIOR Describing the position of an organ located on the side adjacent to the axis. In flowers, the upper lip is posterior, the lower anterior.
PRAEMORSE Short and truncate at the base, as if eaten or chewed off; descriptive of the rhizomes in some species of *Viola* and *Hieracium.*
PRECOCIOUS Developing or appearing very early; denoting flowers that appear in advance of the leaves.
PREHENSILE Clasping or grasping; e.g., tendrils.
PRICKLE A slender, sharp, epidermal outgrowth without vasculature; e.g., the armature of roses.
PRIMOCANE The first year's shoot of woody biennials, typically non-flowering; e.g., *Rubus*.
PRISMATIC Angulate with flat sides; shaped like a prism.
PROCUMBENT Trailing or prostrate, not rooting.
PROLIFEROUS Bearing or developing offshoots or redundant parts; producing numerous new individuals, or parts, of the same kind; bearing offsets, bulbils, or other vegetative progeny.
PROPHYLL, **PROPHYLLUM** (a) In the Poaceae, the first leaf of a lateral shoot or vegetative culm branch, consisting of a sheath without a blade; (b) bracteole subtending an individual flower; e.g., in some species of *Juncus*.
PROPHYLLATE Furnished with prophylls.
PROSTRATE Lying flat.
PROTANDROUS, **PROTERANDROUS** Having the anthers mature before the pistils in the same flower.
PROTHALLUS, **PROTHALLIUM** Gametophyte stage or generation in ferns and fern-allies, bearing the sexual organs.
PROTOGYNOUS Having the stigma receptive to pollen before pollen is shed from the anthers of the same flower.
PROTUBERANCE A protrusion, swelling, bump, or bulge.
PROXIMAL Located nearest to the base or attachment point of a structure; contrasting with distal.
PRUINOSE Having a bloom on the surface; with a waxy or powdery secretion; with a surface coating more pronounced than glaucous.
PSEUDO- Greek prefix meaning false, not genuine.
PSEUDOANTAGONISM Pollination system (e.g., in some Orchidaceae) in which a flower mimics a male insect, thereby attracting a male insect that "fights" with the flower in an effort to protect his territory. In the process of repeating this activity, pollen can be transferred from one plant to another.

Pseudobulb The thickened or bulb-like, above ground stems of certain orchids.

Pseudocarp A structure made up of the mature ovary combined with some other organ; e.g., the hip of a rose.

Pseudocopulation Pollination system (e.g., in some Orchidaceae) in which a flower mimics a female insect (e.g., wasp or fly), thereby attracting male insects who copulate with the flowers and in the process of repeating this activity transfer pollen from one plant to another.

Psychoactive Mind altering. A number of psychoactive materials are produced by plants.

Pteridology The study of ferns and similar plants.

Pteridophyte A fern or similar plant; any member of the Lycopodiophyta, Psilophyta, Polypodiophyta (formerly Pteridophyta), or Equisetophyta (formerly Sphenophyta).

Puberulent Minutely pubescent.

Pubescence The covering or indumentum of hairs on a plant without reference to specific type (e.g., pilose, hirsute).

Pubescent (a) General term for covering or indumentum of hairs; (b) sometimes used in a more restricted sense to refer to fine short hairs; downy.

Pulp The juicy or fleshy tissue of a fruit.

Pulvinate With a pulvinus; cushion-shaped.

Pulvinus The swollen base of a petiole, as in many Fabaceae. The structure is often involved in leaf movements.

Punctae Dots, depressions, or pits, commonly glandular in nature.

Punctate With translucent or colored dots, depressions, or pits.

Puncticulate Minutely punctate.

Pungent (a) Ending in a rigid sharp point or prickle; (b) acrid to the taste or smell.

Purpurascent Becoming or turning purple.

Pustulate With pustules, blisters, or blister-like swellings.

Putamen The bony endocarp or "pit" of some fruits.

Pyrene The "nutlet," "pit," or stone in a drupe or drupelet; a seed together with the bony endocarp.

Pyriform Pear-shaped.

Pyxis (pl. Pyxides) A capsule with circumscissile dehiscence, the top coming off as a lid; e.g., in *Plantago*.

Q

Quadr- Latin prefix meaning four.

Quadrangular Four-cornered; square.

Quadrate Nearly square.

Quasi- Prefix meaning "as if."

R

Raceme An unbranched (= simple) inflorescence with pedicelled flowers from an elongate main axis. Racemes are indeterminate.

Racemiform Having the form but not necessarily the technical character of a raceme.

Racemose In racemes or resembling a raceme.

Rachilla (a) A small rachis; (b) specifically the axis of a spikelet in the Poaceae.

Rachis (a) Leaflet-bearing central axis of a pinnately compound leaf; (b) axis of an inflorescence.

Radially symmetrical Descriptive of a structure that can be cut into halves from any marginal point through the center. When used in reference to flowers, the term is synonymous with actinomorphic or regular.

Radiate (a) Spreading from a common center; (b) in Asteraceae, describing a head with disk florets in center and a whorl of ray (= ligulate) florets around the periphery.

Radiate head In Asteraceae, a head with both peripheral ray (= ligulate) florets and central disk florets.

Radical leaves Leaves arising from a root crown; basal leaves.

Radicle Embryonic root of a germinating seed.

Rameal Pertaining to or located on a branch.

Ramification The arrangement of branching parts.

-ranked Suffix, when combined with a numerical prefix, indicating the number of longitudinal rows in which leaves or other structures are arranged along an axis or rachis.

Raphide Needle-shaped crystal in a plant cell, typically of calcium oxalate.

Raphidulous Resembling or having raphides.

Ray (a) Flat or strap-shaped type of corolla found in many Asteraceae; (b) primary branch of a compound umbel.

Ray floret (= Ligulate floret) Flower, with corolla expanded into a ligule, typical of many Asteraceae.

Receptacle (a) (= Torus) Tip of a stem or pedicel, usually more or less enlarged, on which flower parts are attached; (b) in Asteraceae, the structure on which the florets of a head are attached.

Receptacular Referring to the receptacle.

Reclined, **Reclinate** Bent or turned downward.

Recumbent Leaning or reclining.

Recurved Curved downward or backward.

Reduced Small but probably derived from larger forerunners.

Reflexed Abruptly bent downward.

Regular (= Actinomorphic or Radially symmetrical) Referring to a structure that can be cut into halves from any marginal point through the center; with the parts in each series alike or uniform. The term usually refers to flowers.

Relic (a) A long-surviving species whose relatives have become extinct; (b) a plant persisting in a relatively small portion or portions of its former range.

Remote Widely or distantly spaced.

Reniform Kidney-shaped.

Repand With a shallowly sinuate, undulating, or slightly wavy margin; less strongly wavy than sinuate.

Repent Creeping and rooting at the nodes.

Replicate Folded backward.

Replum The partition between the halves of a fruit; e.g., Brassicaceae.

Resin, **resinoid** A miscellaneous or catchall term for a variety of amorphous, sometimes semisolid, perhaps gummy substances from plants. A number are toxic, sometimes extremely so; some are terpene derivatives while others are phenolic compounds; examples of phenolic resins are tetrahydrocannabinol (THC) from marijuana, urushiol from poison ivy, and hypericin from *Hypericum perforatum*.

Resinous, **Resiniferous** Producing or bearing resin.

Resupinate Upside down; inverted; turned 180 degrees; e.g., some members of the Fabaceae and Orchidaceae have resupinate flowers.

Reticulate Net-veined or with a net-like pattern.

Retinaculum (pl. Retinacula) (a) In Asclepiadaceae, the filament-like band connecting a pollinium to the gland-like corpusculum; (b) in Acanthaceae, the curved, hook-like, modified funiculus that retains the seed until maturity.

Retrorse Bent or turned backward or downward; e.g., hairs pointing down a stem, the free end of the hair below or proximal to the attached end; contrasting with antrorse.

Retrorsely barbed With barbs (= points) pointing downward toward base.

Retuse Shallowly notched at a rounded apex.

Revolute With margins rolled down and inward; e.g., revolute leaves.

Rhizoid A filamentous root-like structure (without the anatomy of a root) on the gametophyte of ferns or other non-seed-producing plants.

Rhizomatous Possessing a rhizome.

Rhizome Underground stem with nodes and scale leaves.

Rhizophore In certain Pteridophytes, a specialized leafless stem emitting roots.

Rhombic Somewhat diamond-shaped; shaped like two adjacent equilateral triangles.

Rhomboid, **Rhomboidal** A three-dimensional rhombic figure.

Rib (a) One of the principal longitudinal veins of a leaf or other organ; (b) ridge on a fruit.

Ribbed With prominent ribs or veins.

Ringent Gaping; open.

Root The portion of the main axis (or one of its subdivisions) of a plant usually found below ground and lacking nodes, internodes, or leaves.

Rootlet (a) A little root; (b) term often applied to the holdfast roots of certain climbing plants.

Rootstock According to Shinners (1958), a "weasel-word" indicating an elongate crown, rhizome, or rhizome-like structure; an old inaccurate term for rhizome.

Roseate Rosy or pinkish.

Rosette A cluster or whorl of leaves or other organs closely arranged in a radial pattern.

Rostellate Diminutive of rostrate.

Rostellum (a) A small beak; (b) in Orchidaceae, an extension from the upper edge of the stigma.

Rostrate Beaked.

Rostrum A beak or any beak-like extension.

Rosulate In rosettes.

Rosy The rich pink characteristic of the petals of some roses.

Rotate Wheel-shaped or saucer-shaped as in a sympetalous corolla with an obsolete or very short tube and a flat circular limb.

Rotund Essentially circular in outline.

Ruderal Weedy or growing in waste places.

Rudiment A structure very imperfectly developed, non-functional, or represented only by a vestige; e.g., rudimentary non-functional florets in some grass spikelets.

Rudimentary Having the character of a rudiment.

Rufescent Becoming reddish brown.

Rufous Reddish brown.

Rugose Wrinkled.

Rugulose Diminutive of rugose.

Ruminate Appearing as through chewed or wadded; roughly wrinkled.

Runcinate With margins that are coarsely serrate to sharply incised with the segments pointing toward the base, as in *Taraxacum*.

Runner An elongate, slender, prostrate stem taking root at the nodes or tip.

Rupturing Bursting open along irregular lines.

Russet Reddish brown.

S

s South.

Sac A pouch or bag.

Saccate Sac-like; pouch-like.

Sagittate With the form of an arrowhead; triangular with the basal lobes pointing downward or inward toward the petiole.

Salient Projecting forward.

Saline Of or pertaining to salt.

Salverform Descriptive of a corolla having a narrow, nearly straight basal tube, abruptly expanded at top into a flattened or saucer-shaped limb.

Samara A dry, indehiscent, winged fruit; a fruit that is achene-like but with a flat wing; e.g., in maple, *Acer* (Aceraceae).

Sap The juice of a plant.

Saponaceous Soapy, slippery to the touch.

Saponic or **Saponin glycoside** A glycoside (two-component molecule) that upon breakdown yields a saponin.

Saponin A soap-like molecule that lowers the surface tension of aqueous solutions. Saponins usually have a bitter acrid taste and are commonly irritating to mucous membranes; chemically saponins are either triterpenes or steroids; they can alter the permeability of cell membranes and may react with proteins and are thus potentially toxic; they are highly toxic to cold-blooded animals and have long been used to stun fish.

Saprophyte A non-photosynthetic plant without chlorophyll, deriving its food from dead organic material in the soil by mycorrhizal relationships or otherwise; e.g., *Monotropa* (Ericaceae).

Saprophytic Subsisting on dead organic matter.

Saxicolous Growing on rocks.

Scaberulous Minutely scabrous.

Scabridulous Slightly rough.

Scabrous Rough to the touch due to short stiff hairs or the structure of the epidermis.

Scalariform Ladder-like.

Scale Any small, thin, usually dry, appressed leaf or bract, often only vestigial.

Scalloped Crenate.

Scandent Climbing without aid of tendrils.

Scape A naked (leafless but scales or bracts may be present) flowering stem or stalk arising from the ground.

Scapiform Resembling a scape.

Scapose Bearing or resembling a scape.

Scarious Membranous, dry, papery, translucent or transparent, not green.
Scattered Distributed in an irregular manner; not clustered together.
Schizo- Greek preffix meaning split or divided.
Schizocarp A fruit that splits between carpels into one-seeded portions (= mericarps); e.g., in the Apiaceae or Boraginaceae.
Sciophyte A plant adapted to grow in or tolerate shade.
Scimitar-shaped With the shape of a curved sword or scimitar.
Sclerenchyma An internal tissue composed of hard, thick-walled cells.
Sclerenchymatous Having sclerenchyma.
Sclerotic Hardened; stony in texture.
Scorpioid Uncurling, like a scorpion's tail.
Scrobiculate Marked by minute or shallow depressions.
Scrotiform Pouch-like.
Scrub Vegetation of stunted or densely crowded bushes.
Scurfy With whitish, scaly, blister-like structures or scales on the surface.
Scutellum A shield-like protrusion on the calyx; e.g., in some Lamiaceae.
Second glume The uppermost of the two glumes of a grass spikelet.
Secondary compounds Naturally occurring plant materials not essential to the primary (= life-sustaining) metabolism of the plant; examples of categories include alkaloids and glycosides. Many are significant because of their physiological activity when given to animals; they are probably important to plants in defense against herbivores or microbes.
Secund Directed to one side; arranged on one side only; unilateral; one-sided.
Seed A fertilized ripened ovule, covered by a seed coat [developed from the integument(s)] and containing the embryo and in flowering plants the endosperm. The seed also contains the remnants of the nucellus (= sporangium) and megagametophyte.
Seed coat (= Testa) Outer covering of a seed, developed from the integument(s).
Seep A moist spot where underground water comes to or near the surface.
Segment One of the parts of a leaf, petal, or calyx that is divided but not truly compound.
Segregate Term used as a noun or adjective to refer to or describe a taxon that is sometimes recognized separately from a more inclusive group; e.g., depending on authority, the segregate, *Tovara* (or the segregate genus, *Tovara*), is either included in, or recognized separately from, the more inclusive genus *Polygonum*.
Seleniferous Containing selenium.
Selenium An element that is concentrated in the tissues of some plants (e.g., poison-vetches in genus *Astragalus*) and can cause a toxic, sometimes fatal response in livestock.
Self-fertile Capable of self-fertilization (= union of gametes from same plant).
Self-incompatible Incapable of self-fertilization.
Semi- Latin prefix meaning half.
Semiparasitic (= Hemiparasitic) Descriptive of a plant that carries out photosynthesis but obtains some of its food, mineral nutrition, or water needs from another living organism (the host).
Senescent Aging or aged.
Sensu lato "In a broad sense"; used to refer to the broad treatment of taxa; e.g., a genus sensu lato is one that has not been split into a number of segregates.
Sensu stricto "In a narrow sense"; used to refer to a restricted or narrow treatment of a taxonomic group; e.g., a genus sensu stricto is viewed in a more restricted sense than previously as the result of segregating or splitting out various taxa.
Sepal A single unit of the calyx; one of the outermost whorl of parts in a complete flower. Sepals typically cover the other flower parts during the bud stage; they are collectively referred to as the calyx.
Sepaloid Sepal-like, usually green and thicker in texture than a petal.
Separate Not joined; of individual units.
Septate With partitions or divisions.
Septicidal Descriptive of a capsule that dehisces along or through the septa or partitions separating its locules or seed chambers; contrasting with loculicidal.
Septifragal Breaking away at the partitions, as the valves of a capsule.
Septum A partition or cross wall within an organ; e.g., the septa of an ovary or of the leaf of a rush (*Juncus*).
Seriate, **Serial** With series or distinct rows.
Sericeous Silky; with appressed, fine, and straight hairs.
Serotinous Literally, "late"; in *Salix* indicating those species in which the catkins develop later than the leaves; produced or occurring late in the season.
Serrate With pointed teeth sloping forward; saw-toothed.
Serrulate Finely serrate.
Sessile Without a pedicel, petiole, or stalk; inserted directly.
Seta (pl. Setae) A bristle.
Setaceous Bristle-like.
Setiferous Bearing bristles.
Setiform Resembling a bristle.
Setose Bearing bristles.
Setulose Diminutive of setose.
Sheath (a) ± tubular structure surrounding an organ; portion that clasps or encloses; (b) specifically, the basal tubular portion of the leaf in grasses and grass-like plants between the node and the blade.
Shoot (a) A young stem or branch; (b) the ascending axis of a plant.
Shoulder That part of an organ that rather abruptly curves inward.
Shrub A woody perennial usually branching from the base with several main stems.
Sigmoid S-shaped; doubly curved.
Silica Silicon dioxide; a white or colorless, very hard, crystalline mineral substance.
Siliceous Containing or composed of silica (the principal component of glass and sand); e.g., descriptive of certain hairs, with high silica content, that easily break off in the flesh.
Silicle, **Silicula** A short silique; short and broad capsular fruit

of the mustard family. A silicle is not much longer than broad; sometimes defined as < 3 times as long as broad.

Silique, **Siliqua** Dry, dehiscent, variously shaped, many-seeded, 2-valved capsule with valves splitting from the bottom and leaving a false partition known as a replum; the fruit type typical of the mustard family. The term is sometimes restricted to long and narrowly cylindrical fruits 3 times as long as broad or longer; shorter fruits with the same structure are then referred to as silicles.

Silky Sericeous; with appressed, fine, and straight hairs.

Silvery With a whitish, metallic, more or less shining luster.

Simple (a) Single, of one piece, not compound, as a pistil of one carpel; (b) descriptive of an unbranched stem, inflorescence, or other structure; (c) descriptive of a leaf that is not compound.

Simple leaf Single-bladed leaf, not divided into individual leaflets.

Simple pistil Pistil composed of only one carpel (and with a single style branch).

Sinuate, **Sinuous** Having the margin wavy with regular strong indentations.

Sinus The space or recess between two lobes, segments, or divisions of a leaf or other expanded organ.

Slough A wet place or deep mud or mire; a sluggish channel.

Smooth Not rough to the touch; without vestiture or other special covering.

Sobol A basal shoot.

Soboliferous Producing basal shoots, clump-forming.

Solitary Borne singly.

Sordid Dirty white.

Sorus (pl. Sori) A cluster or heap of sporangia. The term is used mainly to refer to the sporangial clusters of ferns.

Spadix (pl. Spadices) Fleshy spike with inconspicuous flowers, usually surrounded or partially enclosed by a spathe; e.g., characteristic of Araceae.

Spathaceous, **Spathiform** Resembling a spathe.

Spathe Enlarged leafy bract surrounding or partially enclosing an inflorescence.

Spatulate Spatula-shaped; rounded above and gradually narrowed to base.

Species Unit of classification below the rank of genus; a group of individuals that are actually or potentially capable of interbreeding in natural populations and are reproductively isolated from other such groups. Generally there are morphological characteristics that distinguish and can thus be used to separate such groups; the definition is complicated by instances of asexual reproduction.

Specific epithet The second half of the scientific name of a species, the scientific name being composed of the generic name and the specific epithet.

Spermatophyte A plant that produces seeds; all gymnosperms and angiosperms.

Spherical Globular; orbicular.

Spicate In spikes or resembling a spike.

Spiciform Having the form of a spike but not necessarily the technical structure.

Spike Indeterminate inflorescence with sessile flowers on an ± elongate floral axis.

Spikelet The basic unit of the grass inflorescence, usually consisting of a short axis (= rachilla) bearing two empty bracts (= glumes) at the basal nodes and one or more florets above. Each floret usually consists of two bracts (the lemma = lower bract, and the palea = upper bract) and a flower. The flower usually includes two lodicules (= vestigial perianth segments that become turgid and open the bracts at flowering time), three stamens, and a pistil. The term spikelet is also used to refer to the basic unit of the inflorescence in the Cyperaceae.

Spine A sharp-pointed structure, usually vascularized and thus ± stout or woody, generally modified from part or all of a leaf or stipule. A spine is sometimes distinguished from a thorn, which is a modified branch.

Spinescent Becoming spine-like; ending in a spine; having spines.

Spiniferous, **Spinose** Having spines.

Spinulose With small spines over the surface, margin, or edge.

Spiral Describing the arrangement of like organs, such as leaves, at regular angular intervals along an axis.

Spiral thickening Thickening of the walls of a xylem cell laid down in the form of a spiral.

Splitter A taxonomist who in general has the tendency to split or divide larger taxa into a number of segregates; contrasting with lumper.

Spongiose Soft, spongy.

Sporadic Of irregular occurrence.

Sporangiophore An appendage holding a sporangium.

Sporangium (pl. Sporangia) A spore case or spore sac.

Spore An asexual, usually one-celled reproductive body; a cell resulting from meiotic cell division in a sporangium representing the first cell of the gametophyte generation.

Sporocarp A specialized structure containing sporangia.

Sporophyll Spore-bearing leaf.

Sporophyte The spore-producing, typically diploid generation that alternates with the gametophyte (= gamete-producing, typically haploid); the dominant generation in most plants except mosses and liverworts.

Spreading Diverging to the side, almost to the horizontal.

Spreading hairs Hairs that are ± erect, not at all appressed.

Spur (a) Basal, sac-like, hollow projection, short or long and narrow, from a corolla or calyx and often containing nectar; (b) a short lateral branch with little internode development resulting in closely clustered leaves or flowers.

Squama (pl. Squamae) A scale, usually reduced from and homologous to a leaf.

Squamella (pl. Squamellae) A tiny or secondary scale.

Squamose, **Squamate** Covered with scales; scaly.

Squamulose With small scales.

Squarrose Spreading rigidly at right angles or more; e.g., with leaves or bracts spreading and bending backward abruptly in the upper part.

Stalk The supporting structure of an organ; e.g., petiole, pedicel, peduncle.

Stamen The male reproductive organ of a flower consisting of a filament (= stalk) and anther (= pollen-bearing structure). The stamens of a flower are collectively referred to as the androecium.

Staminal Pertaining to a stamen.

Staminate Referring to a flower with only the stamens being functional or with stamens only.

STAMINODE, STAMINODIUM (pl. STAMIDODIA) An abortive, sterile, or nonfunctional stamen with reduced anther or usually none. A staminode can be enlarged or widened, sometimes so much so as to be petal-like.

STANDARD (a) (= Banner) The usually large, upper (= adaxial) petal of a papilionaceous flower (Fabaceae); (b) the inner erect tepals or perianth segments in *Iris* (Iridaceae).

STELE The central vascular cylinder of a plant.

STELLATE Star-shaped or star-like; when used in reference to hairs it means those branched hairs with a central stalk and branch hairs arising at the top of the stalk (like points of light coming out of a star).

STEM A major division of the plant-body in contrast to root and leaf, distinguished from both by certain anatomical features and commonly also by general aspect; the main axis or axes of a plant; the portion of the plant axis bearing nodes, leaves, and buds and usually found above ground.

STERIGMA (pl. STERIGMATA) A very short persistent stipe or stalk.

STERILE Unproductive; nonfruiting; without functional sex organs; without spores.

STERNOTRIBAL Descriptive of flowers in which anthers are positioned to dust pollen on underside of thorax of insects.

STEROID Any of a large group of lipid soluble organic compounds based on a complex framework of four interconnected rings of carbon atoms. A number of plant glycosides have steroids as the aglycone; these aglycones are often toxic.

STEROID GLYCOSIDE A glycoside (two-component molecule) that upon breakdown yields a steroid as the aglycone (= non-sugar component). Cardiac glycosides and some saponic glycosides have steroidal aglycones; these are often poisonous.

STIGMA Portion of pistil (usually terminal and small) modified (roughened, sticky, or branched) to catch or receive pollen; the receptive surface of the pistil.

STIGMATIC Like or pertaining to a stigma.

STIPE (a) In general, a stalk; (b) specifically, the leaf stalk of a fern; (c) specifically, the narrow, stalk-like, basal portion of an ovary or fruit; e.g., in *Cleome*.

STIPEL Appendage at the base of a leaflet, analogous to a stipule at base of a leaf.

STIPELLATE With stipels.

STIPITATE With a stalk or stipe.

STIPULAR Pertaining to or located on a stipule.

STIPULATE With stipules.

STIPULE Paired appendages subtending the petiole of a leaf. Stipules can be conspicuous and persistent, small and rapidly lost, or totally lacking; the evolutionary origin and original function of stipules are unclear. They have become variously modified to serve as spines, additional photosynthetic area, etc.

STOLON A creeping horizontal stem that loops or runs along the surface of the ground and roots at the nodes.

STOLONIFEROUS Producing stolons.

STOMA, **STOMATE** (pl. STOMATA) A minute opening (= "breathing" pore) between the epidermal cells of a leaf or stem through which gases and water-vapor enter and leave the plant.

STOMATIFEROUS Bearing stomata.

STONE Bony endocarp of a drupe.

STONE CELLS (= Grit cells) Individual cells that have become hardened or sclerotic; e.g., in flesh of a pear.

STRAMINEOUS Straw-colored.

STRIATE With fine longitudinal lines, channels, or ridges.

STRICT Very straight, unbranched, upright.

STRIGILLOSE, STRIGULOSE Diminutive of strigose.

STRIGOSE With sharply bent (at base) but otherwise straight, appressed hairs.

STROBILUS (pl. STROBILI) (= Cone) A usually cone-like, globose or cylindrical structure involved in reproduction and composed of an axis with a spiral, usually dense aggregation of sporophylls, bracts, or scales (these bearing spores, pollen, or seeds).

STROPHIOLATE Having a strophiole.

STROPHIOLE On certain seeds, an appendage to the hilum.

STRUMOSE Descriptive of the surface of an organ bearing cushion-like swellings.

STYLE Portion of pistil between ovary and stigma, often elongated and narrow, frequently branched, with the number of branches often indicative of the number of carpels making up the pistil.

STYLOPODIUM Enlarged base of style as in many Apiaceae.

SUB- Latin prefix meaning almost, somewhat, of inferior rank, beneath.

SUBAPICAL Almost at the apex.

SUBBASAL Almost at the base.

SUBCLASS The unit, category, or rank in classification between class and order, composed of one or more orders; e.g., the Liliidae is a subclass of class Monocotyledonae.

SUBCORIACEOUS Somewhat leathery in texture.

SUBEROSE Corky in texture.

SUBFAMILY The unit, category, or rank in classification between family and genus, composed of one or more genera.

SUBGENUS A unit, category, or rank in classification between genus and species, composed of one or more species.

SUBORDER The unit, category, or rank in classification between order and family, composed of one or more families.

SUBMERGED, **SUBMERSED** (= Immersed) Growing under water.

SUBSESSILE Almost sessile.

SUBSPECIES A unit, category, or rank in classification below the level of species and between species and variety; a geographically distinct variant. The categories of subspecies and variety are not used consistently by taxonomists.

SUBTEND To be present just below; e.g., an involucre of bracts immediately subtends the flowers of some Malvaceae.

SUBTERRANEAN Below ground.

SUBULATE (= Awl-shaped) Tapering from the base to a slender or stiff point; narrow and sharp-pointed.

SUCCULENT Fleshy, thickened.

SUCKER A shoot of subterranean origin. Many tree species have sucker shoots with leaves atypical for the species (e.g., oaks).

SUFFRUTESCENT, **SUFFRUTICOSE** Woody only at base with the upper parts herbaceous and annual; obscurely shrubby or fruticose.

SULCATE Grooved or furrowed longitudinally.

SULCUS A furrow or groove.

SUPERIOR OVARY One that is separate from the other flower parts. The other flower parts may overtop it but are attached at or under its base; a superior ovary is found in either a hypogynous or a perigynous flower.

Supine Laying flat with face upward.

Supra-, **Super-** Latin prefix meaning above.

Supramedial Above the middle; when used to refer to the location of fern sori, it means somewhat beyond the middle of the distance between the leaf segment midvein and margin but not so much so as to be called submarginal.

Suppressed Failing to develop.

Surculose Producing suckers or shoots arising from underground parts.

Surcurrent Extending upward; said of a pinnule whose base extends upward and forms a wing along the rachis; opposite of decurrent.

Suspended Hanging downward.

Suture A line of dehiscence or a longitudinal seam.

Swale A moist meadowy area lower than the surrounding areas.

Swamp Wet or periodically wet area with some trees.

Sym-, Greek prefix meaning with or together.

Symmetrical Possessing one or more planes of symmetry; regular in number and size of parts.

Sympatric Growing together with or having the same range as.

Sympetalous (= Gamopetalous) With petals united, at least basally, forming a tube.

Sympodial With the main axis or stem ceasing to elongate but growth being continued by the lateral branches.

Sympodium An apparent main axis formed of successive secondary axes, each of which represents one fork of a dichotomy, the other being much weaker or entirely suppressed.

Syn- Greek prefix meaning united.

Syncarp (= Multiple fruit) Used to refer to a structure composed of several more or less coalescent fruits from separate flowers; e.g., *Morus* (mulberry), *Maclura* (bois d'arc), *Ananas* (pineapple).

Syncarpous (a) Having carpels united; (b) of or pertaining to a syncarp.

Synconium The multiple, hollow "fruit" of a fig (*Ficus*), which is actually an enlarged fleshy branch or receptacle enclosing the inflorescence (with flowers borne inside). Much of the tissue of a fig is morphologically derived from the stem.

Syngenesious With anthers united into a tube surrounding the style. This condition is typical of Asteraceae.

Synonym A currently unaccepted scientific name for a taxon.

Synonymy Referring to the series of names no longer used for a taxon.

Synsepalous (= Gamosepalous) With sepals united, at least basally, forming a tube.

Systematics Scientific study of the kinds and diversity of living organisms and of the relationships between them. The term is often used synonymously with taxonomy.

T

Tannin A type of phenol (= aromatic alcohol) that can act as a digestion inhibitor by binding up proteins and thus stopping enzymatic action. They are widespread in plants apparently as a chemical defense against herbivores; used by humans to tan leather; when ingested in quantity they can be toxic to animals.

Taproot, **Taprooted** The primary descending root, giving off small laterals but not dividing; the one dominant root markedly larger than the others.

Tawny Dull brownish-yellow; fulvous.

Taxon (pl. Taxa) (a) General term referring to any unit of classification such as variety, subspecies, species, genus, family, etc.; (b) term used to refer to a specific variety, subspecies, etc.

Taxonomy The branch of science that deals with classification, identification, and nomenclature.

Teeth (plural of tooth) Marginal projections, protuberances, serrations, or dentations, usually sharply pointed.

Tendril A slender twining or coiling appendage or axis that enables plants to climb; often a modified leaf or stem.

Tepal Part of a perianth, usually of a perianth consisting of only one whorl, or of one not differentiated into sepals and petals; a part of the outermost whorl or whorls of flower parts.

Teratological Distinctly abnormal; malformed.

Terete Rounded or circular in cross-section, cylindrical.

Terminal At the tip or apex; distal.

Terminal bud (= Apical bud) Bud at the end (= apex) of a stem or branch.

Ternate, **Ternary** In threes.

Terpenes, **Terpenoids** Common organic compounds in plants that are products of acetate metabolism. Numerous kinds are known resulting from variations in the use of 5-carbon isoprene units in their structures; they are often combined with other substances to form complex molecules; essential oils, saponins, some resins, latex, cartenoid pigments, and steroids are examples of compounds that are terpene derivatives.

Terrestrial Growing in the ground; supported by soil; contrasting with aquatic.

Testa (= Seed coat) The outer covering of a seed; hardened mature integument(s).

Tetra- Greek prefix referring to four.

Tetrad A group of four similar objects; e.g., in Ericaceae, the four pollen grains remaining together.

Tetradynamous With four long stamens and two short stamens.

Tetragonal, **Tetragonous** Four-angled.

Tetrahedal Four-sided, as a three-sided pyramid and its base.

Tetramerous (= 4-merous) Having flower parts in fours or multiples of four.

Tetraploid With four sets of chromosomes; twice the normal diploid level.

Thalloid Consisting of a thallus; thallus-like.

Thallophytes Algae and fungi.

Thallus (a) A plant body not differentiated into true leaves, stems, or roots; (b) a flat, leaf-like organ.

Theca (= Anther cell) One of the pollen sacs or locules of an anther.

Thorn A sharp-pointed, stiff, woody structure derived from a modified branch.

Throat The area of juncture of limb and tube in a sympetalous corolla.

Thyrse A panicle-like inflorescence consisting of cymules, usually elongate and slender with main axis indeterminate and the lateral axes determinate.

THYRSOID With the appearance of a thyrse.

TOMENTOSE Covered with short, soft, curly, densely matted or entangled hairs.

TOMENTULOSE Diminutive of tomentose.

TOMENTUM Densely matted wool.

TOOTH (pl. TEETH) Any marginal projection, protuberance, serration, or dentation, usually sharp pointed.

TOOTHED With minor projections and indentations alternating along the margin.

TOPOTYPE A specimen from the original or type locality of that species or other taxon.

TOROSE Alternately contracted and expanded.

TORTUOUS Twisted or bent in different directions.

TORULOSE Cylindrical with slight constrictions at intervals; necklace-like.

TORUS (= Receptacle) Tip of a stem or pedicel, usually more or less enlarged, on which flower parts are attached.

TOXALBUMIN Toxic plant proteins; e.g., ricin from *Ricinus*. The term phytotoxin is also often used in this context.

TRABECULA A transverse partition or cross-bar.

TRABECULAR, **TRABECULATE** Like or with a partition or cross-bar.

TRAILING Prostrate but not rooting.

TRANSLATOR In Asclepiadaceae, the wishbone-shaped combination of the clip (= gland-like corpusculum) and bands (= filament-like retinacula) connecting a pair of pollinia from adjacent anthers.

TRANSLUCENT Allowing the passage of light rays but not transparent.

TRANSVERSE Lying or being across or in a cross direction.

TRAPEZOID A body with four unequal sides.

TREE A woody perennial with usually a solitary trunk or main stem.

TRI- Latin prefix indicating three, or three times.

TRIAD In threes.

TRIBE The unit, category, or rank in classification between subfamily and genus, composed of one or more genera.

TRICHOME Any hair, hair-like projection, or bristle from the epidermal surface.

TRICHOTOMOUS Forking into three equal parts.

TRICOLPATE Three-grooved; e.g., a three-grooved pollen grain.

TRIFID Three-cleft.

TRIFOLIATE Having three leaves. The term is often used synonymously with trifoliolate.

TRIFOLIOLATE Having three leaflets.

TRIFURCATE With three prongs; three-forked.

TRIGONOUS, **TRIGONAL** Three-angled.

TRILOBED, **TRILOBATE** Three-lobed.

TRIMEROUS Having the parts in threes.

TRIMORPHIC Of three forms.

TRINERVED With three primary nerves; triple-nerved; usually with a midrib and two main lateral nerves arising from the base of the midrib.

TRIPARTITE Three-parted.

TRIQUETROUS Three-angled in cross-section.

TRISTICHOUS In three vertical rows.

TRULLATE Trowel-shaped, widest below the middle.

TRUMPET-SHAPED Describing a gamopetalous corolla or gamosepalous calyx in which the tube gradually widens upward.

TRUNCATE Ending abruptly as if cut off squarely at the end; appearing "chopped off."

TUBE The narrow, cylindrical, basal portion of a sympetalous corolla or synsepalous calyx.

TUBER Modified underground stem; stem enlarged and subterranean with nodes, buds, and scale leaves, often serving to store food; e.g. in *Solanum* (potato).

TUBERCLE (a) A small, tuber-like structure; (b) small rounded protuberance or projection from a surface; (c) the persistent style base in some Cyperaceae.

TUBERCULATE Covered with tubercles or warty or nipple-like protuberances.

TUBERIFEROUS Bearing tubers.

TUBEROUS Bearing tubers or resembling a tuber in appearance.

TUBULAR With the shape of a hollow cylinder.

TUFT; **TUFTED** A cluster or fascicle of trichomes, leaves, or other elongate structures.

TUMID Swollen; inflated.

TUNIC A loose, membranous, outer skin or coat.

TUNICATE Describing a bulb in which the leaves are arranged in concentric circles; with coats or tunics.

TURBINATE Top-shaped; inversely conical.

TURGID Swollen but solid or full; contrasting with inflated.

TURION A scaly swollen structure or offshoot, often serving to overwinter; e.g., in some *Myriophyllum* species the turions store carbohydrates and serve as propagules.

TWICE-PINNATELY COMPOUND (= Bipinnate) Descriptive of a leaf with leaflets pinnately arranged on lateral axes that are themselves pinnately arranged on the main axis; with the primary divisions (= pinnae) themselves pinnate.

TWIG A young woody stem; the growth of the current season.

TWO-LIPPED (= Bilabiate) Descriptive of a corolla (or calyx) of united petals (or sepals) cut on the two sides forming an upper and a lower portion.

TYPE A plant specimen to which the name of a taxon is permanently attached. When any new taxon (e.g., species, variety) is named, the name has to be associated with a particular "type" specimen.

U

UBIQUITOUS Occurring everywhere.

UMBEL Usually flat-topped or convex inflorescence with flower pedicels all attached at the same point, like the rays of an umbrella; inflorescence type typical of Apiaceae (Umbelliferae).

UMBELLATE Umbel-like, or in an umbel.

UMBELLET A secondary or ultimate umbel; one of the smaller umbellate flower clusters in a compound umbel.

UMBELLIFORM Resembling an umbel in appearance.

UMBO A rounded elevation or protuberance at the end of or on the side of a solid organ.

UMBONATE With an umbo or projection.

UNCINATE With apex hooked; e.g., hairs with a hook at tip.

UNCINULATE Minutely uncinate.

UNDULATE Gently wavy, less pronounced than sinuate.

UNGUICULATE Narrowed at the base into a claw.

UNI- Latin prefix meaning one.

UNIFOLIATE With only one leaf.

UNIFOLIOLATE Referring to a compound leaf reduced to a single leaflet; e.g., in some members of the Fabaceae.

UNILATERAL One-sided; developed or hanging on one side.

UNILOCULAR Having only one locule or cell.

UNISERIATE Arranged in a single horizontal row.

UNISEXUAL Having only stamens or only pistils; of only one sex; having flowers either staminate or pistillate.

UNITED Fused into one unit.

URCEOLATE Urn-shaped or pitcher-like, ovoid or subcylindrical in shape with narrowed top or opening; e.g., corollas in some Ericaceae.

UTRICLE (a) A small, bladder-like, one-seeded, usually indehiscent fruit; (b) a small bladder.

V

VALVATE Meeting along the margins only and not overlapping; contrasting with imbricate.

VALVE A separable part of a capsule; the units or pieces into which a capsule splits or divides in dehiscing.

VARIEGATED Irregularly colored in patches; blotched.

VARIETY A unit, category, or rank in classification below the level of species, sometimes treated as a subdivision of subspecies; group of plants with minor characters or differences separating them from other similar plants. The terms variety and subspecies are used inconsistently by taxonomists.

VASCULAR Pertaining to the conducting tissues (xylem and phloem).

VASCULAR BUNDLE Thread-like fiber of xylem and phloem in a stem or other organ.

VASCULAR CAMBIUM The thin layer of delicate rapidly dividing cells that form wood internally and bark externally; also known as cambium.

VEGETATIVE ORGAN Root, stem, leaf, or other non-reproductive organ of a plant.

VEIN Strand or bundle of vascular tissue.

VEINLET A little or ultimate vein.

VELAMEN A thin sheath or covering; e.g., on orchid roots.

VELAMENTOUS With a thin sheath or covering.

VELUM Thin flap of tissue.

VELUTINOUS Velvety with numerous erect hairs.

VENATION The pattern or arrangement of veins.

VENTRAL Situated on or pertaining to the adaxial side (= side toward axis) of an organ; typically the upper or inner surface; contrasting with dorsal.

VENTRICOSE (= Gibbous) Swollen or inflated on one side.

VERMIFORM Worm-like.

VERMILLION Scarlet; brillant red.

VERNAL Appearing in spring.

VERNATION The arrangement of leaves, sepals, or petals in the unopened bud.

VERRUCOSE Covered with wart-like protuberances.

VERRUCULOSE Diminutive of verrucose.

VERSATILE Attached near the middle and often capable of swinging about the attachment point, typically referring to attachment of an anther to a filament; contrasting with either basifixed or dorsifixed.

VERTICIL (= Whorl) A whorl of three or more members or parts attached at the same node of the supporting axis.

VERTICILLASTER A false whorl composed of pairs of opposite cymes; e.g., in some Lamiaceae.

VERTICILLATE (= Whorled) With three or more leaves or flowers attached at the same node; in a circle or ring.

VESPERTINE Opening in the evening; e.g., night-blooming *Cereus* (Cactaceae).

VESICLE A small cavity or bladder.

VESSEL Water conducting structure of the xylem, formed from the walls of a series of dead xylem cells stacked end to end.

VESTIGIAL Reduced to a trace, rudiment, or vestige; degenerate; referring to a once more fully developed structure.

VESTURE, **VESTITURE** Any covering on a surface making it other than glabrous; e.g., hairs, scales.

VEXILLUM The standard or banner in papilionaceous flowers.

VILLOSULOUS Diminutive of villous.

VILLOUS, **VILLOSE** With long, soft, spreading, or ascending, unmatted hairs; shaggy.

VINE A plant that climbs by tendrils or other means, or that trails or creeps along the ground.

VIRGATE Wand-shaped; slender, straight, and erect.

VISCID, **VISCOUS** Sticky; with sticky surfaces formed by secretions; glutinous.

VISCIDULOUS Slightly viscid.

VIVIPAROUS Germinating or sprouting from seed or bud while attached to the parent plant.

VOLUBLE Twining.

W

W West.

WAIF A species that is only fleetingly established and probably not permanently naturalized.

WEED (a) A plant growing where it is not wanted; (b) a plant with the genetic endowment to inhabit and thrive in places of continual disturbance, most especially in areas that are repeatedly affected by the activities of humankind.

WHORL, **WHORLED** (= Verticillate) With three or more leaves or flowers attached at the same node; in a circle or ring.

WIDE (= Broad) Distance across a structure (equal to diameter if tubular).

WING (a) A thin, membranous or flat extension or projection; (b) the two lateral separate petals in some Fabaceae and Polygalaceae.

WINTER ANNUAL An annual plant (the total life cycle taking one year or less) vegetatively persistent through the winter and flowering and fruiting in the late winter or early spring.

WOOLLY (= Lanate) With long, soft, and more or less matted or entangled hairs; wool-like.

WORT An old word of Anglo-Saxon origin meaning the equivalent of herbaceous plant.

X

XERIC Characterized by or pertaining to conditions of scanty moisture supply; dry.

XERO- Greek prefix signifying dry.

XEROPHYTE A plant that can subsist with a small amount of moisture, such as a desert plant; contrasting with hydrophyte and mesophyte.

XEROPHYTIC Dry-adapted; drought resistant; contrasting with mesophytic and hydrophytic.

XYLEM Water conducting tissue.

Z

ZYGOMORPHIC Referring to a flower or other structure with only one plane of symmetry; divisible into halves in one plane only; bilaterally symmetrical; e.g., with the left half a mirror image of the right; contrasting with both actinomorphic and irregular.

ZYGOTE Cell produced from fertilization or the union of two gametes; a fertilized egg.

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Alphabetical List of Families

Volume One: Pteridophytes, Gymnosperms, and Monocots known to occur in East Texas

Acoraceae
Agavaceae
Alismataceae
Alliaceae
Alstroemeriaceae
Amaryllidaceae
Anemiaceae
Anthericaceae
Araceae
Arecaceae
Asparagaceae
Aspleniaceae
Azollaceae
Blechnaceae
Bromeliaceae
Burmanniaceae
Cannaceae
Colchicaceae
Commelinaceae
Convallariaceae
Cupressaceae
Cyperaceae
Dennstaedtiaceae
Dioscoreaceae
Dryopteridaceae
Ephedraceae
Equisetaceae
Eriocaulaceae
Hemerocallidaceae
Hyacinthaceae
Hydrocharitaceae
Hypoxidaceae
Iridaceae
Isoetaceae
Juncaceae
Lemnaceae
Liliaceae
Limnocharitaceae
Lycopodiaceae
Lygodiaceae
Marantaceae
Marsileaceae
Mayacaceae
Melanthiaceae
Nartheciaceae
Nolinaceae
Ophioglossaceae
Orchidaceae
Osmundaceae
Pinaceae
Poaceae
Polypodiaceae
Pontederiaceae
Potamogetonaceae
Psilotaceae
Pteridaceae
Ruppiaceae
Salviniaceae
Selaginellaceae
Smilacaceae
Sparganiaceae
Thelypteridaceae
Themidaceae
Tofieldiaceae
Trilliaceae
Typhaceae
Xyridaceae
Zannichelliaceae

Geographic Area Information

(from Griffith et al. 2004)

Pineywoods: 24,400 square miles/63,200 square kilometers
Post Oak Savannah (including the Red River Area): 20,600 square miles/53,400 square kilometers
Blackland Prairie: 17,600 square miles/45,600 square kilometers

Total Area for East Texas: 62,600 square miles/162,200 square kilometers

Alphabetical List of Counties

Wholly or Partially in East Texas

Anderson
Angelina
Austin
Bastrop
Bell
Bexer
Bowie
Brazos
Burleson
Caldwell
Camp
Cass
Cherokee
Collin
Colorado
Comal
Dallas
Delta
Denton
Dewitt
Ellis
Falls
Fannin
Fayette
Franklin
Freestone
Goliad
Gonzales
Grayson
Gregg
Grimes
Guadalupe
Hardin
Harris
Harrison
Hays
Henderson
Hill
Hopkins
Houston
Hunt
Jackson
Jasper
Jefferson
Kaufman
Lamar
Lavaca
Lee
Leon
Liberty
Limestone
Madison
Marion
McLennan
Milam
Montgomery
Morris
Nacogdoches
Navarro
Newton
Orange
Panola
Polk
Rains
Red River
Robertson
Rockwall
Rusk
Sabine
San Augustine
San Jacinto
Shelby
Smith
Titus
Travis
Trinity
Tyler
Upshur
Van Zandt
Victoria
Walker
Waller
Washington
Wharton
Williamson
Wilson
Wood

Summary Data on the Flora

AND COMPARISON WITH OTHER FLORAS

Summary of the Flora of East Texas*

	Ferns & Similar Plants	Gymnosperms	Monocotyledons	Dicotyledons	Angiosperms	Total
Families	19	3	46	134	180	202
Genera	39	4	252	784	1036	1079
Species	73	9	978	2342	3320	3402
Additional Infraspecific taxa	1	0	70	187	257	258

* Dicot and total angiosperm data and totals are tentative pending completion of volumes two and three.

Comparison with Other Floras

	East Tx	TX[1]	NCTEX[2]	OK[3]	AR[4]	LA[5]	KS[6]	WV[7]	NC&SC[8]	CA[9]
Genera	1079	1328	854	850	942	1010	801	693	951	1222
Species	3402	5042	2223	2549	2877	3249	2111	2155	3360	5862
Native Species	2783		1829		2427	2423	1667		2913	4739
Introduced Spp.	619		394		760	826	435		747	1023
Total Taxa	3660	5256	2376	2844	3187		2228			
Area (in 1000s of square miles)	62.6	269	40	70	53	52	82	24	86	164

East Texas:

ca. 67 % of the species in Texas (in 23 % the land area)
133 % as many species as Oklahoma (in 89 % the land area)
82 % native species (18 % introduced from outside the United States)
163 Texas endemics and 26 East Texas endemics
115 taxa of conservation concern (Volume I only)

Number of genera and species of Poaceae (Largest East Texas family)	117	410
Number of genera and species of Asteraceae	127	398
Number of genera and species of Cyperaceae	16	248
Number of genera and species of Fabaceae	62	240
Number of species of *Carex* (Largest East Texas genus, Cyperaceae)		80

[1]Turner et al. 2003; [2]Diggs et al. 1999; [3]Taylor & Taylor 1994; [4]Arkansas Vascular Plant Manual Committee 2002; [5]Thomas & Allen 1993–1998; [6]C. Freeman, pers. comm.; [7]Strausbaugh & Core 1978; [8]Radford et al. 1968; [9]Hickman 1993.

ICONOGRAPHY

ENDEMIC TO TEXAS

ENDEMIC TO EAST TEXAS

INTRODUCED

NOXIOUS/HARMFUL EXOTIC PLANT

ENDANGERED OR THREATENED

TOXIC/POISONOUS

FAMILY/GENERIC SYNOPSIS

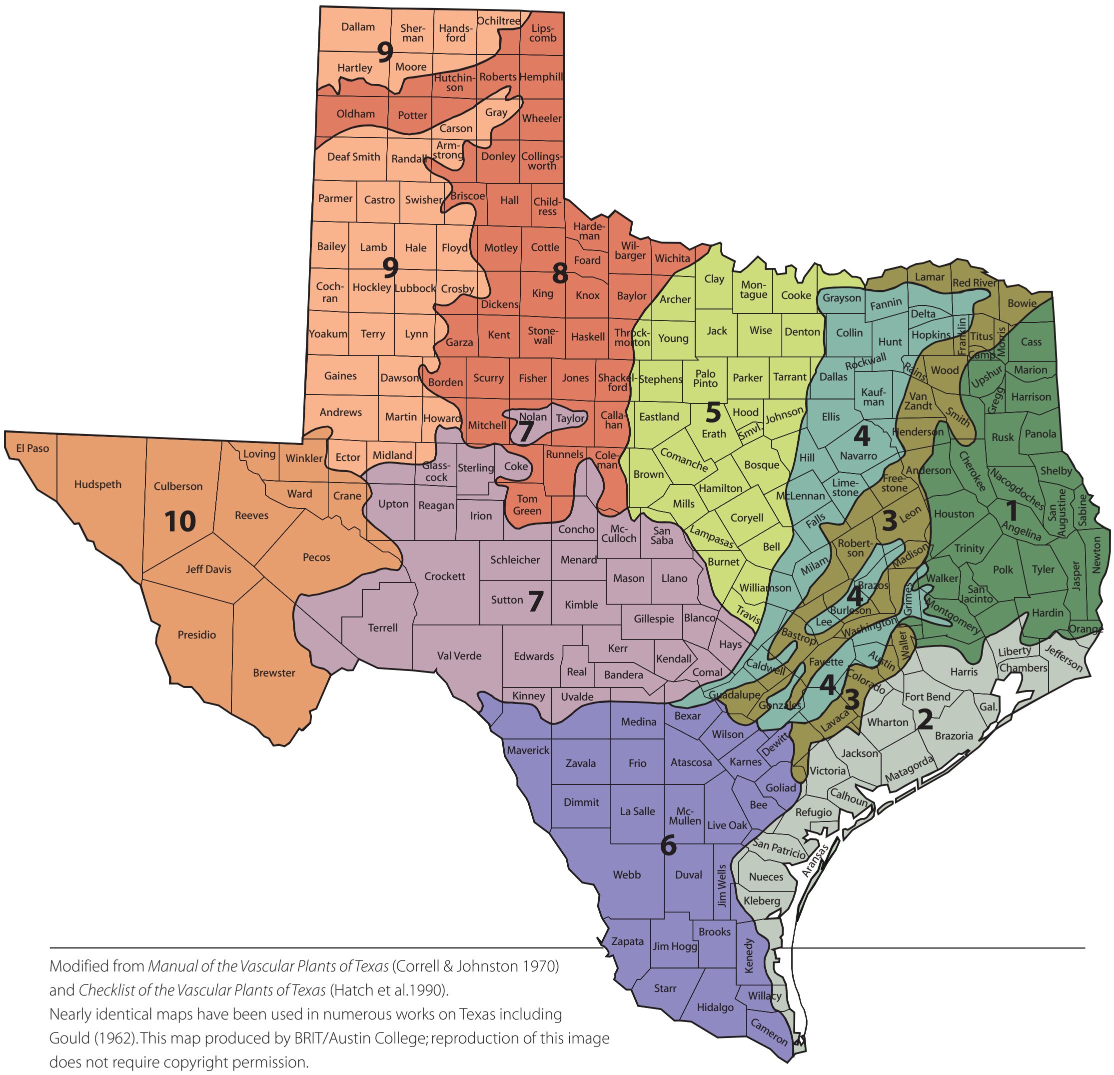
/80 COLOR PHOTOGRAPH AND PAGE NUMBER

/80 COMMERCIALLY IMPORTANT TIMBER TREES AND PAGE NUMBER

INCHES 1 2 3 4 5 6

METRIC 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

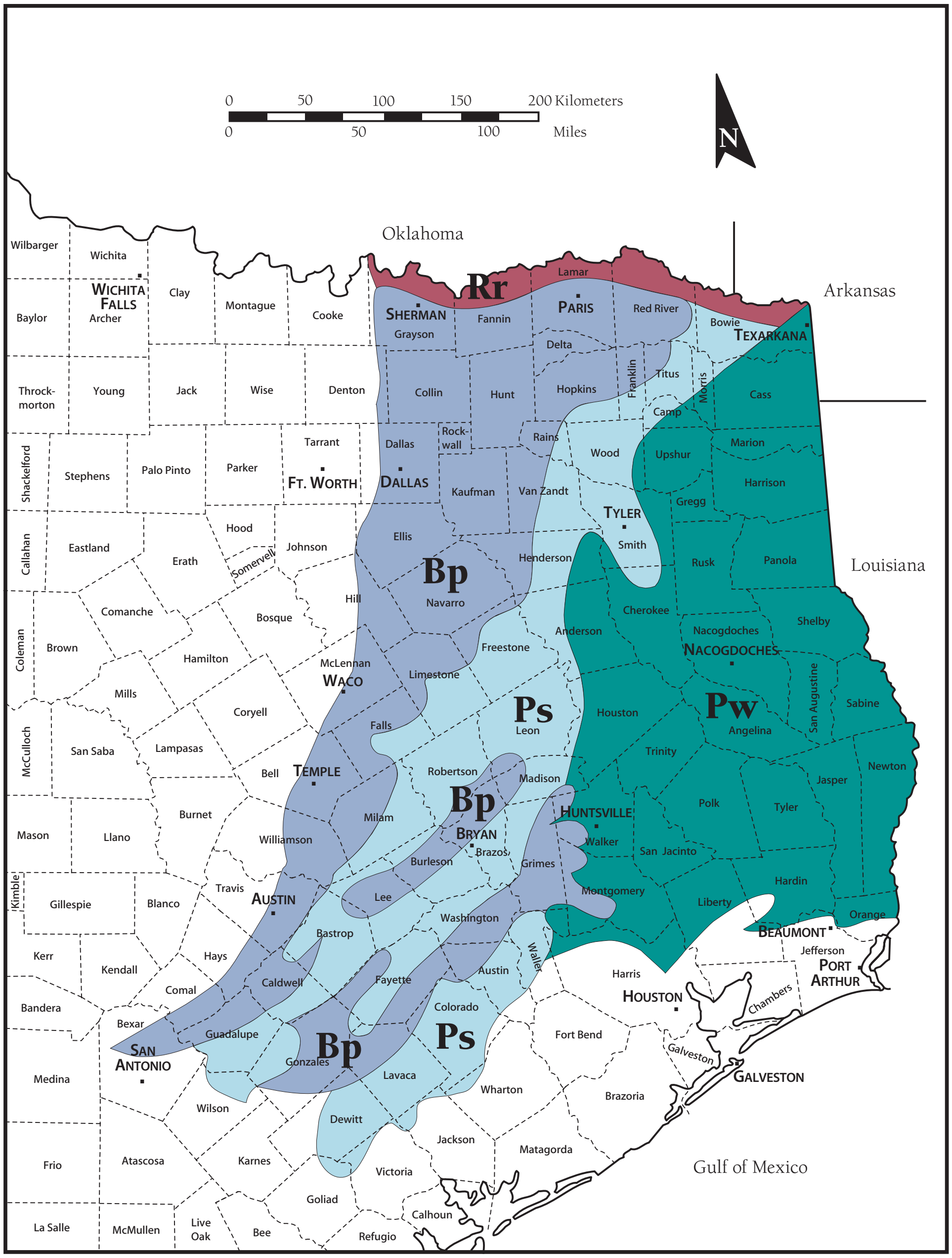
Vegetational Areas of Texas

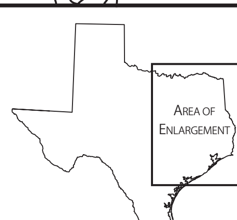


Modified from *Manual of the Vascular Plants of Texas* (Correll & Johnston 1970) and *Checklist of the Vascular Plants of Texas* (Hatch et al.1990).
Nearly identical maps have been used in numerous works on Texas including Gould (1962). This map produced by BRIT/Austin College; reproduction of this image does not require copyright permission.

1 Pineywoods
2 Gulf Prairies and Marshes
3 Post Oak Savannah
4 Blackland Prairies
5 Cross Timbers and Prairies
6 South Texas Plains
7 Edwards Plateau
8 Rolling Plains
9 High Plains
10 Trans-Pecos, Mountains and Basins

Vegetational Areas of East Texas





Bp Blackland Prairie
Pw Pineywoods
Ps Post Oak Savannah
Rr Red River Area