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FERNS AND SIMILAR PLANTS (PTERIDOPHYTES)

Although ferns and similar seedless vascular plants (reproducing by spores) were formerly lumped together as Division Pteridophyta, they are currently segregated into three (or four) separate divisions (Lycopodiophyta, Equisetophyta, and Polypodiophyta) to reflect the great diversity between these ancient plant groups. Thus the group Pteridophyta is no longer formally recognized. Together, the three divisions have nearly 10,000 species (Wagner & Smith 1993), with some authorities indicating as many as 12,000 species (e.g., Hoshizaki & Moran 2001). A fourth very small division of 4--8 species, Psilophyta, is recognized as distinct by some authorities or included in the Polypodiophyta by others (see discussion under Psilophyta). While there are considerable differences between the various groups of ferns and similar plants, molecular and morphological analyses indicate that all living vascular plants (ferns and similar plants, gymnosperms, and flowering plants) represent a monophyletic lineage (Doyle 1998). Ferns and similar plants (sometimes called "fern allies") dominated the extensive swamps of the Carboniferous Period (360--286 million years ago). Over geologic time, the compressed ancient remains of the ferns and similar plants from these swamps became coal (Hoshizaki & Moran 2001). For a Key to Ferns and Similar Plants see page XX.

REFERENCES: Thieret 1980; Tryon & Tryon 1982; Lellinger 1985; Snyder & Bruce 1986; Kramer & Green 1990; Wagner & Smith 1993; Hasebe et al. 1995; Manhart 1995; Kenrick & Crane 1997; Doyle 1998; Nauman et al. 2000; Nelson 2000; Hoshizaki & Moran 2001.

DIVISION **PSILOPHYTA**

WHISK-FERNS

A group represented by a single very small family of spore-bearing plants. Psilophyta lack roots (instead they have rhizomes with absorptive rhizoids and mycorrhizal fungi), have dichotomous branching, and in the East TX species have only small, veinless, scale-like outgrowths (= enations) on the stems (these are usually not considered to be true leaves). This lack of true roots and true leaves makes them morphologically the least complex of all terrestrial vascular plants. The structure of Psilophyta thus resembles (at least superficially) that of some of the earliest land plants (Mabberley 1997), and the group has traditionally been linked to the earliest known vascular plants from the Silurian and Devonian periods---e.g., the fossil genus *Rhynia* (Woodland 1997). Alternatively, it has been suggested (e.g., Bierhorst 1977) that the simple morphology of Psilophyta may instead be the result of reduction from an ancestral leptosporangiate fern. Still another possibility is that a number of molecular studies (e.g.,

Manhart 1995; Wolf 1997; Vangerow et al. 1999) link Psilophyta with the eusporangiate fern family Ophioglossaceae (*Botrychium* and *Ophioglossum*), which are usually considered the most isolated among the modern plants normally classified as ferns (Wagner 1990). Since these molecular studies are based on several different data sets, this is a particularly intriguing connection that needs further study. However, other molecular, chemical, and morphological data are ambiguous (Cooper-Driver 1977; Wallace & Markham 1978; Gottlieb et al. 1990; Pryer et al. 1995), and "there is no concensus on the relationships of Psilotaceae to other vascular plants" (Wolf 1997). For example, based on a recent cladistic analysis using morphological characters, Rothwell (1999) concluded that a link between ferns and Psilophyta was not supported. Thus, since a definitive understanding of the evolutionary relationships of Psilophyta is lacking, and because the group differs from all ferns and similar plants in many characters (Kaplan 1977; Wagner 1977), we are following the general trend among recent authors who continue to recognize the group as a separate division (e.g., Wagner & Smith 1993; Woodland 1997). *Psilotum nudum* is the only species in the division known to occur in North America.

PSILOTACEAE Eichler WHISK-FERN FAMILY

A very small family (2 genera, 4--8 species) found worldwide in tropical regions (Thieret 1993) and extending to warm areas. The other genus, *Tmesipteris*, occurs from se Asia to Australia, New Zealand, and some Polynesian islands.
FAMILY RECOGNITION IN THE FIELD: The only species in the flora is a dichotomously branched, leafless, spore-bearing perennial with green photosynthetic stems 0.5 m or less tall.
REFERENCES: Bierhorst 1977; Cooper-Driver 1977; Gensel 1977; Kaplan 1977; White 1977; Wagner 1977; Kramer 1990a; Thieret 1993; Manhart 1995; Pryer et al. 1995; Wolf 1997; Vangerow et al. 1999; Rothwell 1999; Schneider & Carlquist 2000a.

PSILOTUM Sw. WHISK-FERN, FORK-FERN

A genus of 2 or 3 species with leafless, green, photosynthetic stems. The common name, WHISK-FERN, comes from the much-branched leafless stems which give the plant the appearance of a whisk broom. (Greek: *psilos*, naked, smooth, or bare, either in reference to the leafless stems or to the "naked" sporangia which are not covered by indusia)
REFERENCES: Correll 1960; Lodwick 1975.

Psilotum nudum (L.) P .Beauv., WHISK-FERN, (bare, naked). Terrestrial, sometimes epiphytic; perennial with coral-like, short-creeping, rhizoid-bearing, branched rhizomes; roots absent (but rhizoids absorbtive); aerial shoots erect to ascending, to 25(--75) cm tall, photosynthetic, dichotomously branched 3--5 times, 3(--several)-ridged; stem appendages (enations) vein-less,

scale-like, minute, 0.7--3 mm long; leaves absent; spores all of 1 kind (plants thus homosporous), produced in sporangia, (2--)3 of these fused to form ± globose, (2--)3-lobed synangia; synangia 2--3 mm wide, solitary in axils of minute shoot appendages; gametophytes subterranean, with mycorrhizal fungi; chromosome number variable, *n* = 46--56, 104, 210 (Thieret 1993). Low woods, swamps, wet areas, wet peaty humus, and around bases of trees and stumps; Hardin Co. in s part of Pineywoods (Correll 1960---this collection from the Big Thicket was the first in the state; Lance Rosier led Correll to the location) and Freestone Co. in the Post Oak Savannah (Lodwick 1975); se U.S. from NC s to FL and w to AR and TX, also AZ. Sporulating summer. [*Lycopodium nudum* L.] Grown as an ornamental in some areas, particularly Japan (Hyam & Pankhurst 1995); it can be a minor weed in greenhouses (Thieret 1993). Although extremely rare in TX, in some areas of the U.S. (e.g., FL) it can appear as a weed; the species can be epiphytic in situations such as on tree bases, stumps, old logs, or tree forks with accumulated debris (Nauman et al. 2000; Nelson 2000). The whisk broom or "leafless twig" appearance of the WHISK-FERN is nearly unique among pteridophytes (Nelson 2000).

DIVISION **LYCOPODIOPHYTA**

CLUB-MOSSES, SPIKE-MOSSES, AND QUILLWORTS

A group of 1,200--1,250 species in 12--17 genera arranged in three families (Flora of North America Editorial Committee 1993). Members of all three families, Isoetaceae, Lycopodiaceae, and Selaginellaceae, occur in East Texas. Extinct members of this ancient division (e.g., Lepidodendrales---scale trees to 30 m tall) were dominants of the Carboniferous forests that formed present-day coal deposits. It is one of the oldest plant groups, dating to the Lower Devonian Period (408--360 million years ago) (Benson 1979; Bell & Woodcock 1983; Jones & Luchsinger 1986; Raven et al. 1986). The Lycopodiophyta are characterized by microphylls (= leaves with a single vein), and the group is sometimes referred to as the Microphyllophyta (Woodland 1997). Chloroplast DNA data (Raubeson & Jansen 1992) show that the living Lycopodiophyta (*Lycopodium* sensu lato, *Selaginella*, and *Isoetes*) share with the bryophtes (mosses, liverworts, hornworts) a particular mutation in contrast to all other vascular plants. This and morphological evidence indicate that among living vascular plants the lycopsids are the basal lineage (Raubeson & Stein 1995; Kenrick & Crane 1997; Doyle 1998; Duff 2000). However, the situation is not completely resolved since gene sequence data are ambiguous, with the Lycophyta sometimes appearing polyphyletic (e.g., Manhart 1995; Boivin 1996; Wolf 1997)
REFERENCES: Benson 1979; Bell & Woodcock 1983; Jones & Luchsinger 1986; Raven et al. 1986; Snyder & Bruce 1986; Bold et al. 1987; DiMichele & Skog 1992; Wagner & Smith 1993; Raubeson & Jansen 1992; Raubeson & Stein 1995; Woodland 1997; Duff 2000.

ISOETACEAE Rchb. QUILLWORT FAMILY

A monogeneric, nearly cosmopolitan family of ca. 150 species of superficially grass- or sedge-like plants ranging from perennial evergreen aquatics to ephemeral terrestrials. They are superficially unlike other Lycopodiophyta, but as in other members of the division, the leaves have a single vein; ligules are present as in the Selaginellaceae; spores are differentiated into microspores and megaspores. The long linear leaves have a resemblance to the quills of feathers formerly used as writing implements. This in combination with the Old English, *wort*, (from from Anglo-Saxon: *wyrt*), an herb, root, or plant, gives rise to the common name.
FAMILY RECOGNITION IN THE FIELD: the two East TX species are tufted, wet area plants with superficially grass-like or sedge-like leaves and a corm-like rootstock, giving them a green onion-like appearance; *sporangia are in the leaf bases*.
REFERENCES: Pfeiffer 1922; Correll 1949, 1956, 1966a; Jermy 1990a; Taylor et al. 1993.

ISOETES L. QUILLWORT

Plants tufted perennials, terrestrial or becoming so, superficially resembling a small green onion; rootstock corm-like, globose, 2-lobed, persisting after the leaves die back during hot dry weather; leaves quill-like, linear, hollow, superficially grass-like or sedge-like, tightly clustered together; sporangia solitary, embedded in broadened basal cavity of leaf with ligule inserted above, often partly covered by a velum (= thin flap of tissue); spores of 2 types (plant heterosporous), the megaspores white, often with faint wrinkles or tubercles, the microspores much smaller.

Species are often difficult to identify, sometimes requiring microscopic examination of spores, and interspecific hybrids are frequently seen. The spores are reported to be dispersed in the excreta of earthworms. (Greek: *isos*, equal, and *etos*, year, referring to the evergreen habit of some species)
REFERENCES: Taylor et al. 1975; Taylor & Taylor 1981a; Boom 1982; Lott et al. 1982; Taylor & Hickey 1992; Duff 2000.

1. Leaves dull green to gray-green or yellow-green, twisted; outer surface of leaf bases white to tan or brown, not shiny; megaspores (0.36--)0.48—0.65 mm in diam.; species known in East TX only from Comal Co. near extreme w margin of area..... **I. butleri**
1. Leaves bright green, not or little twisted; outer surface of leaf bases usually black (sometimes brownish), shiny; megaspores 0.25—0.45 mm in diam.; species widespread in East TX..... **I. melanopoda**

Isoetes butleri Engelm., (for George Dexter Butler, 1850--1910, lawyer, teacher, botanist, correspondent of George Engelmann), BUTLER'S QUILLWORT. Leaves to 15(--30) cm long, neither blackish nor shiny towards very base; velum covering less than 1/4 of sporangium; megaspores white. Seasonally saturated soils, temporary or shallow pools, usually on calcareous soils, but also on sandstone or granite (in these cases there is probably a source of calcium nearby influencing pH---Lot et al. 1982); in East TX known only from Comal Co. (Turner & Nichols 2001) near extreme w margin of area; otherwise known in TX only from Llano Co. (Lott et al. 1982). Collections are known from se Oklahoma---Choctaw, Johnston, and McCurtain cos. (Taylor & Taylor 1981a) just across the Red River from ne TX; IL s to GA and w to KS and TX. Spores mature in late spring. Taylor et al. (1993) indicated that the "leaves yellow, wither, and disappear by late spring."

Isoetes melanopoda J. Gay & Durieu ex Durieu, (black-footed), BLACK-FOOTED QUILLWORT. Leaves to 40 cm long, usually blackish and shiny towards very base; velum covering less than 3/4 of sporangium; megaspores white. Seasonally saturated soils, temporary or shallow pools, often on sandstone or non-calcareous subtrates; widely scattered in East TX.; Pineywoods and n Gulf Prairies and Marshes w to Cross Timers and Prairies and e Edwards Plateau; e U.S. from VA s to GA and w to NE and TX, also MT and UT. Sporulating Mar--Oct.

Isoetes lithophila N. Pfeiff., (rock-loving), ROCK QUILLWORT, the only other *Isoetes* species in TX, occurs just to the w of East TX on granite or gneiss outcrops in Burnet (BRIT), Llano (Turner & Nichols 2001), and Mason (TOES 1993) cos. It can be distinguished from the two species above by its velum covering the entire sporangium, the gray to gray-brown megasporangia, and the leaves not or slightly twisted, and pale towards base. Endemic to TX. Sporulating Apr--Jun. (TOES 1993: V) ⚠

LYCOPODIACEAE P. Beauv. ex Mirb. CLUB-MOSS FAMILY

Perennials with horizontal and upright shoots; roots produced along the horizontal shoots; leaves numerous, small, with a single unbranched vein (= microphylls); upright shoots simple or branched, with terminal strobili (= cones); sporangia solitary per sporophyll (= fertile leaf); spores all of 1 kind (plants homosporous).

A diverse ancient family with a long fossil history dating to the late Paleozoic Era (Thomas 1992). It is cosmopolitan and contains 10--15 genera and ca. 350--400+ species. They are terrestrial or epiphytic, evergreen, coarsely moss-like, vascular plants with scale- or needle-like leaves containing a single vein; ligules (= minute, tongue-like, basal protuberance on a leaf) are absent and spores are all of one type. The family "is widely regarded as a relict group, because living species bear a striking resemblence to early fossils and modern species diversity is low"

(Wikström & Kenrick 2000). Many species were previously recognized in the large genus *Lycopodium*, which is now often divided into a number of segregate genera---three of these, *Lycopodiella*, *Palhinhaea*, and *Pseudolycopodiella*, are treated here. Some of these segregates are known to hybridize. Taxonomic opinion on the family differs, with Øllgaard (1987, 1992) recognizing only four genera. Certain species were in the past gathered for making Christmas wreaths, and in some areas (e.g., Appalachian Mts.) this resulted in populations being greatly reduced. The very flammable (due to presence of volatile oils) dust-like spores of some burn with a quick flash---as a result they were formerly used in fireworks, signal fires, for stage-lighting, and in photography as flash powder (Whitebread 1941; Jones & Luchsinger 1986). Also in the past, when pills were hand-made, the spores were used by pharmacists to coat pills and prevent them from sticking together. In addition, they were used as a powder on rubber surgical gloves and suppositories, but are considered dangerous for such uses (and have been replaced) because they can cause inflammation (Whitebread 1941; Hoshizaki & Moran 2001). Temperate species are reported to be difficult to cultivate, often requiring specific mycorrhizal fungi (Hoshizaki & Moran 2001). Family name from *Lycopodium*, CLUB-MOSS, now recognized as a mainly temperate and subarctic genus of 15--25 species (Wagner & Beitel 1993). (Greek: *lykos*, wolf, and *pous* or *podium*, foot; in reference to the resemblance of the branch tips to a wolf's paw)

FAMILY RECOGNITION IN THE FIELD: evergreen, superficially somewhat moss-like herbs with stems covered by numerous, small, linear to linear-lanceolate or lanceolate, *1-veined leaves*; stems lying flat on the ground with upright shoots terminating in *cylindrical, spore-producing cones*.

REFERENCES: Correll 1949, 1956, 1966a; Holub 1983; Øllgaard 1987, 1990b; 1992; Thomas 1992; Wagner & Beitel 1992, 1993; Wikström & Kenrick 1997.

1. Upright shoots with many branches; strobili (= cones) many per shoot, nodding or pendant at the tips of the many branches of the upright shoots ..... **Palhinhaea**

1. Upright shoots unbranched; strobili solitary and erect at ends of upright shoots.
   2. Upright, unbranched shoots (serving as peduncles) with crowded leaves; horizontal stems lying flat on ground OR strongly arching; leaves of horizontal stems all ± the same size, neither spreading nor appearing 2-ranked..... **Lycopodiella**
   2. Upright, unbranched shoots with only scattered, scale-like, subulate leaves; horizontal stems lying flat on ground; leaves of horizontal stems not all the same size, the lateral leaves larger than medial leaves, the lateral leaves spreading and appearing 2-ranked ..... **Pseudolycopodiella**

LYCOPODIELLA Holub BOG CLUB-MOSS

Plants perennial; horizontal stems evergreen at least at apex, prostrate or arching; leaves densely covering stems, linear to linear-lanceolate or lanceolate, entire to conspicuously toothed; upright, unbranched shoots (serving as peduncles) scattered along horizontal stems, densely leafy; strobili solitary, terminating peduncles; sporophylls (= spore-bearing leaves) appressed to wide-spreading, similar to but generally slightly longer than other leaves; sporangia globose or subglobose, solitary at base of upper side of sporophylls.

Lycopodiella has traditionally been treated as part of a more broadly defined *Lycopodium*. As treated here, *Lycopodiella* is a genus of 8--10 species of the n temperate region and tropical America. Molecular evidence tentatively calibrated using fossils places the split between *Lycopodium* and *Lycopodiella* during the early Jurassic Period (208 million years ago) (Wikström & Kenrick 2000), providing support for its recognition at the generic level. Species of *Lycopodiella* hybridize readily and all possible hybrids between the three East TX species are known (Thieret 1980; Wagner & Beitel 1993). The *L. alopecuroides* [X] *L. prostrata* and *L. appressa* [X] *L. prostrata* hybrids have been reported for TX (Snyder & Bruce 1986). (Name derived from the genus *Lycopodium* (Greek: *lykos*, wolf, and *pous* or *podium*, foot; in reference to the resemblance of the branch tips to a wolf's paw), plus the Latin diminutive suffix, *-ella*) REFERENCES: Cranfill 1981; Øllgaard 1987; Wikström & Kenrick 2000.

1. Strobili 3--6(--9) mm wide (including leaves); sporophylls appressed; leaves of horizontal stems sparsely or not toothed; stems prostrate ..... **L. appressa**
1. Strobili 11--20 mm wide (including leaves); sporophylls usually ± spreading or wide-spreading; leaves of horizontal stems usually conspicuously toothed; stems prostrate OR strongly arching.
   2. Stems strongly arching, rooting at intervals; largest leaves on horizontal stems usually 0.5--0.7 mm wide; horizontal stems (excluding leaves) 2--4 mm in diam. ..... **L. alopecuroides**
   2. Stems prostrate, rooting throughout; largest leaves on horizontal stems usually 0.8--1.8 mm wide; horizontal stems (excluding leaves) 1--1.5 mm in diam. ..... **L. prostrata**

Lycopodiella alopecuroides (L.) Cranfill, (resembling *Alopecurus*, foxtail grass, apparently in reference to the resemblence of the strobili to the seed heads of that grass which superficially resembles a fox's tail), FOXTAIL BOG CLUB-MOSS, FOXTAIL CLUB-MOSS. Horizontal stems long-

creeping, strongly arching, rooting at intervals, 2--4 mm in diam. (excluding leaves); leaves monomorphic, linear to linear-lanceolate, ca. 5--7 mm long, ca. 0.5--0.7 mm wide, with conspicuous marginal teeth, spreading to ascending; upright shoots unbranched, (6--)10--30(--45) cm tall, densely covered with leaves; strobili 2--6(--11) cm long, 11--20 mm wide; sporophylls wide-spreading. Wet places in savannahs, boggy areas in low open pinelands and seeps, in acidic soils; Jasper (TAES), Austin, Hardin, Henderson, Lamar, Newton, and Orange (Turner & Nichols 2001) cos., mainly Pineywoods; also Jefferson Co. in n Gulf Prairies and Marshes; e U.S. from NY s to FL and w to AR and TX. Sporulating Jul--Nov. [*Lycopodium alopecuroides* L.] (TOES 1993: IV) ⚠

Lycopodiella appressa (Chapm.) Cranfill, (appressed or lying close, in reference to the appressed leaves), CHAPMAN'S CLUB-MOSS, SOUTHERN CLUB-MOSS, APPRESSED BOG CLUB-MOSS, TIGHT-LEAF CLUB-MOSS, SLENDER CLUB-MOSS, APPRESSED CLUB-MOSS, SOUTHERN APPRESSED CLUB-MOSS. Horizontal stems long-creeping, flat on ground, rooting throughout from lower surface, 1.5--2 mm in diam. (excluding leaves); leaves monomorphic, linear-lanceolate, ca. 5--7 mm long, ca. 0.8--1.2 mm wide, appressed, sparsely toothed or entire; upright shoots usually unbranched, 8--30(--40) cm tall, densely covered with leaves; strobili slender, ca. 2.5--7.5(--11) cm long, 3--6(--9) mm wide; sporophylls incurved, appressed. Depressions, bogs, moist areas; Pineywoods w to Austin, Henderson, Robertson (BRIT) Anderson, Leon (TAMU), and Wood (Turner & Nichols 2001) cos. in the Post Oak Savannah near e margin of Blackland Prairie; also n Gulf Marshes and Prairies (Jefferson Co.---Turner & Nichols 2001); se Canada and e U.S. from ME s to FL and w to KS and TX. Sporulating Jun-Oct. [*Lycopodium adpressum* (Chapm.) F.E. Lloyd & Underw., *Lycopodium appressum* (Chapm.) F.E. Lloyd & Underw.]

Lycopodiella prostrata (R.M. Harper) Cranfill, (prostrate, in reference to the prostrate stems), CREEPING CLUB-MOSS, PROSTRATE BOG CLUB-MOSS, SOUTHERN CLUB-MOSS, FEATHER-STEM CLUB-MOSS. Horizontal stems long-creeping, flat on ground, essentially rooting throughout, 1--1.5 mm in diam. (excluding leaves); leaves linear-lanceolate, 3--8 mm long, 0.4--1.8 mm wide, with conspicuous marginal teeth, spreading, feathered into the horizontal plane, slightly dimorphic, those of the upper side slightly smaller (3--5 mm long); upright shoots usually unbranched, 15--35 cm tall, densely covered with leaves; strobili 4--8 cm long, 15--20 mm wide; sporophylls wide-spreading. Travis Co. (Correll 1956) near the w edge of the Blackland Prairie, also the range map in Wagner and Beitel (1993) indicate occurrence in the se part of the Pineywoods and the n part of the Gulf Prairies and Marshes; se U.S. from NC s to FL and w to AR and TX. Sporulating mainly summer--fall. [*Lycopodium alopecuroides* L. var. *pinnatum* (Chapm.) J. Lloyd & Underw. ex C.A. Br. & Correll, *Lycopodium inundatum* L. var. *pinnatum* Chapm, *Lycopodium prostratum* R.M. Harper] The Travis Co. site is significantly disjunct to the w from most of the range of this species. This species hybridizes with *L. alopecuroides* (Snyder & Bruce 1986) and has sometimes been lumped with it (Radford et al. 1968); however, most

recent taxonomic treatments (e.g., Wagner & Beitel 1993; Nauman et al. 2000) recognize both species.

PALHINHAEA Vasc. & Franco NODDING CLUB-MOSS

☙*Palhinhaea* has traditionally been placed in a more broadly defined *Lycopodium* or by some authorities in *Lycopodiella* (e.g., Mabberley 1997; Wikström & Kenrick 2000). As treated here, following the treatment in *Flora of North America* (Wagner & Beitel 1993), *Palhinhaea* is a genus of 10--15 species, widespread mainly in the tropics and subtropics. (Named for Ruy Telles Palhinha, 1871--1950, Azores-born, Portuguese botanist)
REFERENCES: MacRoberts & MacRoberts 1995b.

Palhinhaea cernua (L.) Vasc. & Franco, (nodding, drooping, in reference to the drooping branch tips), NODDING CLUB-MOSS, STAG-HORN CLUB-MOSS. Plant overwintering as buried stem tips, the rest dying; horizontal stems branching, rooting where they touch the ground, with remote leaves; upright shoots to 45(--70) cm tall, many-branched (and resembling a miniature tree), with lateral branches drooping at tips; leaves linear-needle-like; strobili nodding, terminating branches, 4--8 mm long; sporophylls triangular-ovate, 1--2 mm long, coarsely toothed, wider than the sterile leaves; sporangia nearly globose, solitary at base of upper side of sporophylls. Hillside pitcher plant bog on wet but not inundated sand in full sun; Jasper Co. (Pineywoods) in the Angelina National Forest---known in TX only from two recently discovered plants and thus photographed but not collected (MacRoberts & MacRoberts 1995b); se U.S. from SC s to FL and w to AR and TX. Sporulating summer--fall. [*Lycopodiella cernua* (L.) Pic. Serm., *Lycopodium cernuum* L.] This species was previously known from the se U.S. w to LA; the TX location is ca. 125 km sw of the nearest known location in LA, and as such is the westernmost station for the species in the U.S. (MacRoberts & MacRoberts 1995b). This species, widespread in both the Old and New World tropics, is probably the world's most abundant CLUB-MOSS (Wagner & Beitel 1993). However, it is certainly one of the rarest native species in the East TX flora. It is easily distinguished by the many-branched upright shoots.

PSEUDOLYCOPODIELLA Holub BOG CLUB-MOSS

☙*Pseudolycopodiella* has traditionally been placed in a more broadly defined *Lycopodium* or by some authorities in *Lycopodiella* (e.g., Øllgaard 1987; Mabberley 1997; Wikström & Kenrick 2000). As treated here, following the treatment in *Flora of North America* (Wagner & Beitel 1993), *Pseudolycopodiella* is a widespread genus of 12 species, with only one species in North America. (Name derived from Greek: *pseudo*, false, and the genus *Lycopodium* (Greek: *lykos*, wolf, and *pous* or *podium*, foot; in reference to the resemblance of the branch tips to a wolf's paw), plus the Latin diminuative suffix, *-ella*)

REFERENCES: Bruce 1976; Holub 1983.

Pseudolycopodiella caroliniana (L.) Holub, (of Carolina, because its type specimen came from the "Carolinas," a region which historically included much of the se U.S.---Nelson 2000), SLENDER BOG CLUB-MOSS, CAROLINA CLUB-MOSS, SLENDER CLUB-MOSS. Plant perennial; horizontal stems evergreen at least at apex, short-creeping, flat on ground, rooted throughout from lower surface, densely covered with leaves, 8--12 mm wide including leaves; horizontal stem leaves dimorphic, the lateral leaves spreading and appearing 2-ranked, lanceolate to lanceolate-ovate, 3.5--7 mm long, 1.2--2.1 mm wide, entire; median leaves smaller, ascending; upright shoots (serving as peduncles) unbranched, scattered along stems, 5--30 cm long, with only scattered, scale-like, subulate leaves; strobili solitary, terminating peduncles, slender, 9--80(--120) mm long, 2.5--5(--8) mm wide including sporophylls; sporophylls (= spore-bearing leaves) diverging, broadly ovate to deltoid, acuminate, very different from the leaves of the peduncles; sporangia reniform (= kidney-shaped), solitary at base of upper side of sporophylls. Depressions in savannahs and open flat pinelands, in acidic soils, often with sphagnum moss; Angelina, Jasper, Tyler (BRIT), and San Augustine (Turner & Nichols 2001) cos. in s Pineywoods and Lee Co. (Turner & Nichols 2001) in the Post Oak Savannah; e U.S. from PA s to FL and w to AR and TX. Sporulating Jul-Sep. [*Lycopodium carolinianum* L.]

SELAGINELLACEAE Willk. SPIKE-MOSS FAMILY

An ancient, cosmopolitan but primarily tropical and subtropical family currently treated as a single genus with > 700 species. According to Korall et al. (1999), "Greatest diversity occurs in lowland to midmontane primary tropical rain forest, but this cosmopolitan family is also widely distributed in subtropical, temperate, montane, and rarely subarctic regions." Selaginellaceae are usually terrestrial or epiphytic, superficially moss-like vascular plants bearing spores differentiated into microspores and megaspores (plants heterosporous). The leaves usually have a single vein and ligules (= minute, tongue-like basal protuberance on a leaf; the function is uncertain) are present. Recent molecular evidence supports the monophyly of the the Selaginellaceae (Korall et al. 1999). This family is apparently only distantly related to the Lycopodiaceae and Isoetaceae.

FAMILY RECOGNITION IN THE FIELD: superficially somewhat moss-like, small herbs with numerous, scale-like, *1-veined leaves*; stems terminating in ± *4-angled, spore-producing cones*.

REFERENCES: Alston 1955; Correll 1956, 1966a; Jermy 1990b; Valdespino 1993; Korall et al. 1999.

SELAGINELLA P. BEAUV. SPIKE-MOSS

East TX species small terrestrial or lithophytic (= growing on rocks) plants (epiphytic elsewhere); stems leafy; vegetative leaves small, with ligule on adaxial side near base, all alike or of 2 kinds; sporophylls (= fertile leaves) modified, in strobili (= cones) at branch tips; sporangia solitary in axils of sporophylls, of 2 kinds (microsporangia and megasporangia).

Selaginella, the only extant genus in the family, has an extremely long history in the fossil record---fossils resembling *Selaginella* are known from the Carboniferous Period onwards (Thomas 1992). It is currently most diverse in the tropics. A number have xerophytic (= drought tolerance) adaptations and some are well known as "resurrection" plants, capable of reviving after long periods of dessication. Because of its heterogeneity, some authorities recommend splitting *Selaginella* into several genera (e.g., Skoda 1997). Small (1938), for example, separated *S. apoda* and similar species into the genus *Diplostachyum*, and Thomas (1992) argued that, "The presence of both isophyllous and heterophyllous *Selaginella*-like plants in the Carboniferous [ca. 300 million years ago] supports the idea that the genus should be divided into at least two genera." However, we are following most recent authors (e.g., Valdespino 1993; Korall et al. 1999) in treating all the species in a single genus. Tropical species are known for their unusually colored leaves---reddish or bronze or iridescent blue-green (Hoshizaki & Moran 2001). (From *Selago*, an ancient name for *Lycopodium*, a genus resembling *Selaginella*, and the Latin diminutive suffix, *-ella*)
REFERENCES: Clausen 1946; Tryon 1955; Skoda 1997.

1. Plants of moist habitats, delicately thin-herbaceous; stem leaves not overlapping or only slightly so, in 4 ranks, 2 lateral and spreading, 2 smaller and appressed-ascending along the upper surface of the stem; under surface of the stem easily visible; plants annual ..... **S. apoda**
1. Plants of xerophytic habitats, rather rigid; stem leaves crowded, conspicuously overlapping, appressed to stem, not in 4 distinct ranks; surface of the stem; stems not visible (concealed by leaves completely surrounding the stem); plants perennial ..... **S. arenicola**

Selaginella apoda (L.) Spring var. **apoda**, (footless, in reference to the prostrate habit), MEADOW SPIKE-MOSS, BASKET SELAGINELLA. Plant prostrate-creeping or ascending, often forming mats; leaves of 2 distinct kinds; lateral leaves ovate to ovate-elliptic, asymmetrical, ca. 1.35--2.25 mm long, 0.75--1.35 mm wide; appressed-ascending leaves smaller, to ca. 1.2(--1.6) mm long; strobili solitary or paired, obscurely quadrangular (= 4-sided)-flattened, 0.5--2 cm long; 2--4 mm in diam.; sporophylls apically acute to acuminate. Moist areas, low fields and woods; widespread in e TX w to Hays (BRIT), Lamar (Carr 1994), Bexar, Comal, Ellis, and Travis (Turner &

Nichols 2001) cos., mainly Pineywoods and Post Oak Savannah and extreme w edge of East TX adjacent to the Edwards Plateau; also Gulf Prairies and Marshes, several localities in s TX, and the e Edwards Plateau; e U.S. from ME s to FL and w to IL, OK, and TX. Sporulating May--Dec. A new variety of *S. apoda*, var. *ludoviciana* (A. Braun) B.F. Hansen & Wunderlin (based on *S. ludoviciana* (A. Braun) A. Braun), was recently named from the Gulf coastal plain (Hansen & Wunderlin 1998). This variety, which differs in minor ways (e.g., hyaline leaf margins) from var. *apoda*, is known from GA, FL, AL, MI, and se LA.

Selaginella arenicola Underw. subsp. **riddellii** (Van Eselt.) R.M. Tryon, (sp.: growing in sandy places or sand dweller; subsp.: for J.L. Riddell, 1807--1865, botanist), RIDDELL'S SELAGINELLA, RIDDELL'S SPIKE-MOSS. Vegetative part of plant erect to ascending, forming clumps, to ca. 12 cm tall, usually smaller; leaves essentially of 1 kind, narrowly triangular-lanceolate to linear-lanceolate, ca. 1.2--3 mm long, 0.4--0.5 mm wide, marginally ciliate, apically with whitish bristle; strobili solitary, sometimes with apical vegetative growth, quadrangular, ascending, (0.5--)1--3(--3.5) cm long and ca. 1.2 mm in diam.; sporophylls often with a bristle. Rocky areas, sandy or gravelly soils, longleaf pine sand ridges; widespread in East TX; e 1/3 of TX w to e Edwards Plateau; AL, AR, GA, LA, OK, and TX. Sporulating throughout the year. [*S. riddellii* Van Eselt.] There has long been disagreement over the taxonomy of *S. arenicola*. Tryon (1955) recognized three subspecies, while other authors (e.g., Clausen 1946; Snyder and Bruce 1986) treated the three taxa as separate species. Valdespino (1993) recognized two species in the complex, but maintained subsp. *riddellii* as a subspecies of *S. arenicola*. Nauman et al. (2000), did not recognize intraspecific taxa. Until further study is done, we are following Valdespino (1993) who treated all of the taxa occurring in North America.

Selaginella peruviana (J. Milde) Hieron., (of Peru, the species ranging to South America), PERUVIAN SPIKE-MOSS, [*S. sheldonii* Maxon], occurs just w of East TX (Burnet Co., also Comanche Co.---Stanford 1971); Edwards Plateau and Trans-Pecos; NM, OK, and TX. It can be distinguished from *S. arenicola* subsp. *riddellii* as follows:

1. Vegetative part of plant erect to ascending; leaves not curving upward, the leaf-covered stems therefore appearing radially symmetrical ..... *S. arenicola*
1. Vegetative part of plant ± prostrate; leaves curving upward making the upper and under views of the leaf-covered stems distinctly different ..... *S. peruviana*

DIVISION **EQUISETOPHYTA**

HORSETAILS

This is a very ancient group consisting of a single extant family. Fossil forms date to the Devonian Period (408--360 million years ago) and the division reached its maximum diversity and abundance in the Paleozoic Era. They were components of the Carboniferous Period's swamp forests that formed present-day coal deposits; some reached the proportions of trees (to 18 m tall) and were probably competitors of the tree Lycopodiophyta. The largest living species is the tropical *Equisetum giganteum* L., which may exceed 5 m in height (Bell & Woodcock 1983; Raven et al. 1986; Bold et al. 1987). The division is sometimes referred to as the Arthrophyta (Woodland 1997) or the Sphenophyta (Raven et al. 1986). The Equisetophyta are characterized by whorled microphylls (= leaves with a single vein) and hollow, jointed, green stems. Some species have numerous small branches and bear a slight resemblance to a horse's tail (but note derivation of scientific name discussed in the generic synopsis of *Equisetum*).
REFERENCES: Bell & Woodcock 1983; Raven et al. 1986; Bold et al. 1987; Wagner & Smith 1993; Woodland 1997.

EQUISETACEAE Michx. ex Dc. HORSETAIL FAMILY

The family is represented in the modern flora only by the distinctive genus *Equisetum*. It contains ca. 15 species and is nearly cosmopolitan, being absent only from Australia and New Zealand (Hoshizaki & Moran 2001). While most botanists accept only a single genus (e.g., Hauke 1993), some (e.g., Skoda 1997) would segegrate a number of species into the genus *Hippochaete*.
FAMILY RECOGNITION IN THE FIELD: plant body consisting primarily of *hollow, jointed, green* stems; leaves inconspicuous, scale-like, in whorls at the very distinct nodes; sporangia in *small, terminal cones*.
REFERENCES: Correll 1949, 1956, 1966a; Skoda 1997, Hauke 1990; 1993.

EQUISETUM L. HORSETAIL, SCOURING-RUSH

Plants perennial, rhizomatous; stems hollow in center, with a series of smaller canals, jointed with very distinct nodes, ridged, green and photosynthetic, usually unbranched (in East TX species) but some lateral branches forming if the apex is injured; leaves small, inconspicuous, whorled, scale-like, fused into sheaths surrounding the nodes but with tips free and tooth-like; sporangia on the undersurface of pelate sporophylls arranged in discrete terminal strobili (= cones); spores of 1 kind (plant homosporous).

The coarse, somewhat abrasive stems contain silica and were used by early settlers to scour pots and pans (Woodland 1997)---hence the common name. The common name, HORSETAIL, was given to species (in other geographic regions) with whorled branches---in reference to their

bushy appearance (Hoshizaki & Moran 2001). ☠ Some species contain alkaloids or other toxins such as thiaminase, an enzyme that destroys thiamine and causes Vitamin B_1 deficiency; they can be poisonous to livestock when included in hay (Kingsbury 1964; Burlage 1968; Fuller & McClintock 1986; Weathers 1998). Hybridization between species is frequent. *Equisetum* is often used in Japan in flower arrangements (Hoshizaki & Moran 2001). (Latin: *equis*, horse, and *seta*, bristle, referring to the coarse black roots of *E. fluviatile* L)

1. Sheaths (= fused leaves) dark-girdled at most nodes of stem (in addition to thin dark line at sheath apex where teeth are shed), ashy-gray to brownish above girdle; aerial stems usually persisting more than one year; cone apex pointed; teeth of sheaths promptly shed OR persistent ..... **E. hyemale**
1. Most sheaths green, with only a thin dark line at sheath apex where teeth are shed, only some near stem base dark-girdled; aerial stems lasting less than a year, occasionally overwintering; cone apex rounded to pointed; teeth of sheaths promptly shed ..... **E. laevigatum**

Equisetum hyemale L. subsp. **affine** (Engelm.) Calder & R.L. Taylor, (sp.: of winter, in reference to the evergreen habit; subsp.: related), TALL SCOURING-RUSH, AMERICAN SCOURING-RUSH, COMMON SCOURING-RUSH, GREAT SCOURING-RUSH, ROUGH HORSETAIL, WINTER SCOURING-RUSH, CAÑUELA. Stems 18--220 cm tall; leaves 14--50 per node (number evident as teeth of sheaths). Stream banks, wet places, seepage areas, often forming large colonies; widespread from Pineywoods w nearly throughout TX; throughout Canada and the entire U.S. Sporulating Mar--late fall. [*E. hyemale* L. var. *affine* (Engelm.) A.A. Eaton, *E. prealtum* Raf.] Poisonous (Burlage 1968). ☠

Equisetum laevigatum A. Braun, (smooth), SMOOTH HORSETAIL, SMOOTH SCOURING-RUSH, BRAUN'S SCOURING-RUSH, KANSAS HORSETAIL, KANSAS SCOURING-RUSH, SUMMER SCOURING-RUSH, COLA DE CABALLO, CAÑUELA. Stems 20--150 cm tall; leaves 10--32 per node. Dallas, Harris, and Travis cos. (BRIT), Brazos, Liberty, Robertson, Walker, Washington (TAMU), Bexar (Turner & Nichols 2001), and Waller (Correll 1956) cos.; widely scattered in TX; s Canada and through much of U.S. except ne and se. Sporulating May--Jul. [*E. kansanum* J.F. Schaffn.] Poisonous (Burlage 1968). ☠

These two species are often very difficult to distinguish in East TX and seem to intergrade. According to Hauke (1993), we are within the range of *E.* [x]*ferrissii* Clute, FERRISS' SCOURING-RUSH, a hybrid between *E. hyemale* and *E. laevigatum*. Hauke (1993) distinguished *E.* [x]*ferrissii* from the two parental species (with greenish spherical spores) by its white misshapen spores.

DIVISION **POLYPODIOPHYTA**

FERNS

A group of 8,550 species in 223 genera arranged in 33 families (Mabberley 1997). The fossil record of ferns dates to the Carboniferous Period (360--286 million years ago) and related groups occurred as early as the Devonian Period (408--360 million years ago). The leaves are megaphylls (= with branched veins) which apparently are derived from modified branch systems; spores are of one (plants homosporous---most living ferns) or two (plants heterosporous---Azollaceae, Marsileaceae, and Salviniaceae) types. Modern species range from tree ferns (to 24 m tall) to free-floating aquatics but are mostly rhizomatous perennial herbs. The group is also referred to as the Filicophyta or the Pterophyta (Bell & Woodcock 1983; Raven et al. 1986). The ferns have traditionally been divided into a eusporangiate group and a leptosporangiate group. The eusporangiate ferns, consisting of only two families, the Ophioglossaceae and the Marattiaceae, have large thick-walled sporangia each containing from several hundred to thousands of spores and have the sporangia developing from several initial cells. These plants are apparently only distantly related to all other ferns (see discussion under Ophioglossaceae). The leptosporangiate group (the rest of the ferns) have small delicate sporangia each usually containing 128 spores or fewer and have the sporangia developing from a single cell or a small group of cells (Jones & Luchsinger 1986; Camus 1990; Wagner 1990; Doyle 1998). For a Key to Ferns and Similar Plants see page XX.

REFERENCES: Bush 1903; Reverchon 1903; Small 1938; Correll 1949, 1956, 1966a; Thieret 1980; Tryon & Tryon 1982; Taylor 1984; Lellinger 1985; Bell & Woodcock 1983; Raven et al. 1986; Bold et al. 1987; Flora of North America Editorial Committee 1993; Wagner & Smith 1993; Pryer et al. 1995; Raubeson & Stein 1995; Smith 1995; Nauman et al. 2000; Nelson 2000; Hoshizaki & Moran 2001.

ANEMIACEAE Mickel. ANEMIA OR FLOWERING FERN FAMILY

A family of 2 genera and ca. 119--124 species (Mickel 1993; Roux 1995) widespread in the tropics and subtropics. It is sometimes lumped with the Schizaeaceae (e.g., Kramer 1990f). *Mohria*, the other genus in the family, with 7 species (Roux 1995) is restricted to Africa, Madagascar, and Réunion Island; it includes *M. caffrorum* (L.) Desv. (FRANKINCENSE FERN), a cultivated ornamental with scented fronds. The common name, FLOWERING FERN, is said to be used because the fertile structures of some species are “held erect above the sterile fronds, and are conspicuously covered with yellow to golden brown sporangia which can be quite showy…” (Nelson 2000).

FAMILY RECOGNITION IN THE FIELD: the single local species has ± 1-pinnate leaves with 2 conspicuously different types of pinnae: 4--6 pairs of sterile pinnae and below these a pair of *very long stalked*, bipinnate, fertile pinnae.
REFERENCES: Mickel 1993.

ANEMIA Sw. FLOWERING FERN, PINELAND FERN

A genus of 117 species of tropical and subtropical regions of the world, especially Brazil and Mexico; only 3 species occur in the U.S.---2 in FL and 1 in TX. *Anemia* is sometimes placed in the Schizaeaceae (Kartesz 1994); however, we are following Mickel (1993---*Flora of North America*) and Kartesz (1999) in placing it in the Anemiaceae. (Greek: *aneimon,* without clothing or naked, referring to the absence of blade protection for the sporangia, the fertile pinnae lacking blade tissue or nearly so)
REFERENCES: Correll 1956, 1966a; Mickel 1981, 1982; Carlquist & Schneider 1998.

Anemia mexicana Klotzsch, (Mexican), MEXICAN FERN. Plant terrestrial or on rocks, to ca. 50 cm tall; stems short-creeping, horizontal, covered with coarse dark hairs; leaves 1-pinnate (except for fertile pinnae), partially dimorphic, with 4--6 pairs of sterile pinnae distally and with the lowermost pair of pinnae highly modified and extremely different in appearance: fertile pinnae, very long stalked, bipinnate, to 30 cm long, usually exceeding the sterile portion of the leaf in length; sterile pinnae trianglar-ovate to lanceolate, basally truncate, apically subobtuse to acute or acuminate, marginally serrulate, the lowermost sterile pinnae often lobulate; sporangia in 2 rows on ultimate segments (= smallest subdivision) of fertile pinnae; indusia absent. Limestone outcrops, rocky slopes, banks of ravines; Austin Co. in se Blackland Prairie (Correll 1956); found primarily on limestone outcrops on the Edwards Plateau e and n to Bexar, Hays (TAES), Comal (Turner & Nichols 2001), and Travis (BRIT) cos. near the w margin of East TX; in the U.S. known only from TX (also n Mexico). Sporulating Feb--Oct.

ASPLENIACEAE Mett. ex A.B. Frank SPLEENWORT FAMILY

A cosmopolitan family of ca. 700 species (Wagner et al. 1993) with centers of diversity in the Appalachians, Central American mts., Andes, and Himalayas. While all species are often treated as members of a single diverse genus *Asplenium* (e.g., Wagner et al. 1993), other authorities cite molecular and anatomical evidence supporting a division of the family into two genera, *Asplenium* and *Hymenoasplenium* (Schneider 1997; Murakami et al. 1999).
FAMILY RECOGNITION IN THE FIELD: leaves 1-pinnate, all alike or the fertile slightly smaller; *sori elongate* along the veins; indusia attached along one side of the sori.
REFERENCES: Kramer & Viane 1990; Wagner et al. 1993; Schneider 1997; Murakami et al. 1999.

ASPLENIUM L. SPLEENWORT

East TX species terrestrial or on rocks; stems (rhizomes) short-creeping to erect; leaves clustered, 1-pinnate, monomorphic or slightly dimorphic, mostly evergreen; pinnae auricled basally, the auricle on the acroscopic side (= side toward the leaf apex) of the pinna; sori elongate along veins; indusia attached along the edge of the sori.

A large and diverse, cosmopolitan genus of ca. 700 species (followingWagner et al. 1993) of terrestrial, epilithic (= on rocks), and epiphytic species. This is one of the largest genera of ferns, and the species range in size from those with leaves only a few centimeters long to the giant BIRD'S-NEST FERNS, with leaves more than 1 m long (Hoshizaki & Moran 2001). The genus is well known for its interspecific hybridization and complex polyploid series with numerous allopolyploids. Ploidy levels range from diploid to hexaploid and three-fifths of the species are thought to be of hybrid, allopolyploid origin. A number of species are cultivated as ornamentals (e.g., *A. nidus* L.---BIRD'S-NEST FERN). (Greek: *splen*, spleen; thought by Dioscorides, Greek naturalist of the first century A.D., to be useful for treating spleen diseases)
REFERENCES: Wagner 1954; Correll 1956, 1966a; Wagner & Johnson 1981, 1983.

1. Pinnae (leaflets) usually alternate, with their basal auricles overlapping the rachis, their margins subentire to deeply serrate or incised; plants terrestrial or growing on rocks; leaves slightly dimorphic, the fertile erect, the sterile smaller and spreading ..... **A. platyneuron**
1. Pinnae opposite, usually not overlapping the rachis, their margins subentire to crenulate; plants usually growing on rocks; leaves monomorphic, all fertile, erect or ascending ..... **A. resiliens**

Asplenium platyneuron (L.) Britton, Sterns, & Poggenb., (broad-nerved, apparently based on an inaccurate early drawing---Nelson 2000), EBONY SPLEENWORT, BROWN-STEM SPLEENWORT. Leaves to 50 cm tall; leaf blades linear-lanceolate to narrowly elliptic-lanceolate in outline; petiole and rachis usually reddish brown to dark brown (rarely nearly black), shining. Sandy, moist, wooded banks and slopes, or on rocks; Pineywoods and Gulf Prairies and Marshes w to West Cross Timbers; se Canada and throughout e U.S. w to MN and AZ. Sporulating Apr--Dec. [*A. platyneuron* var. *bacculum-rubrum* (Fernald) Fernald] Two varieties are sometimes recognized in this species (e.g., Kartesz 1999). However, we are following Wagner et al. (1993) and Yatskievych (1999) in lumping var. *bacculum-rubrum*. According to Correll (1956), "…this is one of the commonest woodland ferns occurring in eastern Texas. It may be found not only as a solitary plant but also in extensive stands." Wagner et al. (1993) indicated that this species "…is remarkable in that it occurs in southern Africa as well as in North America. No other

North American fern has this distribution." The species is also unusual in possessing trophopods; these modified petiole bases accumulate food reserves and persist after withering of the leaf blade (Wagner & Johnson 1983; Nauman et al. 2000).

Asplenium resiliens Kunze, (resilient, springing or bending back), LITTLE EBONY SPLEENWORT, BLACK-STEM SPLEENWORT. Leaves to ca. 35 cm tall, the blades linear-oblong to linear-lanceolate, usually more coriaceous than in *A. platyneuron*; petiole and rachis black, shining. Usually growing on rocks; Bell, Grayson, and Travis (BRIT), Bexar (TAES), Angelina, Bastrop, Comal, Hays, Orange, and Williamson (Turner & Nichols 2001) cos., widely scattered in TX; across s 1/2 of U.S. from PA s to FL and w to NV and AZ. Sporulating Apr--Nov.

AZOLLACEAE Wettst.
AZOLLA, MOSQUITO FERN, OR WATER FERN FAMILY

A cosmopolitan family of a single genus and only ca. 7 species of floating aquatics (sometimes stranded on mud) with highly reduced vegetative morphology (Saunders & Fowler 1992). Because of their minute size and numerous leaves, the plants superficially resemble mosses. The family is often included in the Salviniaceae, but according to Lumpkin (1993), the relationship is not close. Three families of heterosporous water ferns occur in East TX (*Azolla*---Azollaceae, *Marsilea, Pilularia*---Marsileaceae, and *Salvinia*---Salviniaceae). These groups are quite distinct morphologically, and traditionally the marsileaceous (*Marsilea* and *Pilularia*) and salviniaceous (*Azolla* and *Salvinia*) lines were considered to have evolved independently from different homosporous fern ancestors. However, based on recent morphological, fossil, and molecular evidence, all three living heterosporous water fern families appear to comprise a monophyletic group (Rothwell & Stockey 1994; Hasebe et al. 1995; Pryer 1999).
FAMILY RECOGNITION IN THE FIELD: tiny, liverwort-like, free-floating or mat-forming plants that sometimes form conspicuous velvet-like, green to red mats on the surface of quiet waters.
REFERENCE: Schneller 1990a; Lumpkin 1993; Dickinson & Miller 1998.

AZOLLA Lam. WATER FERN, MOSQUITO FERN, FAIRY-MOSS

The minute size results in *Azolla* being considered the world's smallest fern (Moran 1997). The upper emergent leaf lobes are hollow and inhabited by a symbiotic nitrogen-fixing cyanobacterium (= blue-green bacterium), *Anabaena azollae* Strasb., that combines, or "fixes" atmospheric nitrogen with hydrogen to make ammonia, which can be utilized by plants (Moore 1969; Hoshizaki & Moran 2001). Because of the resulting nitrogen content, *Azolla* species have been widely used agriculturally as a fertilizer. "Cultivating *Azolla* as an organic fertilizer for rice

has been a centuries-old practice in China and Vietnam…" (Moran 1997), dating back perhaps to the 11th century. Wagner (1997) reviewed the extensive literature on the uses of *Azolla* (e.g, biofertilizer, animal feed, human food, medicine, water purifier). Because of these uses, particularly as a biofertilizer, *Azolla* is considered by some to be the world's most economically important fern (Moran 1997). The common name, MOSQUITO FERN, is said to be "due to the belief that its dense covering on the surfaces of ponds retards or prevents the growth of mosquitoes" (Nelson 2000). Because of their small size and difficult to observe microscopic characters (e.g., megaspores), species of *Azolla* are extremely hard to identify (Hoshizaki & Moran 2001); fortunately, in this regard, only one species is known for East Tx. (Greek: *azo*, to dry, and *ollyo*, to kill, alluding to death from drought, in reference to its dependence on water)
REFERENCES: Svenson 1944, Correll 1956, 1966a; Moore 1969; Lumpkin and Plucknett 1980; Moran 1997; Wagner (G.M.) 1997.

Azolla caroliniana Willd., (of Carolina), MOSQUITO FERN, WATER FERN, CAROLINA MOSQUITO FERN. Plant small, free-floating or mat-forming, superficially resembling some liverworts, monoecious; stems prostrate, to ca. 1 cm long; leaves minute, deeply bilobed, imbricate, deep green to reddish (under stress); infrequently fertile; sporocarps of two kinds, in the leaf axils, the megasporocarps with 1 megasporangium producing 1 megaspore, the microsporocarps with numerous microsporangia containing numerous microspores; megaspores not pitted, densely covered with tangled filaments. Still water of ponds, lakes, or slow-moving streams or stranded on mud; sporadically but widely scattered in e 1/2 of TX; B.C., Ont., and e U.S. from NH s to FL and w to SD and TX. Sporulating summer--fall. Where found, this species is often abundant and huge numbers of individuals can at certain times of the summer turn the surface of ponds a striking red color. Fertile specimens are rarely collected (Nauman et al. 2000). According to Correll (1956), "Its occurrence in remote locations is doubtless due to its dissemination, in part, by water-fowl."

BLECHNACEAE (C. Presl) Copel. CHAIN FERN, DEER FERN, OR MIDSORUS FERN FAMILY

A family of ca. 10 genera and ca. 250 species; it is mostly tropical and s temperate except for the n temperate *Woodwardia*. Family name from *Blechnum*, DEER FERN, a mostly tropical, especially s hemisphere genus of ca. 220 species. (Greek: *blechnon*, classical name for ferns in general)
FAMILY RECOGNITION IN THE FIELD: sori *discrete, linear-oblong*, in a *chain-like row* along each side of the midvein of a pinna or pinnule; indusia attached by their outer margin, opening towards midvein.
REFERENCES: Kramer et al. 1990a; Cranfill 1993a.

WOODWARDIA Sm. CHAIN FERN

Terrestrial; stems (rhizomes) in East TX species long-creeping with leaves scattered along the stems; leaves monomorphic or dimorphic, deciduous, the blades 1-pinnatifid or 1-pinnate; sori discrete, linear-oblong, in a single chain-like row along each side of the midvein; indusia attached by their outer margin, opening on side next to midvein, often obscured by dehisced (= opened) sporangia.

A genus of 14 species of North America, Central America, Mediterranean Europe, and e Asia. Some authorities (e.g., Nelson 2000) attribute the name chain fern "to the conspicuous netted, chainlke areoles that parallel both sides of the mid-vein on the lower sides of the pinnae and most pinnules, and impart a distinctive, chain-like appearance to the sori.. These 'chains' are easily seen without magnification, especially when held up to light…" (Named for Thomas Jenkinson Woodward, 1745--1820, English botanist)
REFERENCES: Correll 1956, 1966a.

1. Leaves conspicuously dimorphic (pinnae of fertile leaves contracted, linear); sterile blades 1-pinnatifid, with a wing of blade tissue several mm wide along much (at least upper half) of the rachis; pinnae (= subdivisions of leaves) themselves not pinnatifid, sometimes sinuate, the margins serrulate ..... **W. areolata**
1. Leaves monomorphic or nearly so; blades 1-pinnate, with no leaf tissue along the rachis; pinnae deeply pinnatifid with entire margins ..... **W. virginica**

Woodwardia areolata (L.) T. Moore, (pitted), NETTED CHAIN FERN, CHAIN FERN, NARROW-LEAF CHAIN FERN. Sterile leaves few, 40--58 cm long; pinnae of sterile leaves in 7--12 alternate pairs, 1--2.5 cm wide, the veins anastomosing into 2 or more rows of areoles between midvein (= costa) and margin; fertile blades with sori nearly completely covering surface of blade. Low, wet, usually sandy areas; Pineywoods and Gulf Prairies and Marshes w to Fannin Co. (BRIT) in Red River drainage and Bastrop (Turner & Nichols 2001), Van Zandt, and Milam (TAES) cos. near w margin of Post Oak Savannah; e U.S. from NY s to FL and w to IL, OK, and TX. Sporulating Mar--Nov. This species has sometimes been segregated into the genus *Lorinseria* [as *L. areolata* (L.) C. Presl]. The sterile leaves resemble those of *Onoclea* (subopposite pinnae with entire margins) except *W. areolata* usually has alternate pinnae with minutely serrulate margins.

Woodwardia virginica (L.) Small, (of Virginia), VIRGINIA CHAIN FERN. Leaves numerous, 50--100 cm long; pinnae in 12--23 pairs, the middle pinnae 1--3.5 cm wide, the veins anastomosing to form a single row of areoles near midvein; sori covering only a small part of the blade surface.

Low areas; Pineywoods and Gulf Prairies and Marshes w to Bastrop, Lee (TAMU), Gonzales (Turner & Nichols 2001), and Milam (Correll 1956) cos. on w margin of Post Oak Savannah; se Canada and e U.S. from ME s to FL and w to IL, AR, and TX. Sporulating Apr--Dec. According to Nelson (2000), this species is sometimes "confused at a glance with *Osmunda cinnamomea*, with which it is sometimes found, but distinguished at some distance by the dark brown base of the petiole, mostly darker rachis, and by the fronds being well spaced rather than clump forming."

DENNSTAEDTIACEAE Lotsy BRACKEN OR CUPLET FERN FAMILY

As currently recognized, the Dennstaedtiaceae is a cosmopolitan but mostly tropical family of ca. 20 genera and ca. 400 species. It has been variously circumscribed to include as few as 8 genera or in other cases nearly half the genera of higher ferns. Family name from *Dennstaedia*, CUP FERN, a cosmopolitan but mostly tropical genus of ca. 70 species. (Named for August Wilhelm Dennstaedt, 1776--1826, German botanist, physician, and director of the Belvedere Garden)

FAMILY RECOGNITION IN THE FIELD: the single East TX species is a terrestrial plant with large leaves with 3 main divisions, each of these being 2-pinnate-pinnatifid; sori linear, *along margins* of the ultimate leaf segments (= smallest subdivision of leaf) with the leaf *margins recurved* over sori to form a false indusium.

REFERENCES: Mickel 1973; Kramer 1990b; Cranfill 1993b; Wolf 1995.

PTERIDIUM Gled. ex Scop. BRACKEN FERN

A monotypic, cosmopolitan genus sometimes placed in the Pteridaceae. *Pteridium* is treated here as a single species with 12 varieties in 2 subspecies (Tryon 1941; Tryon & Tryon 1982): subsp. *aquilinum* (including var. *pseudocaudatum*) and subsp. *caudatum* (L.) Bonap. Some authorities (Lellinger 1985; Mickel & Beitel 1988), however, recognize some of the intraspecific taxa as separate species. (Greek: *pteridon*, a small fern, from *pteron*, feather or wing, due to the shape of the leaves)

REFERENCES: Tryon 1941; Correll 1956, 1966a; Cooper-Driver 1976; Page 1976; Mickel & Beitel 1988; Jacobs & Peck 1993; Speer et al. 1998a[1999a], 1998b[1999b].

Pteridium aquilinum (L.) Kuhn var. **pseudocaudatum** (Clute) A. Heller, (sp.: eagle-like; var.: false-tailed), WESTERN BRACKEN FERN, PASTURE BRAKE, BRACKEN FERN. Terrestrial; stems (rhizomes) deeply buried, long-creeping; leaves monomorphic, deciduous, scattered along the stems, to 1 m or more tall; leaf blades glabrous or nearly so, broadly triangular to triangular-lanceolate in outline, usually of 3 main divisions, each division 2-pinnate-pinnatifid, the pinnae rigidly herbaceous to subcoriaceous; sori marginal, linear, continuous, covered by a false

indusium formed by the recurved margin of the ultimate leaf segments (= smallest subdivision of leaf) and an obscure inner, delicate, true indusium. Open woods, pastures, thickets, often in sandy soils; Pineywoods and Gulf Prairies and Marshes w through Post Oak Savannah and Red River drainage to Grayson (S. Crosthwaite, pers. comm.), Freestone, Henderson, Milam (BRIT), Bastrop, Caldwell, Guadalupe, and Wilson (Turner & Nichols 2001) cos.; s Canada and throughout most of the U.S. except NE. Sporulating Jun--Nov. This variable species with numerous infraspecific taxa is virtually worldwide in distribution and is the most widely distributed fern. It is considered by some to be the most widespread of all vascular plants (with the exception of a few annual weeds) (Page 1976). Its tenacity is shown by regeneration through several meters of volcanic ash on Mt. St. Helens in Washington within 1--2 years of the volcanic eruption (Woodland 1997). The species has a deep rhizome, making it well adapted to fire prone habitats, and one of the first species to reappear following a fire (Nelson 2000). In some areas (e.g., British Isles) BRACKEN FERN is a problematic weed and the cause of "bracken staggers" or "bracken poisoning," a potentially fatal condition in livestock. Symptoms in livestock include a hemorrhagic syndrome, chronic hematuria, and fever (bovines), neurological symptoms and staggering (horses), and retinal degeneration and cancer (sheep). Toxins reported include an enzyme, thiaminase, which can cause fatal thiamine (Vitamin B_1) deficiency in livestock; a *nor*sesquiterpene (ptaquiloside), a cyanide-producing glycoside (prunasin), and at least two carcinogens which can be passed to humans via cow's milk. Human consumption of the fiddleheads has been suggested as a cause of stomach cancer in some parts of the world. Another interesting chemical defense employed by BRACKEN FERN is the production of phytoecdysones, a class of hormone-like compounds that promote ecdysis (= molting) in insects---insects eating the plant thus have their developmental sequence altered. BRACKEN FERN is also known to be allelopathic, with toxins leaching from the tissues adversely affecting surrounding plants (Mabberley 1987; Turner & Szczawinski 1991; Moran 1993a; Foster & Caras 1994; Weathers 1998; Bruneton 1999). ☠

DRYOPTERIDACEAE Ching WOOD FERN FAMILY

East TX species usually terrestrial or on rocks (*Nephrolepis* potentially epiphytic); leaves monomorphic or dimorphic; leaf blades 1-pinnatifid to 1--more-pinnate or pinnate-pinnatifid; sori on abaxial leaf surfaces, on veins or vein tips, usually not marginal, or in berry-like or bead-like structures on fertile leaves conspicuously different from sterile leaves (*Onoclea*).

The family as broadly described here follows Smith (1993b) and includes genera (*Athyrium, Nephrolepis, Onoclea, Woodsia*) at times segregated into other families. It is cosmopolitan and has ca. 60 genera and ca. 3,000 species. Other authors (e.g., Lellinger 1985) have treated the family in a more restricted sense---32 genera and 850 species, with genera such as *Athyrium,*

Cystopteris, Onoclea, and *Woodsia* segregated into the Woodsiaceae and *Nephrolepis* placed in the Davalliaceae. The family has sometimes been treated as the Aspidiaceae (an illegitimate name).

FAMILY RECOGNITION IN THE FIELD: sori in most species on veins or vein tips (usually not marginal) on lower leaf surfaces, or in *Onoclea* in berry-like or bead-like structures on fertile leaves conspicuously different from the sterile leaves; lower surfaces of leaf blades without transparent needle-like hairs (distinguishing this family from Thelypteridaceae which have such hairs); ultimate leaf segments (= smallest subdivision of leaf) not entire.

REFERENCES: Correll 1956, 1966a; Kramer et al. 1990b; Smith 1993b; Sano et al. 2000.

1. Fertile and sterile leaves completely different (extremely dimorphic); fertile leaves without typical blade tissue, the sori in berry-like or bead-like structures; sterile leaf blades 1-pinnatifid (deeply divided but not completely pinnate); rachis with a conspicuous flange of photosynthetic tissue..... **Onoclea**

1. Fertile and sterile leaves or portions of leaves similar, the fertile portion never so different as to be without blade tissue, the sori on blade tissue; leaf blades at least completely 1-pinnate, often more divided; rachis without a flange of photosynthetic tissue.
   2. Leaf blades only 1-pinnate, the pinnae themselves not further divided, neither pinnate nor pinnatifid (but large basal lobe(s) or auricles sometimes present on pinnae).
      3. Pinnae 1--2(--3) pairs in addition to single terminal pinna (pinnae sometimes with large basal lobe(s) or auricles); plants primarily of the Edwards Plateau, in East TX known only from extreme w margin of area in Comal Co.....**Tectaria**
      3. Pinnae more than four pairs (usually many more) in addition to single terminal pinna; plants widespread in East Texas.
         4. Pinnae ovate, conspicuously narrowed to an acuminate tip; fertile pinnae with sori scattered over whole lower surface (sometimes appearing as if in numerous rows) .....**Cyrtomium**
         4. Pinnae ± oblong, ± parallel sided (but often with a small basal auricle); fertile pinnae with sori in 2--4 distinct rows.
            5. Sori only on the uppermost somewhat reduced fertile pinnae (uppermost 1/3 to 1/2 of leaf); indusia orbicular, not at all kidney-shaped; pinnae with bristly teeth on the margins; stolons absent..... **Polystichum**
            5. Sori not restricted to the uppermost pinnae, the fertile pinnae not reduced; indusia orbicular-kidney-shaped; pinnae without bristly teeth on the margins (but small non-

bristly teeth can be present); stolons present, wiry and widely creeping ..... **Nephrolepis**

2. Leaf blades more than 1-pinnate, the pinnae themselves further divided, either pinnate or pinnatifid.
   6. Sori elongate, straight to hooked or curved; indusia with elongate attachment along one side, the attachment as long as the elongate sori..... **Athyrium**
   6. Sori round or nearly so; indusia variously attached, but attachment not elongate.
      7. Leaf blades relatively large, 8--30 cm wide, (25--)35--120 cm long; pinnules (= subdivisions of pinnae) of middle pinnae typically 5 mm or more wide at their bases, only shallowly toothed and thus not appearing subdivided; indusia attached at narrow sinus, the round-kidney-shaped indusia usually obvious with the naked eye or at least with magnification; petiole bases with 3 or more vascular bundles; plants rare if present in East TX ..... **Dryopteris**
      7. Leaf blades usually smaller, 3.5--10 cm wide, 8--40(--60) cm long; pinnules of middle pinnae typically less than 5 mm wide at their bases, at least some so deeply toothed or incised that they appear subdivided; indusia not attached at a narrow sinus (rather attached below sori and at first cup-like and completely enclosing sori, but later spltting into several irregular lobes or flaps spreading around sori OR attached along one side of sori, hood- or pocket-like, arching over sori) (NOTE: indusia often inconspicuous in mature sori); petiole bases with 2 vascular bundles; including plants widespread and common in East TX.
         8. Petioles with scattered light brown scales, glabrate with age; indusia attached below sori and at first cup-like and completely enclosing sori, but later splitting into several irregular lobes or flaps spreading around sori (sometimes inconspicuous in mature sori); leaf blades usually broadest above the middle; stems (rhizomes) short, not protruding beyond attachment of current season's leaves; petiole bases persistent; plants widespread and common in East TX ..... **Woodsia**
         8. Petioles glabrous except at very base; indusia attached by one side, hood- or pocket-like, arching over sori (sometimes inconspicuous in mature sori); leaf blades

broadest at or below the middle; stems (rhizomes) long-creeping, protruding 1--5 cm beyond attachment of current season's leaves; petiole bases not persistent; plants rare if present in East TX ..... **Cystopteris**

ATHYRIUM Roth LADY FERN

A cosmopolitan genus of ca. 180 species. Recent molecular data (Sano et al. 2000) suggest the genus is polyphyletic. (Greek: *athyros*, doorless; the sporangia only tardily push back the outer edge of the indusium)
REFERENCES: Butters 1917a; Liew 1972; Kato 1993.

Athyrium filix-femina (L.) Roth subsp. **asplenioides** (Michx.) Hultèn, (sp.: lady fern; subsp.: resembling *Asplenium*---spleenwort), SOUTHERN LADY FERN, LOWLAND LADY FERN. Stems (rhizomes) short-creeping; leaves monomorphic, deciduous, clustered, to 120 cm tall, 2-pinnate-pinnatifid (rarely sub-3-pinnate), the pinnae usually short stalked; sori elongate, straight to hooked or curved, somewhat resembling those of *Asplenium*, in a single row on each side of the midrib, ca. midway between midrib and margin of ultimate leaf segments (= smallest subdivision of leaf); indusia membranous, opening facing midrib. Moist woods, thickets, swamps, stream banks; Pineywoods and Gulf Prairies and Marshes w through Post Oak Savannah to Williamson Co. (Correll 1956; Turner & Nichols 2001) in the Blackland Prairie and n to Red River Co. (BRIT); e U.S. from NY s to FL and w to KS and TX. Sporulating May--Nov. [*A. asplenioides* (Michx.) A.A. Eaton] This species is sometimes cultivated as an ornamental, and is said to be "one of the most dependable and often-used in fern gardening" (Nelson 2000). The cultivars are reported to be derived from the European variety, var. [subsp.] *filix-femina* (Hoshizaki & Moran 2001).

CYRTOMIUM C. Presl HOLLY FERN, ASIATIC HOLLY FERN, NET-VEIN HOLLY FERN

A taxonomically difficult genus of ca. 15 species (Yatskievych 1993) mainly from Asia but also found in Africa, including Madagascar, and in the Hawaiian Islands. Some authorities treat it within *Polystichum* (e.g., Mabberley 1997) and according to Yatskievysch (1993), it "might better be considered a subgenus of *Polystichum*, from which it is poorly differentiated morphologically." (Greek: *cyrtoma*, arch, in reference to the arched veins of some species)
REFERENCES: Christensen 1930; Yatskievych 1993.

Cyrtomium falcatum (L.f.) Presl, (sickle-shaped, in reference to the curved pinnae), JAPANESE NET-VEIN HOLLY FERN, JAPANESE HOLLY FERN, HOUSE HOLLY FERN. On rocks or masonry or terrestrial; stems (rhizomes) short, stout, conspicuously scaly; leaves monomorphic, evergreen,

28--60(--100) cm long; leaf blades 1-pinnate, 15--35 cm long; pinnae short-stalked, 4--10(--12) pairs, 4--8.5(--11) cm long, 1.5--3 cm wide, obliquely ovate to lanceolate, usually falcate, sometimes with a short basal lobe, apically acuminate, undulate or irregularly and coarsely dentate marginally, bright green and shiny on adaxial (= upper) surface, leathery; petioles conspicuously scaly at least near base; sori round, conspicuous, scattered over whole abaxial (= lower) surface of pinnae (sometime appearing to be in rows) indusia peltate. Widely cultivated and escaped; remnant brick wall of old sawmill site; Houston Co. (Davy Crockett Natl. Forest---*Stotts 38*, HPC) in the Pineywoods and Hays Co. (Turner & Nichols 2001) near w margin of East TX; also Harris Co. (Turner & Nichols 2001) in Gulf Prairies and Marshes; se U.S. from SC s to Fl and w to TX, also CA, NY, OH, OR, and VA. Sporulating spring--fall. Native of e Asia. [*Polypodium falcatum* L.f.] All U.S. plants appear to be apogamous triploids (Yatskievych 1993). This widely cultivated species is naturalized in many parts of the world (e.g., Great Britain, Azores, Australia) including various parts of the U.S. (Yatskievych 1993; Mabberley 1997). One of the most common cultivars is the ROCKFORD FERN (cultivar "Rockfordianum") (Hoshizaki & Moran 2001). ☜

CYSTOPTERIS Bernh. BLADDER FERN, BRITTLE FERN

A cosmopolitan genus of ca. 20 species. Polyploidy and hybridization are common in the genus and it is taxonomically difficult (Haufler et al. 1993). (Greek: *cystos*, bladder, and *pteris*, fern, in reference to the inflated young indusia covering the sori).
REFERENCES: Blasdell 1963; Haufler et al. 1985, 1993.

Cystopteris protrusa (Weatherby) Blasdell, SOUTHERN BLADDER FERN, LOWLAND BLADDER FERN, LOWLAND BRITTLE FERN, (protruding, in reference to the stem apex extending beyond the point of leaf attachment). Terrestrial; stems (rhizomes) long-creeping, protruding 1--5 cm beyond attachment of current season's leaves, with tan to light brown or golden scales and hairs; leaves appearing in early spring, clustered, seasonally somewhat dimorphic, erect to erect-spreading, to 45 cm long, the blades 1-pinnate-pinnatifid to 2-pinnate, ovate-lanceolate to elliptic, widest at or just below middle, to ca. 25 cm long and 12 cm wide; earliest leaves small, sterile, coarsely divided, with rounded teeth marginally; later leaves larger, fertile, more finely divided, with sharply pointed teeth marginally; sori round, on veins of ultimate leaf segments (= smallest subdivision of leaf) between midrib and margin; indusia delicate, hood- or pocket-like, attached by one side, arching over sori toward segment margin, sometimes ephemeral or obscure at maturity. Moist deciduous forests; cited for Gonzales Co. in the s Blackland Prairie by Correll (1956) (as *C. fragilis* var. *protusa*) and Turner and Nichols (2001). Nixon & Kell (1993) also cited *C. fragilis* (presumably *C. protusa*) for East Texas. Turner and Nichols (2001) also cited Victoria Co. in the Gulf Prairies and Marshes. *Cystopteris protrusa* is also known from McCurtain Co., OK, just n of the Red River (*Taylor & Taylor 28956*, BRIT). While definitive

TX material was not seen in the course of the present study and the range map in Haufler et al. (1993) does not include TX, the species was included based on the citations above and because of the likelihood of its occurrence in East TX; e U.S. from NH s to FL and w to NE, OK, and possibly TX. Sporulating spring--summer. [*C. fragilis* (L.) Bernhardi var. *protrusa* Weatherby] This species is very similar, in general morphology, to *Woodsia obtusa*, BLUNT-LOBE WOODSIA, a species that is much more common in East TX. The two can be distinguished by the indusia and other characters as given in the key to genera of Dryopteridaceae.

DRYOPTERIS Adans. WOOD FERN, SHIELD FERN

Plants terrestrial; rhizomes scaly; leaves 1-pinnate-pinnatifid, slightly dimorphic, the fertile leaves usually larger than the sterile leaves, at least the sterile leaves usually evergreen; pinnae with serrate segments; sori round, in a single row on each side of the midvein of the fertile segments, midway between midvein and margin; indusia round-reniform, attached at a narrow sinus.

A widely scattered but largely north temperate genus of ca. 250 species. A few occur in North America, but most are found in temperate Asia. Hybridization between species is common (Wagner 1970; Montgomery & Wagner 1993). The genus is widely cultivated in temperate gardens (Hoshizaki & Moran 2001). The n temperate *D. filix-mas* (L.) Schott, MALE FERN, is one of the oldest vermifuges (= a medicine that expels intestinal worms) known---it paralyses tapeworms (which can then be removed) but is dangerous because it also paralyses voluntary muscles of patients (Mabberley 1997). (Greek: *drys*, oak or tree, and *pteris*, fern; several species are associated with oak woodlands)

REFERENCES: Wagner 1970; Thomas et al. 1973; Montgomery & Paulton 1981; Carlson & Wagner 1982; Montgomery 1982; Fraser-Jenkins 1986, 1989; Montgomery & Wagner 1993; Hoshizaki and Wilson 1999.

1. Segments of fertile pinnae nearly the same width as those of typical sterile pinnae; base of fertile segments not contracted; pinnae of fertile leaves twisted out of plane of rest of leaf blade and ± perpendicular to it (like open venetian blinds); leaf blades 10--12 cm wide ..... **D. cristata**

1. Segments of fertile pinnae distinctly narrower than those of typical sterile pinnae; base of fertile segments contracted OR not contracted; pinnae of fertile leaves nearly parallel to overall plane of leaf blade; leaf blades 10--30 cm wide ..... **D. ludoviciana**

Dryopteris cristata (L.) A. Gray, CRESTED WOOD FERN, CRESTED SHIELD FERN, (crested). Stems (rhizomes) stout, ascending; petioles scaly at least at base; sterile leaves evergreen; leaf blades 1-pinnate-pinnatifid, narrowly lanceolate or with nearly parallel sides, 30--70 mm long, the basal pinnae somewhat reduced; fertile pinnae typically in distal 1/2 of leaf but sometimes extending into proximal 1/2; segments of fertile pinnae nearly the same width as those of typical sterile pinnae, not more widely spaced, not contracted at base. Swamps, wet woods, bog margins; included based on a 1925 Palmer collection from Bowie Co. (cited in Correll 1956 and Correll & Johnston 1970) in the extreme ne corner of e TX; also cited for vegetational area 1 by Hatch et al. (1990). This species is found primarily in the ne U.S. and Canada (Montgomery & Wagner 1993) and the TX locality is well out of the normal range; its occurrence in TX is thus questionable. Likewise, Thieret (1980) concluded that *D. cristata* "probably does not really grow in Louisiana" Sporulating summer--fall. [*Polypodium cristatum* L.]

Dryopteris ludoviciana (Kunze) Small, SOUTHERN WOOD FERN, (of Louisiana, where it was first discovered---Nelson 2000). Stems (rhizomes) short-creeping, stout; petioles scaly at base; leaves evergreen; leaf blades 1-pinnate-pinnatifid, lanceolate, 25--120 cm long, the basal pinnae much reduced; fertile pinnae in distal 1/2 of leaf; segments of fertile pinnae distinctly narrower than those of sterile pinnae, often more widely spaced, and sometimes contracted at base. Swamps and wet woods; included based on citations for Jasper and Hardin cos. (TOES 1993), Jasper, Hardin, and Polk cos. (Turner & Nichols 2001), for vegetational area 1 by Hatch et al. (1990), for East TX by Nixon and Kell (1993), and for the Big Thicket National Preserve by the National Park Service (1995). Correll (1956) said, “This species was reported by Reverchon (1903) as having been collected by J.M. Fetherolf in Newton County in the Timber Belt. It was also reported from Texas by Cory and Parks (1937). I have not seen any specimens of this species west of East Baton Rouge Parish, Louisiana.” This diploid species is endemic to the se U.S. (Montgomery & Wagner 1993), most collections being from the deep southeast with outlyers in AR, LA, and TX. Sporulating spring--fall. [*Aspidium ludovicianum* Kunze; *Thelypteris ludoviciana* of authors](TOES 1993: IV) ⚠

NEPHROLEPIS Schott BOSTON FERN, SWORD FERN

A genus of 25--30 species widespread in tropical areas. *Nephrolepis* is sometimes placed in the Davalliaceae or Nephrolepidaceae (e.g., Kramer 1990d; Nauman et al. 2000). (Greek: *nephros*, kidney, and *lepis*, scale, in reference to the shape of the indusium)
REFERENCES: Nauman 1981, 1993c; Schneider & Carlquist 1999b.

Nephrolepis exaltata (L.) Schott, (very tall), SWORD FERN, BOSTON SWORD FERN, WILD BOSTON FERN. Stems (rhizomes) short, ± erect, with wiry, widely creeping stolons; leaves monomorphic, evergreen, clustered, 1-pinnate, usually 0.4--1.5 m long, the blades linear-lanceolate; sori

roundish, somewhat closer to margin than to midvein of pinnae, the indusia ± orbicular-reniform. Escaped, persisting and spreading in yard in Highland Park, Dallas Co. (R. O'Kennon, pers. obs.), also Orange (BRIT) and Nacogdoches (TAES) cos.; naturalized in several sites in East TX and on the Edwards Plateau; native to Florida, the West Indies, and scattered Pacific Islands. Sporulating throughout most of the year (Correll 1956). This species is terrestrial or most often epiphytic in its native habitat. It is a commonly cultivated (particularly indoors) and commercially important fern with many cultivars including cv. 'Bostoniensis' (BOSTON FERN) and the locally developed DALLAS JEWEL FERN,™ commonly known as the DALLAS FERN. There is debate over the origin of the name BOSTON FERN, but it apparently originated in the late 1800s or early 1900s when plants of a particular form of *N. exaltata* became popular in nurseries in and around Boston, MA (Benedict 1916).

ONOCLEA L. SENSITIVE FERN

A monotypic genus of n temperate areas; sometimes cultivated as an ornamental.(Greek: *onos*, vessel, and *cleisto*, closed, in reference to the sori, which are enclosed by the revolute fertile leaf margins)

REFERENCES: Lloyd 1971; Beitel et al. 1981; Rothwell & Stocky 1991; Johnson 1993b.

Onoclea sensibilis L., (sensitive), SENSITIVE FERN, BEAD FERN. Stems (rhizomes) creeping; leaves conspicuously dimorphic, of 2 very different types, scattered along the rhizome, erect, glabrous; sterile leaves to ca. 1(--1.3) m tall, thin herbaceous, deciduous, broadly triangular to ovate in outline, deeply pinnatifid with the pinnae few, the pinnae subopposite (especially the lowermost), undulate to irregularly deeply lobed, the margins entire, the veins reticulate and forming a series of linear to oblong areoles along the midvein (= costa), the rachis winged; fertile leaves persistent over winter, 2-pinnate, the blades greatly reduced, the ultimate blade segments (= smallest subdivisions of blade) rolled into globular, berry-like or bead-like structures concealing the sori, the whole fertile leaf superficially resembling a narrow panicle of small round fruits. Swamps, low woods, and wet areas; mainly Pineywoods and n Gulf Prairies and Marshes w through Post Oak Savannah to Milam, and Upshur (BRIT), Red River, Henderson, Limestone, Falls (Turner & Nichols 2001), and Wilson (Correll 1956; TAES) cos.; also e Edwards Plateau; se Canada and throughout e U.S. w to ND and TX. Sporophylls produced Apr--Oct, persisting through the winter and releasing the green spores in spring before expansion of the sterile leaves (Johnson 1993b). The common name is in reference to the sensitivity of the leaves to even a light frost (Johnson 1993b). The sterile leaves superficially resemble those of *Woodwardia areolata*, but that species has alternate pinnae with minutely serrulate margins.

SENSITIVE FERN is native to both e North America and e Asia (Hoshizaki & Moran 2001); see *Diarrhena* or *Zizania* (Poaceae) for a discussion of this interesting disjunct distribution pattern. Fifty-seven million year old Paleocene Epoch fossils virtually identical to modern members of this species provide evidence that fern species can remain essentially unchanged over millions of years (Rothwell & Stockey 1991; Serbet & Rothwell 1999). This species is reported to be poisonous; horses are said to become unsteady and collapse upon ingesting the plant (Burlage 1968; Turner & Szczawinski 1991). ☠

POLYSTICHUM Roth CHRISTMAS FERN, SWORD FERN, HOLLY FERN

A cosmopolitan genus of ca. 180 species. *Cyrtomium* is related to *Polystichum* and some authorities lump it into *Polystichum* (e.g., Mabberley 1997). (Greek: *poly*, many, and *stichos*, row, presumably in reference to the rows of sori on each pinna)
REFERENCES: Wagner 1993; Noodén and Wagner 1997; Schneider & Carlquist 1997.

Polystichum acrostichoides (Michx.) Schott, (resembling *Acrostichum*, leather ferns, another genus of ferns with many crowded sori---Nelson 2000), CHRISTMAS FERN, DAGGER FERN. Stems (rhizomes) erect; leaves evergreen, clustered, to 70 cm long, the blades elliptic-lanceolate to lanceolate in outline, 1-pinnate; pinnae mostly alternate, auricled basally, the auricle on the acroscopic side (= side toward the leaf apex) of the pinna, the margins bristle-toothed; petioles densely scaly; leaf blades partially dimorphic, the proximal pinnae (those near blade base) sterile, the distal pinnae (those near blade tip) of some blades fertile and conspicuously contracted (but blade tissue still evident); sori round, crowded in 2--4 rows, medial, often confluent at maturity; indusia peltate, entire, persistent. Rich wooded slopes, moist areas; Pineywoods and Post Oak Savannah w to Anderson (Turner & Nichols 2001), Waller, Wood (Correll 1956; TAES), and Red River (BRIT) cos.; se Canada and throughout e U.S. w to MN and TX. Sporulating May--Nov. According to Correll (1956), "In some areas the evergreen fronds are gathered for decorative greens at Christmas time, hence the common name." Experimental evidence (Noodén and Wagner 1997) indicated that the leaves being green in winter is beneficial. The two hypotheses for this benefit are: 1) extension of the period of photosynthesis into the winter, and 2) nutrient storage in the old leaves requiring only a single transfer of nutrients to the new leaves (versus two transfers if storage is in the rhizomes).

TECTARIA Cav. HALBERD FERN

A mostly tropical genus of ca. 200 species; some are cultivated as ornamentals. (Latin: *tectum*, roof, and *aria*, a suffix, in reference to the roof-like indusium of some species---Moran 1993)
REFERENCES: Morton 1966; Moran 1993b.

Tectaria heracleifolia (Willd.) Underw., (with leaves superficially like *Heracleum*---cow parsnip, in the carrot family), BROAD HALBERD FERN. Stems (rhizomes) erect; leaves evergreen, clustered, to 90 cm long; leaf blades monomorphic, ovate to pentagonal in outline, (12--)20--45(--50) cm long, 1-pinnate, with 3--5(--7) pinnae (1--2(--3) pairs plus a single terminal pinna), thick-herbaceous to subcoriaceous; pinnae, particularly the proximal ones, with large basal lobe(s), the margins with shallow lobes, the apices acuminate to long-attenuate; lateral pinnae ± falcate; petioles glabrous, sparsely scaly basally; sori round, in single rows on either side of the side veins of the pinnae, to ca. 3 mm in diam.; indusia peltate, entire, persistent. Limestone sink-holes and cave entrances, occasionally in shaded canyons or shaded rock outcrops or railroad tunnels; in East TX known only Comal Co. (Turner & Nichols 2001) near boundary of Blackland Prairie and Edwards Plateau; mainly Edwards Plateau; in the U.S. otherwise only known from FL. Sporulating Apr--Oct.

WOODSIA R. Br. CLIFF FERN

A genus of ca. 30 species found mainly in n temperate regions and at high elevations in the tropics. The common name, CLIFF FERN, comes from the tendency of a number of species to grow on or among rocks (Hoshizaki & Moran 2001). (Named for Joseph Woods, 1776--1864, English botanist and architect)
REFERENCES: Windham 1987a, 1993d; Carlquist et al. 1997.

Woodsia obtusa (Spreng.) Torr., (obtuse, blunt), COMMON WOODSIA, BLUNT-LOBE WOODSIA, BLUNT-LOBE CLIFF FERN, LARGE WOODSIA. Stems (rhizomes) short; leaves monomorphic, semi-evergreen, clustered, erect-ascending, to 40(--60) cm tall, often smaller, the blades elliptic-lanceolate to broadly lanceolate, 2-pinnate or 2-pinnate-pinnatifid; sori round, between midrib and lateral margins of ultimate segments (= smallest subdivision) of leaf; indusia rather large, at first enclosing the sporangia and later splitting into several spreading, irregular lobes. Rocky areas, outcrops, well-drained often sandy areas; Pineywoods w to Montague and Palo Pinto (BRIT) cos. in the Cross Timbers and Prairies; also e Edwards Plateau; se Canada and throughout e U.S. w to NE and TX. Two subspecies of *W. obtusa*, differing in chromosome number, are recognized by Windham (1993d) as occurring in East TX and have been separated and described by him (see key to subspecies below). We, however, have been unable to clearly and consistently separate the specimens from East TX into the 2 subspecies. Windham (1993d) further indicated that the 2 subspecies hybridize in the area of sympatry and form sterile triploids with malformed spores. According to Turner and Nichols (2001), collections from e of a line from Fannin to Bastrop cos. are var. [subsp.] *obtusa*, while those w of this line are var. [subsp.] *occidentalis*.

1. Spores averaging 42--47 µm; proximal pinnules of lower pinnae usually shallowly lobed or merely dentate; blades coarsely cut and evidently 2-pinnate; stems compact to short-creeping, individual branches usually 5--10 mm diam. ..... subsp. **obtusa**
1. Spores averaging 35--42 µm; proximal pinnules of lower pinnae usually deeply lobed or pinnatifid; blades finely cut, 2-pinnate-pinnatifid; stems short- to long-creeping, individual branches 3--5 mm diam. ..... subsp. **occidentalis**

subsp. **obtusa**. 2*n* = 152. Se Canada and e U.S. w to NE and e 1/3 of TX.

subsp. **occidentalis** Windham, (western). 2*n* = 76. AR, KS, OK, and TX.

LYGODIACEAE C. Presl. CLIMBING FERN FAMILY

A very small family (1 genus, ca. 40 species) of tropical regions nearly worldwide, and temperate areas of North America, Asia, and s Africa, and Pacific Islands. The family is sometimes included in the Schizaeaceae (e.g., Correll 1956; Radford et al. 1968; Correll & Johnston 1970; Kramer 1990f; Mabberley 1997; Nauman et al. 2000). However, we are following Nauman (1993a) and Kartesz (1999) in recognizing it as a distinct family.
FAMILY RECOGNITION IN THE FIELD: the solitary species in the flora is the only twining/climbing, vine-like fern in TX.
REFERENCE: Nauman 1993a.

LYGODIUM Sw. CLIMBING FERN

A tropical and warm area genus of 40 species of climbing vine-like ferns with leaves having indeterminate growth (elongating rachises). The twining stem-like rachises are used for such things as basketry, fish-traps, mats, and yarn. Only one species, *L. palmatum* (Bernhardi) Sw., AMERICAN CLIMBING FERN, is native to the U.S., endemic from ME s and w across the e U.S. as far as MI and MS. According to Hoshizaki and Moran (2001), "The evergreen fronds [of *L. palmatum*] used to be collected during the winter and used for Christmas decorations. This destroyed so many populations that in 1869 the Connecticut legislature enacted a law to protect the plant---the first plant conservation law passed in the United States." This native species is easily distinguished from *L. japonicum* by its 1-palmately lobed pinnules and petioles borne 10--

40 mm apart. ⃠ Another Old World, *Lygodium microphyllum* (Cav.) R. Br. , OLD WORLD CLIMBING FERN, is considered a dangerous invasive weed in Florida (Pemberton 1998; Pemberton & Ferriter 1998; Nauman et al. 2000) and is listed as a category I pest species by the Florida Exotic Pest Plant Council (Nelson 2000). (Greek: *lygodes*, flexible, in reference to the twining rachises---Nauman 1993a).
REFERENCES: Duek 1978; Nauman 1987; Pemberton 1998; Pemberton & Ferriter 1998; Carlquist & Schneider 1998.

Lygodium japonicum (Thunb. ex Murray) Sw., JAPENESE CLIMBING FERN, (of Japan). Terrestrial; stems (rhizomes) subterranean, 2--3 mm in diam., creeping, bearing petioles 2--7 mm apart; leaves with indeterminate growth, climbing, vine-like, to 3(+) m long, the rachis elongate, twining, flexuous, stem-like (true stem below ground); pinnae reduced to short stalks, these short stalks each bearing a pair of opposite pinnules and typically a dormant apical bud; pinnules usually 2--3-pinnate, sparsely to moderately pubescent on the abaxial (= lower) surfaces, the ultimate segments (= smallest subdivisions) of pinnules serrulate; fertile pinnules toward leaf apex, similar to sterile pinnules except having ultimate segments (= smallest subdivisions) fringed with finger-like fertile lobes; sporangia in 2 rows, 1 on each side of midvein of oblong marginal lobes of ultimate segments, covered by hood-like flaps or flanges of tissue which serve as indusia. Naturalized in low woods, thickets, roadside ditches, circumneutral soils; Hardin, Harris, Jasper, Jefferson, Orange (BRIT), Liberty, Montgomery (TAMU), Tyler (TAES), Polk, San Jacinto, and Walker (Turner & Nichols 2001) cos. in s part of the Pineywoods; in some areas (e.g., Jack Gore Baygall Unit of the Big Thicket National Preserve in Hardin Co.) it is so abundant and integrated into the vegetation that it appears native (G. Diggs, pers. obs.); also Chambers Co. (Turner & Nichols 2001) in the n Gulf Prairies and Marshes. Sporulating Apr--frost. Native of e Asia (China and Japan), now naturalized in the U.S. from North Carolina s to FL and w to AR and TX (Nauman 1993a). [*Ophioglossum japonicum* Thunb. ex Murray] This widely cultivated, introduced species has been reported as weedy in some areas of the se U.S.; its dense canopy can prevent the growth of underlying vegetation (Nauman 1993a); it is ranked as a category I species on the Florida Exotic Pest Plant Council's (EPPC) 1999 List of Florida's Most Invasive Species (Nauman et al. 2000). ⃠ ☜

MARSILEACEAE Mirb. WATER-CLOVER OR PEPPERWORT FAMILY

Plants aquatic or of very wet habitats; stems (rhizomes) long-creeping; leaves scattered along the stems, long-petioled and palmately divided into 4 pinnae or else filiform and lacking expanded blades; sori contained in sporocarps (= hard bean- or pea-like structures which are apparently highly modified pinnae) on stalks from near base of petiole; sporangia of 2 kinds within the same sorus, the megasporangia with 1 megaspore, the microsporangia with numerous microspores.

A nearly cosmopolitan family of 3 genera and ca. 50 species. Three families of heterosporous water ferns occur in East TX (*Azolla*---Azollaceae, *Marsilea*, *Pilularia*---Marsileaceae, and *Salvinia*---Salviniaceae). These groups are quite distinct morphologically, and traditionally the marsileaceous (*Marsilea* and *Pilularia*) and salviniaceous (*Azolla* and *Salvinia*) lines were considered to have evolved independently from different homosporous fern ancestors. However, based on recent morphological, fossil, and molecular evidence, all three living heterosporous water fern families appear to comprise a monophyletic group (Rothwell & Stockey 1994; Hasebe et al. 1995; Pryer 1999).

FAMILY RECOGNITION IN THE FIELD: plants of wet areas with leaves resembling a *4-leaf clover* (in 1 species apparently rare in East TX the leaves thread-like and ± resembling those of a grass); sori in hard, *bean- or pea-like structures* near the base of the petioles.

REFERENCES: Correll 1956, 1966a; Kramer 1990c; Johnson 1993a; Lesho 1994; Pryer 1999; Schneider & Carlquist 2000b.

1. Leaf blades (resembling a 4-leaf clover) palmately divided into 4 narrowly to broadly cuneate (= wedge-shaped) pinnae ..... **Marsilea**
1. Leaves filiform, very narrow, somewhat grass-like in appearance, without expanded blades..... **Pilularia**

MARSILEA L. WATER-CLOVER, PEPPERWORT

Small plants, aquatic or of wet habitats, often forming dense colonies; leaves long petiolate with blades palmately divided into 4 pinnae; sporocarps on stalks, the tip of stalk often protruding as a bump or tooth (proximal tooth), a second distal tooth sometimes present on sporocarps beyond the attachment point of the stalk.

A nearly cosmopolitan genus of 45 species. The leaves, with 4 pinnae (= leaflets) have a superficial resemblance to those of CLOVER; young plants can have unlobed leaves like *Pilularia*.

An Australian member of the genus, the NARDOO FERN, (*M. drummondii* A. Braun), is particularly rich in the enzyme thiaminase (which breaks down vitamin B1---thiamine), and is reported to have caused the suffering and death of members of the first scientific expedition to cross Australia from south to north (1860--61). Upon running out of food, the explorers ate the fern, which was known to be consumed by aborigines (but specially prepared by them). The consumption of the inadequately prepared fern resulted in beriberi (vitamin B1 deficiency) affecting almost all members of the expedition; they experienced weakness, emaciation, partial paralysis of the legs, nerve damage, and in some cases death. The fatal poisoning of large numbers of Australian sheep by NARDOO FERN has also been reported (Earl and McCleary 1994; Moran 1995; Bruneton 1999). The sporocarps are extremely durable and resistant to water loss,

and spores may remain viable for up to 130 years (Johnson 1985; Moran 1995). When the sporocarp is moistened, the gelatinous interior uptakes water and a worm-like mass of gelatine is extruded, thus releasing the sori (Kramer 1990d). (Named for Count Luigi Ferdinandino Marsigli, 1656--1730, Italian mycologist at Bologna)
REFERENCES: Gupta 1957; Thieret 1977; Johnson 1986, 1988.

1. Pinnae 9--35 mm long, 8--39 mm wide; sporocarps densely villous with long spreading hairs; distal tooth of sporocarps absent or to 0.5 mm long, blunt; sporocarp stalks usually branched, with several sporocarps per stalk ..... **M. macropoda**

1. Pinnae 4--19 mm long, 4--16 mm wide; sporocarps pubescent with appressed hairs or often glabrate; distal tooth of sporocarps 0.4--1.2 mm long, acute; sporocarp stalks unbranched, with 1 sporocarp per stalk ..... **M. vestita**

Marsilea macropoda Engelm. ex A. Braun, (large-footed), LARGE-FOOT PEPPERWORT, BIG-FOOT WATER-CLOVER, WATER-CLOVER. Petioles 5--39 cm long. Typically in mud, also shallow water; Travis (BRIT), Bexar, Fayette, Wilson (Turner & Nichols 2001) cos. near the w margin of the Blackland Prairie; mainly c to s TX; AL, FK, LA, and TX. Sporocarps produced nearly year round. An attractive plant that is cultivated as an ornamental.

Marsilea vestita Hook. & Grev., (covered), HAIRY WATER-CLOVER. Petioles 2--20 mm long. Ponds, wet depressions, along streams and rivers; sw Canada throughout w U.S. e to MN and LA and extending in the se U.S. e to FL. Sporocarps produced Mar--Oct. Turner and Nichols (2001) cited a number of East TX localities for this species without distinguishing subspecies.

1. Pinnae narrow in appearance, 3--7.5 times as long as wide, narrowly and obliquely cuneate, irregularly toothed or crenulate at apex ..... subsp. **tenuifolia**

1. Pinnae broad in appearance, usually 1--2 times as long as wide, fan-shaped or broadly cuneate, with entire or undulate-crenulate apex ..... subsp. **vestita**

subsp. **tenuifolia** (Engelm. ex A. Braun) D.M. Johnson, (slender-leaved), NARROW-LEAF PEPPERWORT. This rare taxon has been variously treated as a separate species (Correll & Johnston 1970), as a subspecies of *M. vestita* (Johnson 1986; Kartesz 1994), or as part of an undivided *M. vestita* (Johnson 1993a; Jones et al. 1997, Kartesz 1999). Because it can usually be easily distinguished in the field (see key above), we are treating it as a subspecies of *M. vestita*. Included based on citation of Travis Co. (Correll 1956) at the w margin of East TX; also South

Texas Plains, Gulf Prairies and Marshes, and Edwards Plateau. [*M. tenuifolia* Engelm. ex A. Braun]

subsp. **vestita**, HOOKED PEPPERWORT, WATER-CLOVER, HAIRY PEPPERWORT. Travis (BRIT), Austin, Brazos, Burleson, Robertson (TAMU), Bastrop, Colorado, Dallas, Ellis, Gonzales, Hays, and Williamson (Correll 1956) cos.; Post Oak Savannah and Blackland Prairie s and w across TX. [*M. mucronata* A. Braun, *M. uncinata* A. Braun]

PILULARIA L. PILLWORT

A genus of 6 species of inconspicuous grass-like or sedge-like plants of North America, South America, Europe, Pacific Islands, Australia, and New Zealand; sometimes placed in its own family. (Latin: *pilula*, a little ball, in reference to the spheric sporocarps)
REFERENCES: LaMotte 1940; Hill 1980; Dennis & Webb 1981; Culwell 1994.

Pilularia americana A. Braun, (of America), AMERICAN PILLWORT, WATER-PEPPER. Small inconspicuous aquatic, submersed or infrequently persisting on bare mud; leaves filiform, 1.6--10.2 cm long, lacking expanded blades; sporocarps produced just below ground surface, globose, 2--6(--10) mm long, 2--3 mm in diam. Temporary pools, ponds, reservoir margins. According to the range map in Johnson (1993a), *P. americana* occurs widely in the n part of East TX and it is included here on that basis; the only known nearby collection we have seen is from Burnet Co. (Granite Mt.---BRIT, just w of East TX); AR, CA, GA, KS, MO, NE, OK, OR, TN, and TX (Johnson 1993a). The species is so inconspicuous that it is rarely recognized or collected. A large population (ca. 150 sq. m) was discovered in AR (Culwell 1994), prompting the comment that the species "may be more common than herbarium specimens indicate" (Culwell 1994).

OPHIOGLOSSACEAE (R. Br.) C. Agardh ADDER'S-TONGUE FAMILY

East TX species terrestrial; stems ± subterranean, simple, unbranched, upright; leaves 1 or less commonly 2 per stem, with common stalk of a leaf divided into a blade portion (= trophophore) and a fertile sporangia-bearing portion (= sporophore); blade portion simple, divided, or compound; fertile portion lacking blade-like tissue, typically consisting of a long stalk with a terminal, branched or unbranched, sporangia-bearing area; sporangia large (in comparison with those of most other ferns), spherical, thick-walled, borne in 2 rows on the branches or on the unbranched sporangia-bearing area.

A nearly cosmopolitan family of 5 genera and ca. 70--80 species of eusporangiate ferns (= with large sporangia having hundreds to thousands of spores per sporangium). Ophioglossaceae are thought by some (e.g., Kato 1988) to be only distantly related to other ferns. Wagner (1990)

indicated that "Of modern plants normally classified as 'ferns,' the Ophioglossaceae are the most isolated." They are apparently relicts of an ancient lineage (Bell & Woodcock 1983), and a number of characteristics "...suggest closer affinities to progymnosperms or cycadophytes than to typical modern ferns" (Wagner 1990). Likewise, molecular evidence (e.g., Vangerow et al. 1999), suggests that Ophioglossaceae and Marattiaceae (e.g., *Angiopteris*) are in a clade which is the sister group to all other ferns. The family is made up of 2 clearly defined subfamilies, Botrychioideae and Ophioglossoideae, sometimes recognized as distinct families. The young leaves unfold rather than having the form of a fiddlehead that unrolls as in most ferns (conduplicate rather than circinate) (Kato 1988; Wagner 1990; Nelson 2000). The following treatment draws heavily on Wagner and Wagner (1993).

FAMILY RECOGNITION IN THE FIELD: often small plants with only 1 or sometimes 2 leaves; leaves with a blade portion (simple to compound) and an erect, spike-like, fertile portion consisting of an elongate stalk and a terminal, fertile, sporangia-bearing area.

REFERENCES: Clausen 1938; Correll 1956, 1966a; Thomas 1972, 1980; Kato 1988; Wagner 1990; Wagner & Wagner 1993; Vangerow et al. 1999.

1. Leaf blades ternately-pinnately compound, divided, or lobed, the margins usually denticulate to serrate or lacerate; veins of leaf blades dichotomous (= equally 2-forked) and free; sporangia in a pinnately branched, panicle-like arrangement ..... **Botrychium**
1. Leaf blades simple, the margins entire; veins of leaf blades reticulate (= in a net-like pattern); sporangia in an unbranched, linear, spike-like arrangement ..... **Ophioglossum**

BOTRYCHIUM Sw. GRAPE FERN, MOONWORT

Blade portion of leaf compound, divided or lobed, ovate to triangular or broadly triangular in outline, ± ternate (= divided into three ± equal parts); fertile portion of leaf consisting of an elongate stalk terminated by a 1--2-pinnate, panicle-like, sporangia-bearing region.

A nearly cosmopolitan genus of 50--60 species with greatest diversity at high latitudes and high elevations. Most species are quite variable vegetatively, resulting in considerable taxonomic confusion. Plants typically produce only one leaf each year (Nauman et al. 2000). (Latin: *botry*, bunch (of grapes), in reference to the sporangial clusters)

REFERENCES: Butters 1917b; Thomas 1979; Wagner 1960, 1992; Hauk 1995; Do et al. 1996; Holmes et al. 1996; Skoda 1997; Hauk & Haufler 1999.

1. Plants small, to only ca. 12 cm tall; blade portion of leaf prostrate on ground, small, only 3--8 cm long, short-stalked (petiole-like stalk 1.5--3 cm long); ultimate segments (= smallest subdivisions) of leaf fan-shaped, their tips broadly rounded; leaves commonly 2 per plant..... **B. lunarioides**

1. Plants usually larger, 8--75 cm tall; blade portion of leaf raised above the ground, not prostrate, usually larger, 4--30 cm long, either long-stalked (petiole-like stalk 3--20 cm long) OR sessile (petiole-like stalk absent) in *B. virginianum*; ultimate segments of leaf not fan-shaped, their tips usually pointed or obtuse; leaves usually 1 per plant.
   2. Blade portion of leaf long-stalked, appearing to have a long petiole (blade portion well-separated from origin of fertile stalk); blade coarsely divided, the ultimate segments relatively few, large, with finely denticulate margins; leaves present in winter.
      3. Ultimate segments of blade portion mostly oblong to obliquely lanceolate to narrowly lanceolate, the margins nearly parallel, basally cuneate, apically relatively blunter; blade portion of leaf 2--3-pinnate (often 2-pinnate), ± papery/herbaceous, mostly remaining green during winter, only rarely bronze..... **B. biternatum**
      3. Ultimate segments of blade portion usually ± trowel-shaped (rarely linear), the margins usually not parallel, basally truncate or obtuse, apically relatively more pointed; blade portion of leaf mostly 3-pinnate, relatively leathery, bronze in winter if exposed ..... **B. dissectum**
   2. Blade portion of leaf sessile (fertile stalk originating at very base of blade portion); blade finely divided, the ultimate segments numerous, small, with coarsely serrate to lacerate (= irregularly cut) margins; leaves absent in winter..... **B. virginianum**

Botrychium biternatum (Savigny) Underw., (twice-ternate), SOUTHERN GRAPE FERN, SPARSE-LOBE GRAPE FERN, WINTER GRAPE FERN. Plant ca. 10--35 cm tall; roots usually 10 or fewer, blackish; leaves present over winter, mostly green but rarely bronze in winter if exposed; new leaves appearing in late spring to early summer; sterile blade portion green to dark green, long-stalked (stalk 3--20 cm long), ± papery/herbaceous, to 18 cm long and 28 cm wide, usually smaller, 2--3-pinnate (often 2-pinnate); pinnules elongate, obliquely lanceolate to narrowly

lanceolate, the margins nearly parallel, finely denticulate (marginal teeth finer and more uniform than in *B. dissectum*), the apices obtuse to short-acuminate. The leaves are much less finely divided than in *B. virginianum*, the 2 species are immediately distinguishable in the field, herbarium, or illustrations. Low woods; Pineywoods, Post Oak Savannah, and Gulf Prairies and Marshes w to at least Brazos Co (TAMU) and Fannin Co. (BRIT) in the Red River Drainage; e U.S. from PA s to FL and w to IL, OK, and TX. Spores maturing in the fall. [*B. tenuifolium* Underw., *B. dissectum* Spreng. var. *tenuifolium* (Underw.) Farw.] While *B. biternatum* is cited only for vegetational area 1 (Fig. 2) by Hatch et al. (1990), all TX material seen by W.H. Wagner, Jr. (pers. comm.) going under the name of *B. dissectum* is actually *B. biternatum* (with the possible exception of material from very close to the LA border). The map in Wagner and Wagner (1993) clearly shows *B. biternatum* in East TX while *B. dissectum* occurs in the se U.S. w to approximately the LA-TX border. Further, a recent collection (1999) of *B. biturnatum* was made in Fannin Co. (*Diggs & Beach, s.n.,* BRIT) near the w margin of e TX. The Blackland Prairie citation for *B. dissectum* by Hatch et al. (1990) is therefore assumed to be *B. biternatum*. See more discussion under *B. dissectum*.

Botrychium dissectum Spreng., (dissected), DISSECTED GRAPE FERN, OBLIQUE GRAPE FERN, CUT-LEAF GRAPE FERN. Plant similar to *B. biternatum*; leaves present over winter, often bronze or reddish bronze in winter if exposed; new leaves appearing in late spring; sterile blade portion shiny green, relatively leathery, to 20 cm long and 30 cm wide, mostly 3-pinnate; pinnules usually ± trowel-shaped (rarely linear), the margins usually not parallel, denticulate to dentate, the marginal teeth coarser and less uniform than in *B. biternatum*. In various habitats from open grassy areas to deep forests; included based on range map in Wagner & Wagner (1993) showing extreme e margin of Pineywoods (see note under *B. biternatum*); we have, however, seen no specimens that are unambiguously *B. dissectum*; se Canada and throughout e U.S. w to KS, MN, OK, and possibly TX. Spores maturing in the fall. [*B. dissectum* var. *obliquum* (Muhl. ex Willd.) Clute, *B. dissectum* var. *oblongifolium* (Graves) Broun, *B. obliquum* Muhl. ex Willd., *B. obliquum* var. *elongatum* Gilbert & Haberer] This is a highly variable species (Wagner & Wagner 1993), some forms of which resemble *B. biternatum*. According to Taylor (1984) "…there do not appear to be any stable characters which will always clearly distinguish these two taxa." Thomas (1980) indicated that the two intergrade and that some individual specimens puzzle even the experts. Nauman et al. (2000) lumped *B. dissectum* into *B. biternatum* saying, "they intergrade in Florida to such an extent that two species cannot be maintained." However, according to W.H. Wagner Jr. (pers. comm.) and Wagner and Wagner (1993), *B. dissectum* has leaves that are more dissected and the pinnules usually trowel-shaped (rarely linear), apically more pointed, and with the margins more lacerate. While unsure of the best treatment of this taxon, until further study is done, we are following Wagner and Wagner (1993) in recognizing *B. dissectum* as a distinct species. All individuals of this species in LA (Thieret 1980) and

presumably also in TX would previously have been treated as var. *obliquum* rather than the much more dissected northern var. *dissectum*.

Botrychium lunarioides (Michx.) Sw., (resembling moonwort---*Botrychium lunaria*), WINTER GRAPE FERN, PROSTRATE GRAPE FERN. Roots 20--30, yellow to brown; leaves appearing in late fall, overwintering and then dying in early spring (wholly underground and dormant for 8--9 months per year); sterile blade portion usually pale green, short-stalked, fleshy, to 12 cm wide, 2--3-pinnate-pinnatifid; ultimate leaf segments fan-shaped, with midrib absent, denticulate, rounded at apex. Open closely cut grassy areas, often in cemeteries; Pineywoods and Post Oak Savannah w to Bastrop, Falls, Hunt, Hopkins, Kaufman, Limestone, Milam, and Navarro cos. on e edge of Blackland Prairie (Do et al., 1996; Holmes et al. 1996); se U.S. from NC s to FL and w to OK and TX. Spores maturing Feb--Apr. [*Holubiella lunarioides* (Michx.) Skoda] According to Wagner and Wagner (1993), a "...peculiarity of this species is the tendency for the sporophores to remain curled in late fall and early winter and to become erect in February." This species was first collected in TX (San Augustine Co.) in 1972 (Thomas 1979). It was only recently reported from the Blackland Prairie by Holmes et al. (1996) who greatly expanded its known distribution within TX. Wagner (1992) considered *B. lunarioides* to be distinct enough to place it in its own section. This species is easily overlooked. Nelson (2000) indicated that the "most effective way to find this fern is to search for it in closely cut lawns, especially cemeteries, by crawling on hands and knees or by laying one's face close to the ground, then looking laterally across the top of the grass for the fertile frond segments."

Botrychium virginianum (L.) Sw., (of Virginia), RATTLESNAKE FERN, VIRGINIA GRAPE FERN, COMMON GRAPE FERN. Plant erect, 8--75 cm tall; roots 15 or fewer, yellow to brown; leaves seasonal, appearing in early spring and dying in summer; sterile blade portion pale green, sessile, thin, herbaceous, 4--30 cm long and wide, 3--5-pinnate-pinnatifid; ultimate leaf segments linear, with midrib present, serrate to lacerate, pointed at apex. Moist, rich woods and thickets; Pineywoods w to Cross Timbers and Prairies (e.g., Grayson and Tarrant cos.---BRIT); also e Edwards Plateau; throughout most of Canada and the U.S. Spores maturing Apr--Jun. The common name is probably derived from a resemblence of the clusters of sporangia to the rattles of a rattlesnake. Alternatively, it has "been reported that a salve made by boiling the roots of the plant was used by the Cherokee Indians in the treatment of snake bites" (Nelson 2000).

OPHIOGLOSSUM L. ADDER'S-TONGUE

Plants small, East TX species to ca. 25 cm tall; blade portion of leaf simple; fertile portion of leaf consisting of an elongate stalk terminated by an unbranched, linear, spike-like, sporangia-bearing region.

A nearly cosmopolitan, but mainly tropical and subtropical genus of 25--30 species. *Ophioglossum* species have the highest chromosome numbers known for vascular plants, with numbers as high as $2n = 1,200+$ being reported. The genus is noted for its taxonomic problems due to such factors as the inadequacy of herbarium collections, rarity of populations, subtlety of characters, and variability (Wagner et al. 1984). Leaf venation is particularly important for identification of some *Ophioglossum* species. Because this character is often difficult to observe in dried specimens, Wagner et al. (1984) suggested wetting the leaf by putting a few drops of 95% ethanol directly on the leaf surface and then observing using transmitted light. *Ophioglossum polyphyllum* A.Br., widespread in the Old World, but not previously known for North America, was recently reported from the Trans-Pecos of Texas (Zech et al. 1998); it had previously been confused with *O. engelmannii* (Zech & Manning 1996). Many species are small and thus easily overlooked. They also superficially resemble other plants including *Plantago* species (PLANTAINS)---however, *Ophioglossum* species can be distinguished by the lack of a midrib on the leaf blades (Hoshizaki & Moran 2001). (Greek: *ophis*, snake, and *glossa*, tongue, in reference to the tip of the sporangia-bearing structure)

REFERENCES: Thomas 1979; Wagner et al. 1984; Thomas et al. 1987; Zech et al. 1998; Schneider & Carlquist 1999a.

1. Stems (± subterranean and sometimes called rootstocks) globose-bulbous, 3--12 mm diam., nut-like; leaves emerging from cavity in top of stem, the blade portion usually near ground, spreading or nearly flat on ground, usually roughly triangular to orbicular-ovate or cordate, to only 35 mm long; sporangial clusters < 1 cm long; common stalk (to where blade portion and fertile stalk separate) usually < 3 cm long ..... **O. crotalophoroides**

1. Stems cylindric, upright, to ca. 5 mm diam.; leaves developing at top of stem, the blade portion usually well above ground, erect to spreading, usually ovate to lanceolate, to 120 mm long; sporangial clusters 0.5--4 cm long; common stalk varying from <1 to as much as 10 cm long.
   2. Blade portion of leaf with distinct and sometimes prominent apiculate tip, ± folded when alive or not so; principal veins of blade forming large primary areolae (= vein enclosed areas) in which are included numerous veinlets forming secondary areoles (which can enclose free veinlets).
      3. Blade portion of leaf (when alive) commonly folded, to 10 cm long and 4.5 cm wide, when dried uniformly green without pale central band; roots 0.5--1.5 mm in diam.; fertile stalks 1.3--2.5

times length of blade portion; leaves (blade portion and fertile portion combined) 1--2 per stem; widespread in East TX..... **O. engelmannii**

3. Blade portion of leaf (when alive) not folded, to 4.5 cm long and 1.7 cm wide, when dried commonly with a pale central band; roots 0.2--0.8 mm in diam.; fertile stalks 2--6 times length of blade portion; leaves (blade portion and fertile portion combined) 2--3 per stem (this large form of *O. nudicaule* may not occur within TX) ..... **O. nudicaule** (large form)

2. Blade portion of leaf without apiculate tip, usually rounded to acute at apex OR with small apiculate tip (in *O. nudicaule*), commonly plane (= not folded) when alive; principal veins of blade forming areolae but these including only free veinlets (= with one end not touching another vein).

4. Blade portion of leaf rounded at apex, without apiculate tip, to 10 cm long and 4 cm wide (usually > 5 cm long); adult leaves usually 1 per stem, appearing in a single flush once per year..... **O. vulgatum**

4. Blade portion of leaf acute at apex, with OR without apiculate tip, less than 4.5(--6) cm long and 1(--3) cm wide; adult leaves commonly 2--3 per stem, appearing in 1 or more flushes per year, depending on rains.

5. Roots dark brown, usually fewer than 8 per shoot, the major roots generally straight, 0.8--1.3 mm in diam.; blade portion of leaf usually without apiculate tip, usually with coarse venation ..... **O. petiolatum**

5. Roots yellowish to pale brown, usually more than 12 per shoot, 0.2--0.8 mm in diam.; blade portion of leaf with short apiculate tip, usually with fine intricate venation..... **O. nudicaule** (small form)

Ophioglossum crotalophoroides Walter, (from Greek: *krotalon,* a rattle, and *-oides,* like or resembling, due to the resemblance of the sporongial clusters to rattles or castanets), BULBOUS ADDER'S-TONGUE, DWARF ADDER'S-TONGUE FERN. Plant usually to only 15 cm tall; stems (± subterranean) globose-bulbous, 3--12 mm diam., nut-like or pea-sized; leaves (blade portion and fertile portion combined) 2 per stem; blade portion to 35 mm long and 25 mm wide, usually smaller, pale green; fertile stalk 1--5 times as long as blade portion; sporangia 4--8(--12) on each side of fertile stalk. Usually in moist sand, ditches, lawns, cemeteries, areas where grass is short; Pineywoods and Post Oak Savannah w to Fannin (BRIT), Bastrop, Hunt, Limestone, and Milam (Turner & Nichols 2001) cos.; also n Gulf Prairies and Marshes and e Edwards Plateau; se U.S. from NC s to FL and w to OK and TX. Leaves appearing late winter and early spring, sometimes later in season after heavy rains; usually sporulating Mar--May. The globose-bulbous stem is

unique among other TX members of the genus. According to Thomas (1979), "This species is probably the most common fern in East Texas and is found abundantly in early spring in almost every sandy area where grass is short, such as school lawns and cemeteries."

Ophioglossum engelmannii Prantl, (for George Engelmann, 1809--1884, German-born American botanist), ENGELMANN'S ADDER'S-TONGUE, LIMESTONE ADDER'S-TONGUE. Plant to 25 cm tall; leaves (blade portion and fertile portion combined) 1--2 per stem; blade portion to 100 mm long and 45 mm wide, commonly folded when alive, when dried uniformly pale green without pale central band, dull; fertile stalk 1.3--2.5 times as long as blade portion; sporangia 20--40 on each side of fertile stalk. Usually in thin black soils on limestone, wooded rocky slopes; Pineywoods and Gulf Prairies and Marshes w to West Cross Timbers, also e Edwards Plateau and Deaf Smith Co. in the Panhandle (Floyd Waller collection---J. Stanford, pers. comm.); e U.S. from PA s to FL and w to NE and TX and in the sw to NM and AZ. Leaves appearing from early to late spring, often with a second flush of leaves following summer rains; usually sporulating Dec--Jun.

Ophioglossum nudicaule L., (naked stem), SLENDER ADDER'S-TONGUE. LEAST ADDER'S-TONGUE. Plant to ca. 12 cm tall; leaves (blade portion and fertile portion combined) commonly 2--3 per stem; blade portion to 45 mm long and 17 mm wide but often very small (< 4 mm long and 3 mm wide), green, dull, the largest with pale central band; fertile stalk 2--6 times as long as blade portion; sporangia 5--12 on each side of fertile stalk. Disturbed places (e.g., cemeteries, mowed areas around motels), ditches, grassy slopes, wet meadows, damp depressions in pinelands, moist open woods, bog margins; Shelby Co. (*Thomas 27493*, 16 Feb. 1972---BRIT) near the LA border, also Hardin, Orange, and San Augustine (Thomas 1979) cos. in the Pineywoods; se U.S. from VA s to FL and w to OK and TX. Leaves appearing in late winter and early spring, sometimes with a second flush of leaves after heavy rains; usually sporulating Dec--Jun. [*O. dendroneuron* E. St. John, *O. ellipticum* Hook. & Grev., *O. mononeuron* E. St. John, *O. nudicaule* var. *minus* Clausen, *O. nudicaule* var. *tenerum* (Mett. ex Prantl) Clausen, *O. tenerum* Mett. ex Prantl] According to Wagner et al. (1984), this is the most variable and taxonomically confused species of *Ophioglossum* in the se U.S., with a complete transition series from small- to large-leaved (previously called *O. ellipticum*) forms.

Ophioglossum petiolatum Hook., (with a petiole or leaf stalk), STALKED ADDER'S TONGUE, LONG-STEM ADDER'S-TONGUE. Plant to ca. 21 cm tall; leaves (blade portion and fertile portion combined) commonly 2--3 per stem; blade portion to 15--60 mm long and 6--30 mm wide, acute at apex, gray-green, dull, flat or nearly so when alive; fertile stalk 0.8--7 times as long as blade portion; sporangia up to 30 on each side of fertile stalk. Wet woods, disturbed places (e.g., cemeteries, mowed areas around motels), ditches, moist meadows, depressions; Hardin, Orange (BRIT), Jasper, and Liberty (Thomas 1979; Thomas et al. 1987) cos. in the Pineywoods; also

Jefferson Co. (Thomas 1979; Turner & Nichols 2001) in the n Gulf Prairies and Marshes; se U.S. from NC s to FL and w to OK and TX. Leaves appearing during wet periods; usually sporulating Feb--Jun. Native of West Indies, Mexico, n South America, Asia, and Pacific Islands. Wagner & Wagner (1993) indicated that the earliest North American records date from 1900 to 1930, suggesting that the species is probably introduced. The first TX collection was from Jefferson Co. in 1937 (Thomas 1979). In cultivation (as an ornamental), this species "is particularly known for developing root buds and a single plant can fill a pot quickly through root proliferation" (Nelson 2000). ?☜

Ophioglossum vulgatum L., (common), ADDER'S-TONGUE, SOUTHERN ADDER'S-TONGUE. Similar to *O. engelmannii*; leaves (blade portion and fertile portion combined) 1 per stem; blade portion to 120 mm long and 50 mm wide, dark green, somewhat shiny, rounded at apex; fertile stalk 2--4 times as long as blade portion; sporangia 10--35 on each side of fertile stalk. Moist woods, meadows, swamps, usually in sandy soils; Fannin and Lamar cos. in Red River drainage, also Franklin (BRIT), Titus, Wood (TAMU), Cass, Freestone, Red River, Tyler, Upshur (Turner & Nichols 2001), Harrison, and Smith (Correll 1956) cos., mainly n Pineywoods and Post Oak Savannah and w in Red River drainage; also reported for the Cross Timbers and Prairies (Denton Co.---Turner & Nichols 2001) and the n Gulf Prairies and Marshes (Jefferson Co.---Correll 1956); throughout most of the e U.S. w to IL, OK, and TX, also AZ (Wagner & Wagner 1993). Leaves appearing spring to early summer; usually sporulating Mar--Jun. [*O. pycnostichum* (Fernald) A. Löve & D. Löve, *O. vulgatum* var. *pycnostichum* Fernald]

OSMUNDACEAE Gérardin & Desv. CINNAMON OR ROYAL FERN FAMILY

A nearly cosmopolitan family with 3 genera and up to ca. 36 species, with some cultivated as ornamentals. It is one of the oldest living fern families, extending back to the late Permian Period, and in some respects is intermediate between eusporangiate and leptosporangiate ferns. Morphological and molecular evidence indicates it is the most basal leptosporangiate fern family (or alternatatively stated, it is the sister group of a clade containing all other leptosporangiate ferns) (Li & Haufler 1994; Pryer et al. 1995; Hasebe et al. 1995; Doyle 1998; Yatabe et al. 1999). The leptosporangiate ferns, which include all fern families except Ophioglossaceae and Marrattiaceae, have small sporangia usually producing 128 spores or fewer per sporangium and have sporangia developing from a single cell or a small group of cells (Jones & Luchsinger 1986).

FAMILY RECOGNITION IN THE FIELD: leaves usually large, wholly or partly *dimorphic* (fertile leaves or pinnae conspicuously different from sterile); sporangia not in discrete sori.

REFERENCES: Correll 1956, 1966a; Hewitson 1962; Kramer 1990e; Whetstone & Atkinson 1993; Li & Haufler 1994; Phipps et al. 1998; Yatabe et al. 1999.

OSMUNDA L. CINNAMON FERN, INTERRUPTED FERN, ROYAL FERN

Terrestrial; leaves erect to spreading, in a large crown from a stout, woody, creeping to erect stem (rhizome), wholly or partly dimorphic; sori absent; sporangia clustered; indusia absent.

A nearly cosmopolitan genus of 10 species. *Osmunda* fossils described from the Triassic of Antarctica were reported as similar to present day *O. claytoniana* L. (a widespread species native to e North America and Asia) and the fossils were cited as an example of evolutionary stasis (Phipps et al. 1998). However, Yatabe et al. (1999) more recently interpreted the same fossils as being more similar to *O. cinnamomea*. (Saxon: *Osmunder*, name for Thor, Norse god of thunder and war)
References: Miller 1967; Serbet & Rothwell 1999.

1. Fertile leaves not very leaf-like, with no expanded blade tissue, completely different in appearance from sterile leaves; smallest subdivisions of sterile leaves not narrowed at base, the area of attachment as broad as segment ..... **O. cinnamomea**
1. Fertile leaves similar in appearance to sterile leaves except fertile leaves have greatly reduced sporangia-bearing pinnae at tip; smallest subdivisions of leaves greatly narrowed at very base, attached at one stalk-like point only ..... **O. regalis**

Osmunda cinnamomea L., (cinnamon-brown), CINNAMON FERN, BUCKHORN FERN, BUCKHORN BRAKE, FLOWERING FERN. Sterile leaves 1-pinnate-pinnatifid, ca. 0.3--1.5 m long, the smallest subdivisions with margins entire and usually apically mucronate; pinnae with a persistent tuft of tomentum at base; fertile leaves with no expanded pinnae, densely tomentose, much narrower and shorter than sterile leaves; sporangia cinnamon-colored. Wet areas; mainly Pineywoods and Gulf Prairies and Marshes w to to Gonzales, Milam, (Correll 1956; Turner & Nichols 2001) and Lee (BRIT) cos. and to Lamar Co. (BRIT) in Red River drainage; also disjunct to Edwards Co. (Turner & Nichols 2001) on the Edwards Plateau; se Canada and throughout e U.S. w to MN and TX. Sporulating Mar--Jul or later. Based on DNA evidence, *O. cinnamomea* is considered the most basal species in the the family (Yatabe et al. 1999); if this interpretation is correct, the genus *Osmuna* is not monophyletic (unless *O. cinnamomea* is excluded). According to Yatabe et al. (1999), "When the *rbcL* trees, the fossil and morphological evidences are all taken into account, it can be concluded that the extant *Osmunda cinnamomea* has no other closely related living species in Osmundaceae, and it has evolutionarily very static morphology with no

significant modification for more than 200 Myrs. Thus we can call extant *O. cinnamomea* a 'living fossil'." Further, recent fossil discoveries from the Upper Cretaceous (Serbet & Rothwell 1999) provide evidence that *O. cinnamomea* has been in North America "for at least 70 million years" and suggest that fern species can remain virtually unchanged over millions of years. A form of this species, forma *frondosa* (Torr. & A. Gray) Britton, is known (e.g, from Fl, GA, and VA) with aberrant fertile leaves that can have sterile pinnae either apically or basally, or both (Werth et al. 1985; Carter & Faircloth 1986; Nelson 2000). Nelson (2000) indicated that, "According to many workers, this "interrupted cinnamon fern" is likely an environmentally induced variant resulting from disturbances such as mowing, fire, or late season frosts."

Osmunda regalis L. var. **spectabilis** (Willd.) A. Gray, (sp.: royal; var. spectacular), ROYAL FERN, FLOWERING FERN. Leaves 2-pinnate; sterile leaves ca. 0.75--1 m long; pinnules lanceolate, the margins subentire to remotely dentate, apically acute to rounded; pinnae without a persistent tuft of tomentum at base, essentially glabrous; sporangia brown at maturity. Wet areas; Pineywoods and Gulf Prairies and Marshes w to Lamar Co. (Carr 1994) in Red River drainage and Travis Co. (Correll 1956; Turner & Nichols 2001) near the e edge of the Edwards Plateau; se Canada and through e U.S. w to MN and TX Sporulating Mar--Jul. Variety *regalis* is native to Eurasia and is distinguished by its black hair-like scales along the leaf rachis and a more robust habit (Nauman et al. 2000).

POLYPODIACEAE Bercht. & Presl POLYPODY FERN FAMILY

A cosmopolitan family today treated as including ca. 40 genera and ca. 500 species. As previously circumscribed, the Polypodiaceae encompassed ca. 7,000 species or nearly two-thirds of the living ferns. Family name from *Polypodium*, POLYPODY, a cosmopolitan genus of ca. 100 species, currently more narrowly defined than previously. (Greek: *poly*, many, and *pous* or *podiun*, foot, referring to the branched rhizomes, supposedly resembling many feet)
FAMILY RECOGNITION IN THE FIELD: the single East TX species is typically epiphytic or found growing on rocks; the *discrete round sori* without indusia are found in single rows on each side of the midrib of the lobes of the *deeply pinnatifid* leaves.
REFERENCES: Weatherby 1939; Correll 1956, 1966a; Hennipman et al. 1990; Smith 1993c.

PLEOPELTIS Humb. & Bonpl. ex Willd. SHIELD-SORUS FERN, SCALY-POLYPODY

A widespread but primarily neotropical genus of ca. 50 species of mostly epiphytic ferns. Some of the species now treated in *Pleopeltis* were formerly included in *Polypodium* ("Early pteridologists placed any fern with round, non-indusiate sori in *Polypodium*"---Hoshizaki & Moran 2001). (Greek: *pleos*, many, and *pelte*, shield, in reference to the peltate scales covering immature sori)

REFERENCE: Andrews & Windham 1993; Bush et al. 1999.

Pleopeltis polypodioides (L.) E.B. Andrews & Windham subsp. **michauxiana** (Weath.) E.B. Andrews & Windham, (sp: resembling *Polypodium*; subsp.: for Andrè Michaux, 1746--1803, French botanist and explorer of North America), RESURRECTION FERN, GRAY POLYPODY. Usually epiphytic or sometimes growing on rocks; rhizomes slender, widely creeping, densely scaly; leaves monomorphic, evergreen, widely spaced; leaf blades oblong to triangular-oblong in outline, deeply pinnatifid, to 15 cm long and 5 cm wide, thick, opaque, hygroscopic, involute upon drying, glabrous above except for a few scales along midrib, densely covered with peltate scales below, the margins mostly entire; sori round, discrete, in single rows on each side of the midrib of the lobes near the margins, forming conspicuous bumps on the undersurface of leaves; indusia absent. Usually growing on various species of trees, especially oaks, sometimes on rocks, usually in shady damp situations; Pineywoods and Gulf Prairies and Marshes s to South Texas Plains and w to Cross Timbers and Prairies (Parker Co.---Correll 1956; Turner & Nichols 2001) and Edwards Plateau (Uvalde Co.---Correll 1956; Turner & Nichols 2001); e U.S. from DE s to FL and w to KS and TX. Previously lumped into the genus *Polypodium* [as *P. polypodioides* (L). Watt var. *michauxianum* Weath.]. The common name, RESURRECTION FERN, results from the leaves "…which become brown and appear dead during dry periods, but 'resurrect' themselves after rains and rapidly become green and lush" (Nelson 2000). The six varieties of this species range from the se U.S. to Argentina and Africa (Nauman et al. 2000).

PTERIDACEAE Spreng. ex Jameson MAIDENHAIR FERN OR BRAKE FAMILY

East TX species mostly on rocks, sometimes terrestrial (or in *Ceratopteris* aquatic or semiaquatic); leaves monomorphic (rarely somewhat dimorphic) (or in *Ceratopteris* distinctly dimorphic); leaf blades 1--4(--5) pinnate or 1--more pinnate-pinnatifid; sporangia abaxial on the blades, marginal or submarginal; margins of ultimate segments recurved to form false indusia (except in *Astrolepis*).

The taxa included here in the Pteridaceae have been variously treated at the family level; some for instance segregate *Cheilanthes* and close relatives into the Cheilanthaceae (Carlquist & Schneider 2000), while others (e.g.) recognize some of the genera as Sinoperidaceae (Lellinger 1985). We follow Windham's (1993a) treatment and recognize 6 genera in East TX; the newer name Adiantaceae has sometimes been applied to the family. The Pteridaceae is a cosmopolitan family of ca. 40 genera and ca. 1,000 species.

FAMILY RECOGNITION IN THE FIELD: plants typically growing *on rock*s (1 species aquatic or semi-aquatic); *sporangia at or near margins* of the ultimate leaf segments with the leaf *margins usually recurved* over sporangia to form false indusia (except in *Astrolepis*).
REFERENCES: Correll 1956, 1966a; Tryon et al. 1990; Windham 1993a; Gastony & Rollo 1998; Carlquist & Schneider 2000a.

1. Plants aquatic or semiaquatic; leaves distinctly dimorphic (the fertile quite different than the sterile); leaf blades with adventitious buds or small plantlets in notches along margins..... **Ceratopteris**
1. Plants mostly on rocks, sometimes terrestrial; leaves usually monomorphic or in *Pellaea* somewhat dimorphic; leaf blades without adventitious buds or plantlets.
   2. Margins of ultimate leaf segments not recurved to form false indusia; leaf blades 1-pinnate to 1-pinnate-pinnatifid throughout; lower (= abaxial) leaf surfaces densely covered with coarsely ciliate or stellate scales; upper (= adaxial) leaf surfaces with coarsely ciliate or stellate scales ..... **Astrolepis**
   2. Margins of ultimate leaf segments recurved to form false indusia; leaf blades 2--5 pinnate at least at base OR at least partially 2-pinnatifid (1-pinnate in 1 species of *Pteris*); lower leaf surfaces scaly, pubescent, or glabrous; upper leaf surfaces without coarsely ciliate or stellate scales.
      3. Rachis conspicuously winged in at least the distal 1/2 of leaf; leaf blades at least partially 2-pinnate (at least some pinnae are usually deeply palmately 3-divided); ..... **Pteris**
      3. Rachis not winged; leaf blades 2--5 pinnate at least at base.
         4. Ultimate leaf segments with only the apical margin recurved; sporangia borne directly on recurved apical margins of ultimate leaf segments; veins of ultimate leaf segments prominent, dichotomously branched (= equally 2-forked), essentially parallel near the margins ..... **Adiantum**
         4. Ultimate leaf segments with apical and lateral margins recurved over sporangia; sporangia borne on lower leaf surface and covered by the recurved margins; veins of ultimate leaf segments obscure or, if prominent, pinnately branched and more divergent near the margins.
            5. Leaf blades usually 1-pinnate distally (2-pinnate below), glabrous on lower surface or nearly so; largest ultimate leaf segments > 4 mm wide ..... **Pellaea**

5. Leaf blades 2--more pinnate or pinnate-pinnatifid nearly throughout, usually tomentose on lower surface (except sparsely pubescent to nearly glabrous in *Cheilanthes alabamensis*, *C. aemula*, and *Argyrochosma microphylla*) OR lower surface covered with conspicuous whitish powdery material; ultimate leaf segments < 4 mm wide.
   6. Leaf blades with conspicuous whitish powdery material and without pubescence abaxially..... **Argyrochosma**
   6. Leaf blades lacking conspicuous whitish powdery material, often (but not always) tomentose abaxially.
      7. Leaf blades glabrous abaxially; most distal ultimate segments of leaf blades ± cordate at base and attached only by distinct dark-colored stalks..... **Argyrochosma**
      7. Leaf blades usually tomentose abaxially OR if glabrous then the most distal ultimate segments of leaf blades not cordate at base, ± sessile (attached at least partially by blade tissue) ..... **Cheilanthes**

ADIANTUM L. MAIDENHAIR FERN

A genus of 150--200 species, nearly worldwide in distribution except at higher latitudes (> 60˚), but most common in Andean South America.; sometimes placed in the Adiantaceae. Some are used medicinally and a number are cultivated as ornamentals for their delicate, beautiful foliage. The position of the sporangia is definitive for identification---in other related ferns with false indusia (e.g., *Cheilanthes*, *Pellaea*), the sporangia are borne on the blade tissue beneath the false indusium, rather than on the false indusium itself as in *Adiantum*. The leaves "have the unusual property that, when wetted, water beads-up into silvery droplets that quickly roll off" (Hoshizaki & Moran 2001)---hence the scientific name. (Greek: *adiantos*, unwetted, for the glabrous leaves, which shed raindrops)
REFERENCES: Fernald 1950b; Paris 1993.

Adiantum capillus-veneris L., (Venus' hair), VENUS'-HAIR FERN, SOUTHERN MAIDENHAIR, CULANTRILLO. Terrestrial or on rocks; stems (rhizomes) short-creeping; leaves ± monomorphic, weakly deciduous, closely spaced, numerous, lax-arching or pendulous, 15--75 cm tall; leaf blades 2(--more) pinnate, glabrous, membranous to thin-herbaceous, bright green, the ultimate segments usually wedge or fan-shaped to irregularly rhombic (= 4-sided, diamond-shaped), ca. as long as broad, stalked; apical leaf margins recurved to form false indusia; sporangia submarginal, borne on the abaxial (= beneath) surface of the false indusia. Continuously moist calcareous areas, particularly limestone bluffs, rocks and ledges along streams. Hays, Harris

(BRIT), Bell, Bexar, Newton (TAES), Comal, Dallas, Kaufman, Hill, McLennan, Orange, Travis, Washington, Williamson (Turner & Nichols 2001) cos.; scattered nearly throughout TX, common in some areas such as the Edwards Plateau; s 1/2 of U.S. from VA s to FL and w to CA, also SD and B.C. Sporulating May--Jan. The species has long been used medicinally for conditions of the skin, scalp, and internal organs (Cheatham & Johnston 1995). Hoshizaki and Moran (2001) considered this species, widespread in warm-temperate to subtropical areas, to be one of the most widely distributed ferns in the world.

ARGYROCHOSMA (J. Smith) Windham FALSE CLOAK FERN

Plants usually on rocks; stems compact, erect to ascending; leaves monomorphic, clustered; petioles, rachises, and stalks of ultimate leaf segments dark brown, lustrous; leaves to only 25 cm long; leaf blades 3--5 pinnate, deltate to ovate, the abaxial surfaces glabrous or covered by a whitish, mealy, powdery material (= farina); ultimate leaf segments small (< 4 mm wide), their margins recurved to revolute, forming false indusia, these often concealing or partially concealing the sporangia; sporangia on the abaxial leaf surfaces, submarginal.

A New World genus of ca. 20 species. While the species have been variously treated in a variety of genera (e.g., *Cheilanthes*, *Notholaena* and *Pellaea*), Windham (1987b) segregated *A. dealbata*, *A. microphylla*, and related species as the genus *Argyrochosma*. Morphological and chromosome evidence (x = 27---unique among cheilanthoid ferns) supports its separate recognition (Windham 1993b) as does more recent molecular evidence (Gastony & Rollo 1998). (Greek: *argyros*, silver, and *chosma*, powder, referring to whitish farina covering the abaxial surface of leaf blades in most species)

REFERENCES: Tryon 1956; Windham 1987b, 1993b.

1. Abaxial (= lower) surfaces of leaf blades obscured by a covering of a whitish powdery material; ultimate leaf segments not articulate (the dark brown color of the segment stalks continuing into the segment bases on the abaxial side)..... **A. dealbata**
1. Abaxial surfaces of leaf blades without whitish covering; ultimate leaf segments articulate (the dark brown color of the segment stalks ending abruptly at the segment bases)..... **A. microphylla**

Argyrochosma dealbata (Pursh) Windham, (white-washed), POWDERY FALSE CLOAK FERN, POWDERY CLOAK FERN, FALSE CLOAK FERN. Plants small; leaves to only ca. 15 cm long, evergreen; leaf blades 3--5-pinnate, less divided distally, somewhat herbaceous, adaxial (= upper) surface bluish green, glabrous, abaxial (= lower) surface with very conspicuous whitish powdery material. Crevices of limestone and other calcareous rocks; Bell (TAES), Travis (BRIT), Comal, Hays (Turner & Nichols 2001), and Ellis (Correll

1956; TAES; Turner & Nichols 2001) cos. near w margin of East TX; mainly Cross Timbers and Prairies and e Edwards Plateau; AR, IL, KS, KY, MO, NE, OK, and TX. Sporulating summer--fall. [*Cheilanthes dealbata* Pursh, *Notholaena dealbata* (Pursh) Kunze, *Pellaea dealbata* (Pursh) Prantl]

Argyrochosma microphylla (Mett. ex Kuhn) Windham, (small-leaved), SMALL-LEAF FALSE CLOAK FERN, SMALL-LEAF CLOAK FERN. Leaves 7--25 cm long; leaf blades 3--4-pinnate basally, 2-pinnate distally, leathery, glabrous on both surfaces, often glaucous. Limestone hillsides and cliffs; mainly occurring in w Texas and the Edwards Plateau, this species is reported as disjunct in East TX in Brazos Co. (Correll 1956); NM and TX. Sporulating summer--fall. [*Pellaea microphylla* (Mettenius ex Kuhn) Windham, *Cheilanthes parvifolia* (R.M. Tryon) Mickel, *Notholaena parvifolia* R.M. Tryon] It is easily distinguished from *A. dealbata* by the lack of whitish powdery material on the abaxial leaf surfaces. Reported to be poisonous to sheep (Correll 1956). ☠

ASTROLEPIS D.M. Benham & Windham STAR-SCALED CLOAK FERN, SCALY CLOAK FERN

Plants usually on rocks; stems (rhizomes) compact to short-creeping; leaves monomorphic, evergreen, clustered, 1-pinnate to 1-pinnate-pinnatifid, the abaxial (= lower) leaf surfaces with ciliate scales and usually underlying layer of stellate scales concealing the surface, the upper surfaces sparsely to densely covered with stellate or coarsely ciliate scales to glabrescent with age; sporangia marginal or nearly so, forming a ± continuous band; false indusium absent.

A New World genus of ca. 8 species. The taxa treated here as *Astrolepis* have been previously lumped into various genera including *Notholaena* or *Cheilanthes*. Benham and Windham (1992) indicated these and several related species are a monophyletic group worthy of recognition as the genus *Astrolepis*. (Greek: *astro*, star, and *lepis*, scale, in reference to the star-like scales on the adaxial surfaces of the leaf blades)
REFERENCES: Tryon 1956; Benham & Windham 1992, 1993; Carlquist & Schneider 1997.

1. Upper leaf surfaces (= adaxial) densely scaly, particularly near margins, the scales usually persistent, the body of the scales 5--7 cells wide; largest pinnae entire or slightly lobed ..... **A. integerrima**
1. Upper leaf surfaces only sparsely scaly to glabrescent, most scales deciduous with age, the body of the scales 1--2 cells wide; largest pinnae often conspicuously lobed ..... **A. sinuata**

Astrolepis integerrima (Hook.) D.M. Benham & Windham, (very entire) , SOUTHWESTERN CLOAK FERN. Leaves 8--45 cm long; largest pinnae usually 7--15 mm long, entire or

asymmetrically and shallowly lobed. Rocky slopes, outcrops, or cliffs, usually limestone or other calcareous substrates. Comal Co. (Turner & Nichols 2001) on w margin of East TX; w and sw parts of nc TX s and w to w TX; mostly sw U.S. (AZ, NM, NV, OK, and TX), also reported from AL (Kartesz 1999). Sporulating summer--fall. [*Cheilanthes integerrima* (Hook.) Mickel, *Notholaena integerrima* (Hook.) Hevly, *Notholaena sinuata* (Lag. ex Sw.) Kaulf. var. *integerrima* Hook.]

Astrolepis sinuata (Lag. ex Sw.) D.M. Benham & Windham, (wavy-margined), BULB LIP FERN, WAVY SCALY CLOAK FERN, WAVY CLOAK FERN, LONG CLOAK FERN, JIMMY FERN. Leaves 11--130 cm long; longest pinnae 7--35 mm long, symmetrically 6- to 14-lobed. Rocky slopes, outcrops, or cliffs, calcareous or other substrates; Comal Co. (Turner & Nichols 2001) near w margin of East TX and Anderson Co. (Correll 1956); Hatch et al. (1990) also cited vegetational area 4, probably based on the Anderson Co. record from near the boundary of the Blackland Prairie and Post Oak Savannah vegetation areas; mainly c to w TX; mostly sw U.S. (AZ, NM, OK, and TX), also disjunct to GA. Sporulating Mar--Nov. [*Acrostichum sinuatum* Lag. ex Sw., *Cheilanthes sinuata* (Lag. ex Sw.) Domin, *Notholaena sinuata* (Lag. ex Sw.) Kaulf.] Burlage (1968) reported this species as toxic to livestock; an unidentified poison causes incoordination, arched back, rapid pulse, gasping, trembling (known as “the jimmies”), and prostration; sheep are apparently most susceptible, followed by goats and cattle; death can result from respiratory paralysis (Weathers 1998). ☠

CERATOPTERIS Brongn. ANTLER FERN, WATER FERN, FLOATING FERN

A taxonomically difficult genus of 3--4 species of morphologically variable aquatics or semiaquatics (Lloyd 1993); some are grown as aquarium plants (Hoshizaki & Moran 2001). The genus is said to have the fastest life cycle of any fern---as little as one month to go from spore to spore-bearing plant; as a result they are used in laboratory genetics studies (Hoshizaki & Moran 2001). *Ceratopteris* has often been treated as the sole genus in the Parkeriaceae, the ANTLER FERN or WATER FERN family (e.g., Correll & Johnston 1970; Lloyd 1993). According to Lellinger (1985), "The Parkeriaceae clearly belongs to the Schizaeales [including Anemiaceae and Lygodiaceae], but its exact position is uncertain. As in some cases of flowering plants, the aquatic habitat has caused great modifications of structure in *Ceratopteris* that obscure the relationships of these plants to the other, non-aquatic families in the order.” However, recent molecular studies (Gastony & Rollo 1998), that did not rely on highly modified morphological characters, indicated that the sister group of *Ceratopteris* is *Pityrogramma*, a genus traditionally placed in the Pteridaceae. We are thus following Tryon (1987), Tryon et al. (1990), Gastony & Rollo (1998), and Robbin Moran (pers. comm.) in treating *Ceratopteris* in the Pteridaceae; it is probably best placed in its own subfamily, Ceratopteridoideae, as originally suggested by Tryon (1987). *Ceratopteris* is the only group of homosporous (= with 1 spore type) aquatic ferns

(heterosporous aquatic ferns include the Azollaceae, Marsileaceae, and Salviniaceae). The following treatment draws heavily on Lloyd (1993). (Greek: *cerato*, horned, and *pteris*, fern, derived from *pteron*, wing or feather, in reference to the antler-like fertile leaf) REFERENCES: Benedict 1909; Morton 1967; Hannan 1969; Lloyd 1974, 1993; Petrik-Ott & Ott 1976; Tryon 1987; Lemke 1994; Gastony & Rollo 1998; Carlquist & Schneider 2000b.

Ceratopteris thalictroides (L.) Brogn., (resembling *Thalictrum*, meadow-rue), WATER SPRITE, WATER FERN. Plant short-lived, aquatic or semiaquatic, usually rooting, but sometimes floating; leaves dimorphic, with adventitious buds or small plantlets in notches along margins; sterile leaves 1--3 pinnate, the blades lanceolate to ovate or deltate in outline, 2--41 cm long, 2--20 cm wide, with relatively broad ultimate segments (broader than linear in contrast to those of the fertile leaf blades), the petioles 1--31 cm long, not inflated; fertile leaves 3--4 pinnate proximally, 2-pinnate distally, larger than the sterile leaves, 2--117 cm long, to 48 cm wide, the blades lanceolate to ovate, deltate, or cordate in outline, finely dissected with the ultimate segments linear, the petioles 1-46 cm long; margins of fertile blades revolute, covering the 1--3 rows of sporangia and forming false indusia. Cultivated in aquaria and warm-weather lily or fish ponds and presumably escaping; usually rooted in mud in quiet or moving water of springs and adjacent rivers and lakes; Bell, Hays, and Comal cos. (Petrik-Ott & Ott 1976) along the Balcones Fault at the edge of the Blackland Prairie and the Edwards Plateau. According to D. Lemke (pers. comm. 1998), it is still present in the San Marcos River in Hays Co. Petrik-Ott and Ott (1976) suggested that the constant temperature of the springs along the Balcones Fault may allow this mainly tropical species to persist indefinitely in TX. The species was first reported from Texas by Morton (1967) and was apparently introduced to the state in 1963 (Hannen 1969). Native to tropical areas worldwide except Africa, it has been found escaped in the U.S. in CA, FL, LA, TX (Lloyd 1993) and MS (Kartesz 1999). [*Acrostichum thalictroides* L.] This is an extremely widespread and variable species (Lloyd 1974). It is cultivated in some areas (e.g., Japan) as a spring vegetable in flooded rice fields (Mabberley 1997). Tryon and Tryon (1982) suggested that while *Ceratopteris* is usually considered to be an annual, it "...may be more accurately described as short-lived." They indicated that many tropical habitats "...lack the seasonality necessary to provide a basis for an annual lifecycle." ☜

CHEILANTHES Sw. LIP FERN

Plants xerophytic, usually growing on rocks; stems (rhizomes) compact to long-creeping; leaves monomorphic, evergreen, clustered or scattered along the rhizomes; leaf blades 2--more-pinnate-pinnatifid, usually conspicuously tomentose beneath but sometimes glabrous or nearly so; petioles dark brown to black; sporangia marginal on the abaxial (= lower) leaf surfaces; margins

of ultimate leaf segments recurved to form false indusia; veins of ultimate segments free or rarely anastomosing, obscure.

A genus of ca. 150 species found primarily in the New World with a few in Europe, Asia, Africa, Pacific Islands, and Australia. According to Windham and Rabe (1993), *Cheilanthes* is the largest and most diverse genus of xerophytic ferns. Even after the removal of segregates including *Argyrochosma* and *Astrolepis,* it is still a heterogeneous and possibly polyphyletic genus. In fact, recent molecular evidence (Gastony & Rollo 1998) supports the hypothesis that it is polyphyletic. The scientific and common names both come from the position of the sori on the margin or "lip" of the ultimate leaf segments. (Greek: *cheilos*, margin, and *anthus*, flower, referring to the marginal sporangia)
REFERENCES: Mickel 1979; Windham & Rabe 1993.

1. Midrib of leaf segments and/or rachis with scales (hairs can also be present) beneath (= abaxially).
   2. Ultimate leaf segments scabrous (= rough to the touch) on upper surface, covered with stiff hairs ..... **C. horridula**
   2. Ultimate leaf segments smooth to the touch, lacking stiff hairs.
      3. Scales linear, inconspicuous, only slightly wider than hairs, the largest 0.1--0.4 mm wide ..... **C. tomentosa**
      3. Scales linear to lanceolate to ovate, conspicuous, obviously much wider than hairs, the largest 0.4--1.0 mm wide.
         4. Scales ovate to lanceolate, long ciliate, the cilia sometimes forming an entangled mass; rhizome slender, widely creeping, with leaves scattered along the rhizome..... **C. lindheimeri**
         4. Scales linear to lanceolate, not ciliate, rarely with 1--2 cilia at base; rhizome stout, short, with leaves in a dense clump ..... **C. eatonii**
1. Midrib of leaf segments and rachis lacking scales beneath or with extremely narrow inconspicuous hair-like scales (but can be strikingly pubescent to glabrous).
   5. Leaves essentially glabrous to sparsely pubescent beneath; ultimate leaf segments narrowly elliptic to elongate-deltate, not at all suborbicular to bead-like.
      6. Leaf blades lanceolate to oblong, 1--7 cm wide; basal pair of pinnae slightly smaller than adjacent pair; basal pair of pinnules of basal pinnae ± equal in size ..... **C. alabamensis**
      6. Leaf blades broadly triangular to ovate, 5--15 cm wide; basal pair of pinnae slightly larger than adjacent pair; basal pair of pinnules of basal pinnae conspicuously unequal in size..... **C. aemula**

5. Leaves densely pubescent beneath; ultimate leaf segments suborbicular to bead-like (*C. feei* and *C. tomentosa*) OR not so (*C. horridula* and *C. lanosa*).
   7. Ultimate leaf segments scabrous (= rough to the touch) on upper (= adaxial) surface, covered with stiff hairs..... **C. horridula**
   7. Ultimate leaf segments smooth to the touch, lacking stiff hairs.
      8. Ultimate fertile segments of pinnae elongate, not bead-like; leaf blades 2-pinnate-pinnatifid near base.....**C. lanosa**
      8. Ultimate fertile segments of pinnae bead-like; leaf blades 3- or 4-pinnate near base.
         9. Petiole and rachis not densely tomentose, instead very sparsely to densely hispidulose, the hairs noticeably jointed (under strong lens or dissecting scope); leaf blades usually 3-pinnate at base, 1--3 cm wide..... **C. feei**
         9. Petiole and rachis densely tomentose, particularly when young, the hairs not noticeably jointed; leaf blades usually 4-pinnate at base, 1.5--8 cm wide..... **C. tomentosa**

Cheilanthes aemula Maxon, (rivaling, imitating), TEXAS LIP FERN, RIVAL LIP FERN. Leaves clustered, 10--50 cm long; leaf blades broadly triangular to ovate, 5--15 cm wide, the largest ultimate segments 3--6 mm long; one of the two glabrous (or nearly so) East TX *Cheilanthes* species. Rocky slopes and ledges, on limestone; Austin Co. in se Blackland Prairie (Correll 1956; Turner & Nichols 2001) and Comal Co. (Turner & Nichols 2001) on the w margin of East TX; also Edwards Plateau and Trans-Pecos; in the U.S. known only from TX (also n Mexico). Sporulating May--Nov. This species, which is similar to *C. alabamensis*, is apparently known from only ca. 10 localities in e, c, and w TX (Windham & Rabe 1993).

Cheilanthes alabamensis (Buckley) Kunze, (of Alabama), ALABAMA LIP FERN, SMOOTH LIP FERN. Leaves clustered, 6--50 cm long; leaf blades lanceolate to oblong, 1--7 cm wide, the largest ultimate segments 3--7 mm long; one of the two glabrous (or nearly so) East TX *Cheilanthes* species. Limestone hillsides, crevices of limestone ledges and cliffs; Travis (BRIT), Bell, Bexar, Walker, Washington (TAES), Bastrop, Cherokee, Comal, Dallas, Fayette, Grimes, Hays, Sabine, Williamson, and Wilson (Turner & Nichols 2001) cos.; widely distributed across TX; mostly s 1/2 of U.S. from VA s to FL and w to AZ. Sporulating nearly throughout the year, especially Mar--Nov. According to Nelson (2000), both the specific epithet and common name of this species are the result of its initial discovery in Alabama in 1843.

Cheilanthes eatonii Baker, (for its discoverer, A.A. Eaton, 1865--1908), EATON'S LIP FERN. Leaves clustered, 6--35 cm long; leaf blades 1.5--5 cm wide, the ultimate segments oval to

round, bead-like, the largest 1--3 mm long; scales of leaf segment midrib and/or rachis conspicuous. Rocky slopes and ledges; Chambers and Morris (Turner & Nichols 2001) cos. in the ne part of East TX and Wilson Co. (Turner & Nichols 2001) in the sw corner of East TX; also to the w of East TX in Brown Co. (Correll 1956; HPC); mainly Edwards Plateau and Trans-Pecos; mostly sw U.S. (AZ, CO, NM, OK, TX, UT), disjunct to VA and WV. Sporulating Mar--Nov. [*C. castanea* Maxon]

Cheilanthes feei T. Moore, (for A.L.A. Fèe, 1789--1874, French botanist), SLENDER LIP FERN, WOOLLY LIP FERN, FEE'S LIP FERN. Leaves clustered, 4--20 cm long; leaf blades 1--3 cm wide, the ultimate segments 1--3 mm long; similar to *C. tomentosa* but with jointed hairs and without tomentum on the petiole and rachis. Dry, limestone or calcareous, rocky slopes and crevices; the closest citations or specimens we have found are from the Cross Timbers and Prairies---Hamilton and Palo Pinto (Correll 1956; Turner & Nichols 2001) cos.; included based on citation for vegetational area 4 by Hatch et al. (1990). This citation may have been a misinterpretation of Correll's (1956) description of the species' range in TX as including "Hamilton and Palo Pinto counties in the northwest Blackland Prairies" (well to the w of the delineation of Blackland Prairie followed by Hatch et al. and by this book); mainly w part of Cross Timbers and Prairies s and w to w TX; sw Canada and much of w U.S. w to WI and TX, also KY and VA. Sporulating Mar--Nov.

Cheilanthes horridula Maxon, (prickly), ROUGH LIP FERN. Leaves clustered, 5--30 cm long; leaf blades 1--4 cm wide, the ultimate segments narrowly elliptic to elongate-deltate, not bead-like, the largest 3--5 mm long; leaf surfaces scabrous due to distinctive stiff hairs, these often inflated basally (according to Windham & Rabe (1993), these scabrous pustulose hairs make this "one of the most distinctive species of Cheilanthes in North America"). Rock crevices; Bexar, Hays (BRIT), Bell, Comal, and Travis (Turner & Nichols 2001) cos. near border of Blackland Prairie and Edwards Plateau; mainly s and w 2/3 of TX; OK and TX. Sporulating mainly May--Nov.

Cheilanthes lanosa (Michx.) D.C. Eaton, (woolly), HAIRY LIP FERN, WOOLLY LIP FERN. Leaves clustered, 7--50 cm long; leaf blades 1.5--5 cm wide, the ultimate segments oblong to lanceolate, not bead-like, the largest 3--5 mm long; similar in some respects to *C. tomentosa* but with hispidulous jointed hairs instead of tomentum on the petiole and rachis and with ultimate leaf segments not bead-like. Dry rocky slopes and sandstone ledges; the only TX county citation we are aware of is from McLennan Co. (Correll 1956: *Wherry s.n.*, BAYLU; Turner & Nichols 2001); the species is also mapped for ne TX by Windham and Rabe (1993); e U.S. from NY s to FL and w to MN and TX. Sporulating Apr--Oct. Jack Stanford (pers. comm.), who studied the Wherry collection, questioned whether it is actually *C. lanosa*, raising the possibility that this species is not part of the TX flora.

Cheilanthes lindheimeri Hook., (for F.J. Lindheimer, 1801--1879, German-born Texas collector), LINDHEIMER'S LIP FERN, FAIRY-SWORDS. Plants with slender long-creeping rhizomes and scattered leaves (distinguishing this species from all other East TX *Cheilanthes* with compact to short-creeping rhizomes and clustered leaves); scales of leaf segment midrib and/or rachis conspicuous; leaves 7--30 cm long; leaf blades 2--5 cm wide, the ultimate segments round to slightly oblong, bead-like, the largest 0.7--1 mm long. Rocky slopes and ledges; the closest citations or specimens we have found are from the Cross Timbers and Prairies in nc TX, e.g. Palo Pinto (Correll 1956), Burnet, (Turner & Nichols 2001), and Parker (B. Carr, pers. comm.) cos.; included based on citation for vegetational area 4 by Hatch et al. (1990); this citation may have been a misinterpretation of Correll's (1956) description of the species' range in TX as including "Palo Pinto County in the northern Blackland Prairies" (well to the w of the delineation of Blackland Prairie followed by Hatch et al. and by this book); mainly Edwards Plateau, Cross Timbers and Prairies, and Trans-Pecos; AZ, NM, OK, and TX. Sporulating Mar--Nov. Jack Stanford (pers. comm.) indicated that this species is found primarily on granite.

Cheilanthes tomentosa Link, (tomentose, densely woolly), WOOLLY LIP FERN. Leaves clustered, 8--45 cm long; leaf blades 1.5--8 cm wide, the ultimate segments oval (rarely oblong), bead-like, the largest 1--2 mm long; scales of leaf segment midrib and/or rachis inconspicuous. Rocky slopes and ledges; Bastrop, Grayson, San Jacinto, Tyler (BRIT), Milam, Robertson (TAMU), Walker (TAES), Bexar, Falls, and Van Zandt (Turner & Nichols 2001) cos.; widely distributed in TX; across much of s 1/2 of U.S. from PA and WV s to GA and w to AZ. Sporulating mainly May--Oct.

PELLAEA Link CLIFF-BRAKE

Xeric-adapted, usually on rock; stems (rhizomes) compact to creeping; leaves monomorphic or somewhat dimorphic, evergreen, clustered to scattered, 1--3 pinnate, in East TX species glabrous or nearly so, thick-herbaceous to coriaceous; sporangia near margins of leaf segments on the abaxial (= beneath) leaf surfaces; margins of ultimate leaf segments recurved to form false indusia.

A genus of ca. 40 species distributed mainly in the New World with a few in Asia, Africa, the Pacific Islands, and Australia. The genus has often been circumscribed more broadly, but as such is probably polyphyletic. In fact, recent molecular evidence (Gastony & Rollo 1998) supports the hypothesis of a polyphyletic *Pellaea*. Some species previously placed in *Pellaea* are now recognized in *Argyrochosma.* (Greek: *pellos*, dark or dusky, possibly referring to bluish gray leaves)

REFERENCES: Tryon 1957; Knobloch & Britton 1963; Windham 1993c.

1. Petiole and rachis straw-colored or tan, not shiny, usually glabrous; rachis uniformly zigzag throughout .....**P. ovata**
1. Petiole and rachis reddish purple to dark brown or blackish, shiny, glabrous or pubescent adaxially (= above) with curly hairs; rachis not uniformly zigzag, at most slightly flexuous.
   2. Pinnules mucronate (= with a small tip); some scales of the stem (look near attachment of petioles) bicolored with a dark, blackish, linear central region and a lighter brown margin; rachis usually glabrous .....**P. wrightiana**
   2. Pinnules not mucronate; stem scales uniformly reddish brown or tan; rachis pubescent adaxially .....**P. atropurpurea**

Pellaea atropurpurea (L.) Link, (dark purple, in reference to the color of the petiole), PURPLE CLIFF-BRAKE, PURPLE-STEM CLIFF-BRAKE, CLIFF-BRAKE, BLUE FERN. Plants to 45 cm tall; stem (rhizome) scales uniformly reddish brown or tan; leaf blades 1-pinnate or 2-pinnate below, 10--30 cm long, 5--20 cm wide, the sterile ones shorter and less divided. Rocky slopes and woods, cliffs, usually limestone or calcareous rocks; nearly throughout TX; se Canada and most of the U.S. from VT s to FL and w to MN and NV. Sporulating Mar--Nov.

Pellaea ovata (Desv.) Weath., (ovate). Plants usually large, to 1 m or more tall; stem (rhizome) scales bicolored, black centrally, brown marginally; leaf blades 2--3-pinnate, 15--70 cm long, 5--25 cm wide. Rocky slopes and ledges, including limestone; Travis Co. (Turner & Nichols 2001); mainly Trans-Pecos and Edwards Plateau, also Cross Timbers and Prairies; in the U.S. known only from TX (also Latin America). Sporulating Mar--Nov.

Pellaea wrightiana Hook., (for Charles Wright, 1811--1885, Texas collector), WRIGHT'S CLIFF-BRAKE. Plants 15--30(--50) cm tall; stem (rhizome) scales bicolored, black centrally, brown marginally; leaf blades 1-pinnate-pinnatifid to 2-pinnate below, usually 8--25 cm long, 1--5 cm wide. Hays, Travis, Tyler, and Washington cos. (Turner & Nichols 2001) in the s part of East TX; mainly Trans-Pecos, Edwards Plateau, and Cross Timbers and Prairies (mainly w 1/2 of TX); mainly sw U.S. (AZ, CO, NM, OK, TX, and UT), also disjunct to NC and SC. Sporulating Mar--Nov. [*P. ternifolia* (Cav.) Link var. *wrightiana* (Hook.) A.F. Tryon]

PTERIS L. BRAKE

A genus of ca. 300 species found worldwide in warm and tropical areas (Nauman 1993b). The young fronds of some species are reported to be edible or useful medicinally. (Greek: *pteris*, fern, derived from *pteron*, wing or feather, in reference to the closely spaced pinnae which give the leaves a somewhat feather-like appearance---Nauman 1993b).

REFERENCES: Nauman 1993b; Stanford & Diggs 1998.

Pteris multifida Poir., (much divided, in reference to the leaves), HUGUENOT FERN, SPIDER BRAKE, SPIDER FERN, CHINESE BRAKE, SAW-LEAVED BRACKEN. Stems (rhizomes) short-creeping, densely scaly; leaves evergreen, monomorphic, clustered, (10--)25--60 cm long; leaf blades 10--35 cm long, 10--25 cm wide, essentially glabrous, at least partially 2-pinnatifid; pinnae opposite, 3--7 pairs, lanceolate to linear, those of mature leaves decurrent on the conspicuously winged rachis in at least distal 1/2 of leaf (rachis wing constricted distal to each pair of pinnae); basal and sometimes the medial pinnae with 1--2 lobes or pinnules (at least some pinnae are deeply palmately 3-divided except on the leaves of young plants, which can have palmately compound leaves with three unlobed pinnae), the distal pinnae simple; sterile pinnae wider than fertile pinnae, with margins serrulate to serrate; fertile pinnae entire to serrate near apex; sori near margins of fertile pinnae or pinnules, usually ± continuous, the margins reflexed over sori to form false indusia. Masonry of old brick buildings, calcareous sandstone talus blocks, and sandy soils of woods; Fayette Co. (BRIT), also Hardin (TAES), Jefferson, and Montgomery (Turner & Nichols 2001) cos.; also s TX; se U.S. from MD s to FL and w to TX, also CA, IL, IN, K, and NY. Sporulating Jun--Dec. Native of e Asia. [*Pycnodoria multifida* (Poir.) Small] According to Correll (1956), this species "…was cultivated on many of the older plantations in the Deep South where it still persists. It has escaped in many areas into the nearby woods and can now be found some miles from its original point of cultivation. It is so completely at home in some places in east Texas that it must be considered as naturalized." According to Nelson (2000), *P. multifida* "was first discovered in the U.S. in 1868 in a Huguenot cemetery in Charleston, South Carolina; hence, one of its common name, Huguenot fern. The common name 'spider brake' is likely in reference to the spiderlike appearance of the deeply-divided leaves." ☜

Pteris vittata L., LADDER BRAKE, CHINESE BRAKE, CHINESE LADDER BRAKE, (longitudinally striped---in reference to the linear false indusium), an Asian native well known as an escape from cultivation in coastal areas of the southeastern United States, is commonly found on exposed limestone (e.g., pinelands) and on a variety of man-made calcareous substrates (e.g., sidewalks, buildings, old masonry) (Nauman 1993b). It is known from LA (Kartesz 1999) and was recently reported from the Edwards Plateau of Texas (Stanford & Diggs 1998) based on a collection from a stream-side limestone boulder in San Saba Co. (*J.W. Stanford 5308*, 1987, BRIT, HPC, SPLT). It should be watched for in East TX; se U.S. from SC s to FL and w to TX, also CA. The strictly 1-pinnate leaves (the pinnae without lobes or divisions) easily distinguish this species from *P. multifida*. Because of its 1-pinnate leaves, this species (unknown from East TX) will not key properly in the key to genera above. ☜

SALVINIACEAE T. Lestib.

FLOATING FERN OR WATER SPANGLE FAMILY

A very small family (1 genus, ca. 10 species) of heterosporous (= with 2 spore types) aquatic ferns found mostly in the tropics, but ranging from s U.S., Mexico, West Indies, Central America, and South America, to Eurasia and Africa including Madagascar (Nauman 1993d). The Azollaceae has often been included in the Salviniaceae, but according to Lumpkin (1993), the relationship is not close enough to warrant inclusion in the same family. However, molecular evidence does indicate that *Salvinia* and *Azolla* are each other's closest living relative (Hasebe 1995), and the two families are probably appropriately treated in the same order (Schneller 1990b). Three families of heterosporous water ferns occur in East TX (*Azolla*---Azollaceae, *Marsilea, Pilularia*---Marsileaceae, and *Salvinia*---Salviniaceae). These groups are quite distinct morphologically, and traditionally the marsileaceous (*Marsilea* and *Pilularia*) and salviniaceous (*Azolla* and *Salvinia*) lines were considered to have evolved independently from different homosporous fern ancestors. However, all three living heterosporous water fern families appear to comprise a monophyletic group based on recent morphological, fossil, and molecular evidence (Rothwell & Stockey 1994; Hasebe et al. 1995; Pryer 1999).

FAMILY RECOGNITION IN THE FIELD: Small free-floating aquatics with leaves in groups of three (two floating, nearly rounded to elliptic, entire, with conspicuous branched hairs; one submerged, finely dissected, root-like).

REFERENCES: Schneller 1990b; Nauman 1993d.

SALVINIA Séguier FLOATING FERN, WATER SPANGLES, WATER-MOSS

Free-floating aquatics (can be trapped on mud when water levels fall); roots absent; stems short, creeping; leaves dimorphic, in groups of three---two floating and one submerged; floating leaves green, simple, unlobed, nearly round to oblong or elliptic, entire, obtuse or notched apically, the upper surface with numerous whitish, multicellular, papillate hairs, these having a single base and four branches, the lower surface with unbranched hairs; submerged leaves finely dissected, root-like; sporangia (either microsporangia or megasporangia) in sporocarps (formed by membranous indusia surrounding the sori) on submerged leaves, indehiscent, dispersed when the sporocarps decay (but plants usually infertile and reproducing vegetatively).

A genus of ca. 10 species of floating ferns (Nauman 1993d). The hairs on the upper leaf surfaces trap air, thus causing the plants to right themselves if turned over in the water (Lellinger 1985). The leaves are unusual in that the upper sides of the floating leaves (the sides visible to an observer), which appear to face the stem axis, are actually morphologically the lower (= abaxial) leaf surface (Croxdale 1978, 1979, 1981; Nauman 1993d). Some species have become serious aquatic weeds, particularly on man-made reservoirs and in irrigation systems (Schneller

1990b). Because of their potential threat to aquatic ecosystems, all species of the genus are prohibited in Texas (Harvey 1998). While the floating leaves of the two species discussed below are often different in size, crowding or low-light conditions tend to reduce leaf size, making the character less useful in determining species (Lellinger 1985). (Named for Professor Antonio Maria Salvini, 1633--1729, Italian botanist and professor of Greek at Florence)
REFERENCES: Mitchell & Tur 1975; Croxdale 1978, 1979, 1981; Forno 1983; Jacobsen 1983; Moran 1992; Jacono 1998, 1999a, 1999b, 1999c; O'Kennon et al. 1999.

1. Hairs of the upper (adaxial) surface of floating leaves 4-branched, the branches free at their tips (sometimes difficult to observe on herbarium specimens); floating leaves usually 6--15 mm long, usually not folded; lower surface of floating leaves ± covered with hairs ..... **S. minima**
1. Hairs of the upper surface of floating leaves 4-branched, the hair joined at their tips (use hand lens---the joined branches cause the hairs to resemble a "cage" or an "egg beater"); floating leaves usually 13--30(--38) mm long, often folded; lower surface of floating leaves sparsely hairy or ± glabrous except for hairs along the midrib ..... **S. molesta**

Salvinia minima Baker, (least, smallest), COMMON SALVINIA, WATER-SPANGLES, FLOATING FERN. Stems 1--6 cm long; floating leaves usually 7--15 mm long, rounded to cordate basally, obtuse or notched apically, usually not folded. Lakes and other aquatic habitats; Jasper (B.A. Steinhagen Lake---G. Diggs, pers. obs.), Jefferson (TAES), and Robertson (Turner & Nichols 2001) cos., in addition, according to R. Helton (pers. comm.), this species is now in Orange and Tyler cos. and is probably in Newton and Sabine cos. (it is known from the LA side of Toledo Bend); scattered across se U.S. (AL, GA, FL, LA, OK, and TX), also MA, MD, NM, and NY. Sporulating spring and fall (Nauman 1993d). In TX it is considered a "harmful or potentially harmful exotic plant" and it is illegal to release, import, sell, purchase, propagate, or possess this species in the state (Harvey 1998). This species had been considered to be native to the se U.S. (Nauman 1993d), but is now considered to be introduced to the U.S. (www.bonap.org/biological.html 2001). 

Salvinia molesta D.S. Mitch., (annoying or burdensome, in reference to the rapid vegetative growth), GIANT SALVINIA, KARIBA WEED, AQUARIUM WATER-MOSS, AFRICAN PYLE. Leaves ca. 13--30(--38) mm long, usually cordate basally, usually notched apically, often folded and compressed into dense chains (flat when young). Lakes and other aquatic habitats, reproducing vegetatively very effectively; Robertson (BRIT, TAMU), Fort Bend, Harris, Liberty, Montgomery, Newton, Orange, Sabine, and San Jacinto (R. Helton, pers. comm.) cos.; it has also

been reported from the Coastal Praires and Marshes and as far nw as Flower Mound (Denton Co.) in North Central TX (http://nas.er.usgs.gov/ferns/ 2001). It was first observed in TX in 1997 (Jacono 1999c), and as of summer 2000, it is known in TX from 4 reservoirs and ca. 40 private water bodies (R. Helton, pers. comm.). Now known in the se U.S. in AL, FL, LA, SC, and TX. Considered "one of the world's worst weeds" (Jacono 1999c), it is thought to be native to South America (se Brazil---Forno 1983; http://nas.er.usgs.gov/ferns/ 2000), and is possibly of hybrid origin. The sporangia abort and the chromosome number of 45 suggests a pentaploid condition (Jacobsen 1983). It has been introduced by humans to fresh waters of Australia, New Zealand, Asia, Africa, and the South Pacific, and has resulted in severe economic and environmental problems (Jacono 1999a, 1999b). The plants can grow rapidly and under good conditions doubling can occur in ca. one week, with a range of four to ten days (Mitchell & Tur 1975). GIANT SALVINIA covers the surface of lakes and streams, and the floating mats shade and crowd out native plants. Additionally, the thick mats reduce oxygen content, degrade water quality, and can cause physical problems including hindering boats and clogging water intakes. Plants used in aquaria or water gardens are among the likely sources for the escaped populations (Janoco 1998, 1999a, 1999b, 1999c). According to R. Helton (pers. comm.), "all reservoirs in East TX are imminently threatened" by this species. In TX, it is considered a "harmful or potentially harmful exotic plant" and it is illegal to release, import, sell, purchase, propagate, or possess this species in the state (Harvey 1998). GIANT SALVINIA is listed as a federal noxious weed (http://www.aphis.usda.gov:80/ppq/weeds/fnwsbycat-e.html 2001), and as such is prohibited in the U.S. by federal law. Janco (1998, 1999a) indicated that, if seen, the species should be eradicated immediately and that the Texas Parks and Wildlife, Inland Fisheries Division should be contacted at (409) 384-9965. Biological control by the salvinia weevil (*Cyrtobagous* spp.) is being contemplated; this weevil, native to South America, has been successfully used in control programs in various places in the Old World (Moran 1992; R. Helton, pers. comm.). Colette Jacono (U.S. Geological Survey, Giant Salvinia Education Committee Chair) (cited at http://www.toledo-bend.com/alliance/docs/salvinia2.html 2001) indicated that "*Salvinia molesta* is not known to reproduce by spores. It reproduces vegetatively, that is, new plants develop as fragments break off from mature individuals." ⊘☜

THELYPTERIDACEAE Pic. Serm.MARSH FERN OR MAIDEN FERN FAMILY

East TX species terrestrial; stems short- or long-creeping; leaves usually monomorphic or nearly so (somewhat dimorphic in *Thelypteris dentata*); leaf blades 1-pinnate-pinnatifid, 2-pinnate-pinnatifid, or 2--3-pinnatifid near base, less divided distally, usually abaxially with an indument (sometimes sparse) of transparent needle-like hairs, the ultimate segments often, but not always,

entire; sori usually round, abaxial on the blades, medial to submarginal; indusia round to kidney-shaped or obscure or absent.

A medium-sized (6 genera and ca. 900 species---Mabberley 1997) family of terrestrial ferns. While the group is subcosmopolitan, most members are tropical. There is disagreement on the number of genera, with the number ranging from 1 to ca. 30 depending on circumscription (Smith 1993a). While members of the family have traditionally been associated with *Dryopteris* (Dryopteridaceae) (e.g., Correll 1956), there is no close relationship (Smith 1993a); the similarities are apparently due to convergent evolution.
FAMILY RECOGNITION IN THE FIELD: sori usually on veins (but not marginal) on lower leaf surfaces; leaves usually all alike, 1-pinnate-pinnatifid, 2-pinnate-pinnatifid, or 2--3 pinnatifid, the lower surfaces with transparent needle-like hairs (distinguishing this family from Dryopteridaceae, which lack such hairs), the ultimate leaf segments often (but not always) entire.
REFERENCES: Smith 1990, 1993a.

1. Rachis conspicuously and irregularly winged between pinnae (wing tissue extended as obvious lobes in some places); leaf blades ± triangular in outline, ca. as wide as long, usually 7--25(--30) cm long; indusia absent ..... **Phegopteris**
1. Rachis not winged; leaf blades much longer than wide, often > 30 cm long; indusia present, often conspicuous with a hand lens (but in *Macrothelypteris* they can be small or obscured in mature sori).
   2. Midrib of pinnae grooved on upper surface; leaf blades 1-pinnate-pinnatifid; veins of ultimate leaf segments reaching segment margins; indusia usually obvious with a hand lens ..... **Thelypteris**
   2. Midrib of pinnae (= costae) not grooved on upper (= adaxial) surface; leaf blades mostly 2-pinnate-pinnatifid; veins of ultimate leaf segments not reaching segment margins; indusia small (< 0.3 mm in diam.) or obscure ..... **Macrothelypteris**

MACROTHELYPTERIS (H. Ito) Ching FALSE MAIDEN FERN

A genus of ca. 10 species of tropical and subtropical regions in Asia, Africa, the Pacific Islands, and Australia (Smith 1993a). (Greek: *macro*, large, *thelys*, female, and *pteris*, fern)
REFERENCES: Holttum 1969; Leonard 1972.

Macrothelypteris torresiana (Gaudich.) Ching, (for Luis de Torrès of the Marianas Islands and governor of Guam in 1820), TORRE'S FERN, MARIANA MAIDEN FERN, FALSE MAIDEN FERN. Stems short-creeping; leaves monomorphic, evergreen; leaf blades mostly 2-pinnate-pinnatifid,

broadest at base, much longer than wide, to ca. 85 cm long; veins of ultimate leaf segments not reaching segment margins, rachis not winged; costae (= midrib of pinnae) not grooved on adaxial (= upper) surface; sori round, medial to submedial; indusia small (< 0.3 mm in diam.) or obscure. Along streams, damp woods, and moist areas; Liberty (TAMU), Newton (BRIT), and Hardin (Turner & Nichols 2001) cos. in the Pineywoods; se U.S. from sc s to FL and w to AR and TX. Sporulating summer and fall. Native to tropical and subtropical Asia and Africa, originally described from the Marianas Islands (Thieret 1980). [*Dryopteris setigera* of authors, not (Blume) Kuntze, *Polystichum torresianum* Gaudich., *Thelypteris torresiana* (Gaudich.) Alston] This species has become naturalized from SC s to FL and w to TX; it was first collected in TX by Eula Whitehouse in 1950 (Correll 1956). ☜

PHEGOPTERIS Fée BEECH FERN

A genus of three species with 1 n temperate and boreal, 1 e North America, and 1 e Asia.(Greek: *phegos*, beech, and *pteris*, fern)
REFERENCE: Holttum 1969.

Phegopteris hexagonoptera (Michx.) Fée, (6-angled wing, apparently in reference to the shape of the rachis wings), BROAD BEECH FERN, SOUTHERN BEECH FERN. Stems long-creeping; leaves monomorphic, dying back in winter; leaf blades 2--3 pinnatifid near base, less divided distally, broadest at base, ± triangular in outline, ca. as wide as long, usually 7--25(--30) cm long; veins of ultimate leaf segments reaching segment margins or nearly so; rachis conspicuously and irregularly winged between pinnae (wing tissue extended as obvious lobes in some places); costae not grooved adaxially (vs. costae grooved in *Thelypteris*); sori round, submarginal; indusia absent. Moist wooded areas, margins of bogs, ravines along streams, often in acidic soils; Shelby (TAES), Marion, Rusk, Sabine, and San Augustine (Turner & Nichols 2001) cos. in the e Pineywoods; se Canada and throughout the e U.S. w to MN and TX. Sporulating summer and fall. [*Dryopteris hexagonoptera* (Michx.) C. Chr., *Polypodium hexagonopterum* Michx., *Thelypteris hexagonoptera* (Michx.) Nieuwl.]

THELYPTERIS Schmidel FEMALE FERN, MAIDEN FERN, MARSH FERN

Terrestrial; stems (rhizomes) horizontal, short- or long-creeping; leaves usually ± monomorphic (somewhat dimorphic in *T. dentata*); leaf blades 1-pinnate-pinnatifid, much longer than wide;

ultimate leaf segments entire, with veins reaching segment margins; rachis not winged; midrib of pinnae grooved on adaxial (= upper) surface; petioles straw-colored or purplish; sori round, in medial to submarginal position on the leaf segments on the abaxial (= lower) surfaces; indusia round to kidney-shaped, usually obvious with a hand lens, usually with pubescence.

A nearly cosmopolitan genus of ca. 875 species (Smith 1993a). Some of the species are similar and difficult to distinguish without close observation of the venation pattern of the ultimate leaf segments, particularily the basal veins---in some the basal veins of adjacent lateral segments join together and run united to the base of the sinus between the lateral segments---in others the basal veins reach the margins of the lateral segments at or above the sinus. (Greek: *thelys*, female, and *pteris*, fern, derived from *pteron*, wing or feather, perhaps in reference to the delicate appearance in contrast to the "male fern," *Dryopteris*---Nauman et al. 2000)
REFERENCES: Smith 1971a, 1971b.

1. Lateral veins of ultimate leaf segments often forked; margins of fertile ultimate segments usually turned downward; leaf blades with all lateral veins of ultimate segments extending to margin of blade tissue **above** (= beyond) sinuses between ultimate segments..... **T. palustris**
1. Lateral veins of ultimate leaf segments usually not forked; margins of fertile ultimate segments usually not turned downward; leaf blades with at least some basal lateral veins of ultimate segments extending to, joined at, or united **below** the sinuses between the ultimate segments.
   2. Basal veins of adjacent ultimate blade segments united below the sinuses between the segments, with the resulting single vein extending toward the sinuses.
      3. United portion of veins below sinuses usually 2--4 mm long; midrib of pinnae with hairs mostly very short (0.3 mm or less long) on the lower surface (= abaxially); petioles often purplish; leaves usually with more than 2 pairs of greatly reduced basal pinnae..... **T. dentata**
      3. United portion of veins below sinuses usually < 2 mm long; midrib of pinnae with hairs variable in length (0.3--0.8 mm long) on the lower surface; petioles straw-colored; leaves usually with 0--2 pairs of slightly reduced basal pinnae ..... **T. hispidula**
   2. Basal veins of adjacent ultimate blade segments not united (and thus reaching margin of segments slightly above the sinuses) or meeting at the sinuses.

4. Upper surface of midveins of pinnae glabrous or with a few minute hairs, these never much longer than width of the midveins; a few scales often persistent on lower surface of rachises and costae of mature leaves ..... **T. ovata**

4. Upper surface of midveins of pinnae with conspicuous (use lens) hairs usually longer than width of the midveins; scales absent on lower surface of rachises and costae of mature leaves.

5. Basal veins of adjacent ultimate blade segments not united, sometimes meeting at the sinsues; leaf blades usually broadest at or near base, the basal pinnae as long as or only slightly shorter than more distal pinnae; leaf blades glabrous or sparsely hairy above, except along veins ..... **T. kunthii**

5. Basal veins of adjacent ultimate blade segments variable, some not united, some meeting at the sinuses, some united below the sinuses into a single vein; leaf blades broadest above base, the basal and near basal pinnae noticeably shorter than more distal pinnae; leaf blades often somewhat hairy above, on regular blade tissue as well as along the veins ..... **T. hispidula**

Thelypteris dentata (Forsskål) E.P. St. John, (toothed), DOWNY SHIELD FERN, DOWNY MAIDEN FERN. Stems short-creeping; leaves somewhat dimorphic, evergreen; leaf blades (25--)40--100 cm long, usually with more than 2 pairs of greatly reduced basal pinnae; basal veins of adjacent ultimate blade segments united below the sinuses between the segments, with the resulting single vein extending toward the sinuses, the united portion usually 2--4 mm long; midrib of pinnae abaxially with mostly very short (0.3 mm or less long) hairs; petioles often purplish; sori round, medial to supramedial; indusia pubescent. Wooded slopes, damp woods, swamp hummocks, and along streams; Angelina (Turner & Nichols 2001), Harris, and Sabine (Correll 1956) cos.in the Pineywoods; also Harris Co. (Turner & Nichols 2001) at the n margin of the Gulf Prairies and Marshes; se U.S. from SC s to FL and w to TX, also KY. Sporulating summer and fall. Native to the tropics and subtropics of Asia and Africa. [*Dryopteris dentata* (Forssk.) C. Chr., *Polypodium dentatum* Forssk.] ☜

Thelypteris hispidula (Decasne) C.F. Reed var. **versicolor** (R.P. St. John) Lellinger, (sp.: diminutively hairy or bristly; var.: changing color), VARIABLE MAIDEN FERN, ST. JOHN'S SHIELD FERN, ROUGH-HAIRY MAIDEN FERN. Stems short-creeping to ascending at tip; leaves monomorphic, evergreen; leaf blades 14--55 cm long, broadest above base, the basal and near basal pinnae usually noticeably shorter than more distal pinnae; basal veins of adjacent ultimate blade segments variable, some united below the sinuses into a single vein (usually for < 2 mm) which then runs to the sinuses, some meeting at the sinuses, some free; leaf blade tissue (in

addition to veins) often somewhat hairy above; midrib of pinnae abaxially with hairs variable in length, 0.3--0.8 mm long; petioles straw-colored; sori medial to supramedial; indusia with pubescence. Wooded slopes and ravines, low woods, along streams; Jasper, Orange, Sabine, and San Jacinto (BRIT) cos. in the Pineywoods; se U.S. from SC s to FL and w to TX. Sporulating summer and fall. [*Dryopteris versicolor* (R.P. St. John) M. Broun, *T. quadrangularis* (Fée) Schelpe var. *versicolor* (R.P. St. John) A.R. Sm., *T. versicolor* R.P. St. John] This species was at one time considered to be a hybrid between *T. dentata* and *T. kunthii* (e.g., Correll & Johnston 1970). However, Smith (1971a, 1971b) showed this was not possible because the proported parents were tetraploids and this species is a diploid.

Thelypteris kunthii (Desv.) C.V. Morton, (for Karl Sigismund Kunth, 1788--1850, German botanist), WIDESPREAD MAIDEN FERN, SOUTHERN SHIELD FERN, KUNTH'S MAIDEN FERN. Stems short- to long-creeping; leaves monomorphic, evergreen; leaf blades (9--)30--80 cm long, usually broadest at or near base, the basal pinnae as long as or only slightly shorter than more distal pinnae, glabrous or sparsely hairy above, except along veins, the lower surface with indument of short hairs on costae, veins, and blade tissue; basal veins of adjacent ultimate blade segments not united, sometimes meeting at the sinsues; sori medial to supramedial; indusia with pubescence. Woodlands, streambanks, swamps, ditches; widespread in East TX w to the Blackland Prairie (Bastrop, Dallas, and Wilson (Turner & Nichols 2001) cos.); a recent Parker Co. collection (*Jeff Quayle, s.n.*, 1997, BRIT), in the Cross Timbers and Prairies, is well to the w of the species' typical range; se U.S. from NC s to FL and w to AK and TX. [*Dryopteris normalis* C. Chr., *T. normalis* (C. Chr.) Moxley] This species has often been confused and lumped (e.g., Correll 1956, 1966a) with *Thelypteris ovata* var. *lindheimeri*, sometimes under the name *Dryopteris normalis*. Hybridization between *T. kunthii* and both *T. hispidula* and *T. ovata* has been reported (Smith 1993a).

Thelypteris ovata R.P. St. John var. **lindheimeri** (C. Chr.) A.R. Sm., (sp.: ovate; var.: for F.J. Lindheimer, 1801--1879, German-born Texas collector), LINDHEIMER'S MAIDEN FERN, OVATE MARSH FERN. Stems usually long-creeping; leaves monomorphic, sometimes evergreen; leaf blades usually broadest at or near base, glabrous or with minute pubescence above, with scattered hairs along veins, the lower surface with indument of short hairs on costae, veins, and blade tissue; basal veins of adjacent ultimate blade segments not united, sometimes meeting at the sinsues; sori supramedial to submarginal (sori typically closer to leaf margins than in *T. kunthii*); indusia with pubescence. Low, moist areas, wet bluffs and ledges, including limestone; Bell Co. (BRIT), Comal, Hays, Travis, and Williamson (Turner & Nichols 2001) cos.; mainly Edwards Plateau and Trans-Pecos; in the U.S. known only from TX (also Latin America). Sporulating May--Nov. [*Dryopteris normalis* C. Chr. var. *lindheimeri* C. Chr.] This species has often been confused and lumped (Correll 1956, 1966a, Correll & Johnston 1970, Hatch et al. 1990)

with *Thelypteris kunthii* (either as *T. kunthii* or under the name *Dryopteris normalis*). While strikingly similar in overall aspect, the two can be readily distinguished by the characters in the key.

Thelypteris palustris Schott var. **pubescens** (Lawson) Fernald, (sp.: marshy; var.: downy), SOUTHERN MARSH FERN, MARSH FERN, EASTERN MARSH FERN. Stems long-creeping, leaves monomorphic or nearly so, dying back in winter; leaf blades 10--40(--55) cm long; lateral veins of ultimate leaf segments often forked, usually extending to margin of blade tissue above sinuses between ultimate segments; margins of fertile ultimate segments usually turned downward; sori medial; indusia often with pubescence. Terrestrial in low woods, along streams, and in swamps and bogs; Titus (BRIT), Washington (TAMU), Anderson, Jasper, Jefferson, Leon, Liberty, Marrion, Harrison, Robertson, Wood (Turner & Nichols 2001), Houston, and Waller cos. (Correll 1956), in the Pineywoods and Post Oak Savannah; also n Gulf Prairies and Marshes; se Canada and throughout e U.S. w to ND and TX. Sporulating late summer and fall. [*Dryopteris thelypteris* (L.) A. Gray var. *pubescens* (Lawson) Weath., *Thelypteris palustris* var. *haleana* Fernald]

GYMNOSPERMS

The term gymnosperm (literally, "naked seed"), referring to those plants with ovules, and subsequently seeds, borne on the surface of an open scale, is not recognized here as a formal taxonomic category. The classification of the gymnosperms has varied considerably over time. At one point all were treated in the Class Gymnospermae, implying a close relationship. Later, the evolution of the seed in the different gymnosperm groups was thought to have occurred independently from different non-seed ancestors, making the group polyphyletic and thus not worthy of formal recognition. However, recent molecular studies (e.g., Qiu et al. 1999; Mathews & Donoghue 1999) suggest that all living gymnosperms form a monophyletic group. According to Mathews and Donoghue (1999), "...analyses of molecular data often unite Gnetales with conifers and support a clade of all extant seed plants except angiosperms." However, because of their distinctiveness, the four living gymnosperm groups (surviving remnants of ancient and much more diverse lineages; currently totaling 840 species in 86 genera arranged in 17 families worldwide) are treated in this flora as separate divisions (Cycadophyta---CYCADS, Ginkgophyta---MAIDEN-HAIR TREE, Gnetophyta, and Pinophyta) only two of these (Pinophyta---CONIFERS, Gnetophyta---JOINT-FIRS and relatives) are native to East TX. The other two are widely cultivated as ornamentals and street trees in East TX. Brief accounts of the Cycadophyta and Ginkgophyta are included here for educational purposes.

REFERENCES: Hardin 1971; Kramer & Green 1990; Eckenwalder 1993; Doyle 1998; Mathews & Donoghue 1999; Qiu et al. 1999; Wunderlin & Hansen 2000b.

DIVISION **GNETOPHYTA**
JOINT-FIRS AND RELATIVES

A small group of 3 distinctive families: Ephedraceae, Gnetaceae (1 genus, 28 species), and Welwitschiaceae (monotypic). The division is unusual among the gymnosperms in having double fertilization (in *Ephedra*---Friedman 1990, 1994) and xylem with vessels (as in most flowering plants). Molecular studies link the three families (i.e., suggest the Gnetophyta is monophyletic), and at least some of these studies suggest the Gnetophyta as the sister group of the flowering plants (i.e., their closest living relatives) (Hambry & Zimmer 1992; Chase et al. 1993; Qui et al. 1993; Doyle et al. 1994; Price 1996; Stefanovic 1998). However, more recent molecular data relying on a variety of different genes seem to clearly link the Gnetophyta with the rest of the gymnosperms and suggest the gymnosperms are monophyletic (e.g., Hasebe 1999; Mathews & Donoghue 1999; Qiu et al. 1999). According to Mathews and Donoghue (1999), while "Analyses of morphological characters consistently suggest that Gnetales are the closest living relatives of angiosperms, ...analyses of molecular data often unite Gnetales with conifers and support a clade of all extant seed plants except angiosperms." Extensive information on the evolution, relationships, and morphology of the Gnetophyta can be found in Friedman (1996).

REFERENCES: Arber & Parkin 1908; Bell & Woodcock 1983; Bold et al. 1987; Doyle 1996; Friedman 1996; Price 1996; Mathews & Donoghue 1999; Qiu et al. 1999.

EPHEDRACEAE Dumort. MORMON-TEA OR JOINT-FIR FAMILY

A monogeneric family of ca. 60 xerophytic (= dry-adapted) species found mainly in the n hemisphere and South America.

FAMILY RECOGNITION IN THE FIELD: Plants shrubby with *jointed photosynthetic* stems and leaves *reduced to minute scales*; seeds borne in *small cones* at the nodes.

REFERENCES: Correll 1966b; Kubitzki 1990; Stevenson 1993.

EPHEDRA L. MORMON-TEA, JOINT-FIR, MEXICAN-TEA

Ephedra is unusual among the gymnosperms in having double fertilization (Friedman 1990, 1994), a characteristic previously thought to occur only in flowering plants. A number of species

have been used medicinally. Ephedrine, an alkaloid commonly used as a decongestant and in the treatment of asthma, sinusitis, and bronchial disorders, is derived from Asian species (e.g., *Ephedra sinica* Stapf---MA HUANG); it has been used in China for 5,000 years. Ephedrine is an ingredient in a large number of over-the-counter and herbal medications and is used for a number of purposes (decongestant, stimulant, weight loss). ☠ However, "multiple cases of psychotic reactions linked to the use of ephedrine have been described" (Bruneton 1999), and numerous other symptoms have been reported. These include dizziness, headache, gastrointestinal distress, cardiac arrhythmias, heart attacks, seizures, strokes, and death (http://vm.cfsan.fda.gov/~dms/ds-ephed.html 2001). Because of its molecular structure, ephedrine can be converted to amphetamine-type compounds. As a result "certain states in the U.S. have adopted legislation to restrict the sale of plant products and ephedrine-containing products" (Bruneton 1999). The common name MORMON-TEA comes from the use of various sw U.S. species as a beverage by early Mormon settlers (Woodland 1997). (Greek: *ep-*, upon, and *hÈdra*, seat or sitting upon a place; from the ancient name used by Pliny for *Equisetum*; the stems resemble the jointed stems of *Equisetum*, the segments of which appear to sit one upon the other)
REFERENCES: Cutler 1939; Steeves & Barghoorn 1959.

Ephedra antisyphilitica Berland. ex C.A. Mey., (against syphilis), JOINT-FIR, CLAPWEED, POPOTE, TEPOPOTE, CAÑATILLA. Dioecious (pollen- and seed-producing cones on separate plants), erect to spreading shrub to ca. 1 m tall; bark gray; branches jointed, alternate to whorled, stiff, to ca. 4 mm thick; twigs green to yellow-green, photosynthetic, glaucous, the internodes ca. 2--5 cm long; leaves opposite, scale-like, minute, 1--3 mm long, connate 2/3--7/8 their length, mostly not photosynthetic; cones 1--2 per node on the twigs; staminate (= pollen-producing) cones lance-ellipsoid, 5--8 mm long, compound (made up of smaller cones), of 5--8 pairs of pale green to red bracts, the proximal bracts empty, the distal bracts each subtending a small cone composed of 2 basally fused bracteoles and a stalk-like sporangiophore; sporangiophores 4--5 mm long, exserted to 1/2 their length, bearing 4--6 pollen-producing microsporangia; microsporangia sessile or on stalks < 1 mm long; ovulate (= seed-producing) cones ellipsoid, 6--12 mm long, sessile or nearly so, compound, of 4--6 pairs of bracts (the inner ones becoming fleshy and red, the cones thus fruit-like), with 1 (rarely 2) seeds per cone; seeds 6--9 mm long, 2--4 mm wide. Gravelly or rocky soils; Bexar, Comal (Turner & Nichols 2001), and Travis (Correll 1966b; R. George, pers. comm.) cos. near the extreme w margin of East TX; mainly South TX Plains and w 1/2 of state; OK and TX. With cones late winter--early spring. According to Correll (1966b), this taxon can be distinguished from all other TX *Ephedra* species by the very narrow, pale orange-yellow or tannish band that encircles the stem at the very base of the connate leaves.

DIVISION **PINOPHYTA**

CONIFERS

This is the gymnosperm division with the largest number of living representatives (68 genera and 629 species arranged in 8 families---Farjon 1998). The seeds are typically borne in cones, thus the common name, CONIFERS, from Latin *conus*, cone, and *-fero*, bearing. Recent molecular evidence (Stefanovic et al. 1998) supports the theory that the conifers are a monophyletic group. The fossil history of the conifers extends to late in the Carboniferous Period (360--286 million years ago). Vast forests of Pinophyta (PINE, SPRUCE, FIR, DOUGLAS-FIR, CEDAR, etc.) are present across the northern part of the world between areas of tundra and deciduous forest; they dominate the biome known as taiga. These mostly evergreen species have xerophytically adapted desiccation resistant foliage that allows them to maintain their photosynthetic surface through the long winter and make immediate and maximal use of the short growing season available in the taiga. Having evergreen leaves that last for several years also means that the high nutrient demand associated with making a new set of leaves each spring is not required---this is considered a significant advantage on the generally nutrient-poor soils of the taiga (Pielou 1988). The result is that this is one of the few gymnosperm groups that has maintained dominance over flowering plants across vast areas. The small family Taxaceae (YEWS) is important because the bark of *Taxus brevifolia* Nutt. (PACIFIC YEW, CALIFORNIA YEW) is the source of the terpenoid taxol, a promising anti-cancer drug used in the treatment of ovarian and other types of cancer; as a result, PACIFIC YEW populations in some areas have been greatly reduced. While not important as a direct source of taxol, the leaves of the European and Mediterranean *Taxus baccata* L. (EUROPEAN YEW, ENGLISH YEW) contain a compound that is now being used in taxol synthesis. It is interesting to note that like many medically valuable plants "discovered" by modern medicine, the genus has a long history of medicinal use; e.g., early Europeans used it in treating hydrophobia and heart ailments and Native Americans used it against such conditions as rheumatism, bronchitis, fever, scurvy, and skin cancer. Also like many medicinal plants, YEWS are poisonous; the species have long been used in various ways such as arrow poisons, to kill fish, and in murder and suicide, and are known to be fatally poisonous to animals and humans. Death from YEW can be sudden with animals sometimes being found close to the plant with foliage still in their mouths (Kingsbury 1964; Hartzell 1991, 1995; USDA Forest Service 1993; Cragg et al. 1995; Suffness & Wall 1995). The Pinophyta is sometimes referred to as the Coniferophyta (Raven et al. 1986).

REFERENCES: Hardin 1971; Bell & Woodcock 1983; Raven et al. 1986; Bold et al. 1987; Hart 1987; Eckenwalder 1993; Woodland 1997; Stefanovic et al. 1998.

CUPRESSACEAE Rich. ex Bartl. CYPRESS OR REDWOOD FAMILY

Evergreen or deciduous trees or shrubs; monoecious or in *Juniperus* usually dioecious; leaves varioiusly alternate and spirally arranged, or opposite, or whorled, sometimes appearing 2-ranked due to twisting, sometimes dimorphic, often with an abaxial resin gland; pollen cones usually solitary, terminal; pollen not winged; seed cones with scales fleshy or woody.

This family has often been divided between Cupressaceae (in the strict sense), for those genera having opposite or whorled leaves (including *Juniperus*), and Taxodiaceae, or REDWOOD FAMILY, for those genera having leaves mostly alternate. We follow Eckenwalder (1976), Hart and Price (1990), and Watson and Eckenwalder (1993) in treating them as a single family. Recent molecular evidence (Brunsfeld et al. 1994) shows Cupressaceae (in the strict sense) derived from within Taxodiaceae, supporting the single family treatment. The family is widespread in temperate areas and has ca. 25--30 genera and ca. 110--130 species. It includes many interesting and important genera including *Metasequoia*, *Sequoia*, *Sequoiadendron* (GIANT REDWOOD), and *Thuja* (ARBORVITAE). *Metasequoia glyptostroboides* Hu & W.C. Cheng (DAWN REDWOOD), known from only one remote area of China, was discovered in 1945. It has an extensive fossil record---it was the most abundant conifer in w and arctic North America from the late Cretaceous to the Miocene---and is thus often referred to as a living fossil. *Sequoia sempervirens* (D. Don) Endl. (COAST REDWOOD) of the Pacific coast of the U.S. is the world's tallest tree, reaching heights of over 117 m (Raven et al. 1986). It has been greatly overexploited and is now restricted to a few reserves. Family name from *Cupressus*, CYPRESS, a genus of 10--26 species of warm north temperate areas. (Latin name for the Italian cypress, *C. sempervirens* L.)

FAMILY RECOGNITION IN THE FIELD: EITHER evergreen trees or shrubs of dry habitats with opposite or whorled, *scale-like* leaves and *small, berry-like,* fleshy cones OR trees of wet habitats with alternate, linear to linear-lanceolate, *flat and feathery, deciduous* leaves, nearly *globose, plum-sized,* woody cones, and often with "*knees*" (erect woody projections) from the roots.

REFERENCES: Dallimore & Jackson 1931; Correll 1966b; Eckenwalder 1976; Hart 1987; Price & Lowenstein 1989; Hart & Price 1990; Page 1990b, 1990d; Watson & Eckenwalder 1993; Brunsfeld et al. 1994.

1. Leaves (adult) scale-like, closely appressed to stem, to 2.5 mm long, opposite or whorled, evergreen; cones globose to ovoid, to ca. 10 mm long, berry-like, fleshy; plants typically of dry habitats ..... **Juniperus**
1. Leaves linear to linear-lanceolate, conspicuously flat and feathery, not appressed, 5--17 mm long, alternate, deciduous; cones usually nearly globose, 15--25(--40) mm in diam., woody; plants of wet habitats ..... **Taxodium**

JUNIPERUS L. JUNIPER

Dioecious (pollen cones and seed cones on separate trees) or rarely monoecious (pollen cones and seed cones on same tree), evergreen, aromatic, resinous trees or shrubs; bark (in East TX species) reddish brown to brown or ashy gray, with long, thin, shreddy scales; adult leaves usually scale-like, opposite or in whorls; juvenile leaves needle-like; staminate cones small, cylindric, shedding pollen in late winter or early spring; mature ovulate cones fleshy, berry-like, variously colored, often glaucous, globose to ovoid, to ca. 10 mm long, reaching maturity in fall; seeds (in East TX species) 1--several, wingless.

A genus of ca. 60 species, primarily n hemisphere in distribution with 1 species in e Africa. The decay-resistant wood of *Juniperus* species is often used for fence posts, the cones are an important food for birds, and gin is flavored by the cones of *Juniperus communis* L. of n North America. Numerous cultivars are used in landscaping, particularly those with unusual habits or foliage. Junipers are wind-pollinated and shed large amounts of pollen (e.g., the "MOUNTAIN-CEDAR" pollen of local TV weather); this pollen is one of the most serious allergens (e.g. hay fever) in East TX. JUNIPERS are problematic near apple trees and native hawthorns (*Crataegus* species) since they serve as an alternate host for cedar apple rusts (*Gymnosporangium* spp.). Ecologically, due to fire suppression and other human-induced changes, a number of native species of *Juniperus* have become problematic invaders of native rangelands; currently millions of acres are affected (Adams et al. 1998). (Latin: *juniperus*, name for JUNIPER)
REFERENCES: Hall 1952; Adams 1972, 1975, 1977, 1986, 1993, 2000a, 2000b; Flake et al. 1978; Owens 1996; Adams et al. 1998.

1. Plant usually with one main trunk from base; abaxial (= on side away from twig) leaf glands usually elliptic to elongate, usually not conspicuously raised (10X lens); leaf margins entire, smooth (under a dissecting scope); extremely abundant in East TX..... **J. virginiana**
1. Plant usually with several trunks from near base; abaxial leaf glands usually roundish in outline, often conspicuously raised (10X lens); leaf margins irregularly very minutely cellular-serrulate or cellular-denticulate, not smooth (under a dissecting scope); rare in East TX, known only from Dallas Co. .....**J. ashei**

Juniperus ashei J. Buchholz, (for its discoverer, William Willard Ashe, 1872--1932), MOUNTAIN-CEDAR, ASHE'S JUNIPER, ROCK-CEDAR, POST-CEDAR, MEXICAN JUNIPER. Large shrub or small tree to ca. 6 m tall, usually with several trunks from near base; not resprouting after cutting or burning; bark ashy-gray to brown; ovulate cones mostly 7--8.5 mm long when mature,

dark blue, glaucous, sweet, resinous; seeds 1(--3), covered by hilum for 1/3 their length. Rocky soils; often forming thickets or "cedar brakes" (further s and w in TX); Bexar, Travis, Williamson (LL), Bell (TAES), Dallas (BRIT), Hays (SHST), and Comal (Turner & Nichols 2001) cos. on the w margin of East TX s and w to w TX; AR, MO, OK, and TX. Due to fire supression, this species currently covers much more area (e.g., in the Cross Timbers and Prairies) than previously (Hall 1952; Fuhlendorf & Smeins 1997). In fact, Owens (1996) indicated that in central Texas *J. ashei* was previously confined to steep slopes, rocky outcrops, and waterways. This human-induced expansion of *J. ashei* has significant negative impacts on other native plants and is problematic for ranchers. *Juniperus ashei* is sometimes distinguished with difficulty from *J. virginiana*; in addition to the characters in the key, *J. ashei* usually has stiffer twigs and more odoriferous herbage. Hybridization and introgression have been reported where the 2 occur together (Correll 1966b, Hall 1952). Hall (1952) noted that *J. ashei* can also hybridize with *J. pinchotii*. However, Adams (1977) refuted these reports of hybridization using chemical and morphological studies.

Juniperus virginiana L., (of Virginia), EASTERN RED-CEDAR, RED-CEDAR, VIRGINIA RED-CEDAR, RED SAVIN, PENCIL-CEDAR, RED JUNIPER. Medium to large tree to 30 m tall, typically much smaller, usually with one main trunk; not resprouting after cutting or burning; bark reddish brown; ovulate cones 5--8 mm long, blue to bluish black or bluish purple, glaucous, resinous; seeds 1--2(--3), the hilum small, inconspicuous. Dry sandy and rocky soils, old fields, fencerows, forest margins; Pineywoods and Gulf Prairies and Marshes w to West Cross Timbers and Edwards Plateau; Little (1971) mapped the species in TX as far w as Wichita Co. in the Rolling Plains; Turner and Nichols (2001) mapped locatities in the Panhandle; se Canada and e US w to ND and TX. This is a problematic invader of native prairies under conditions of fire suppression. The aromatic, moth-repelling heartwood is used for cedar chests and closets. RED-CEDAR symbolized the tree of life for a number of Native American tribes and was burned in sweat lodges and in purification rituals (Kindscher 1992).

Juniperus pinchotii Sudw., (for botanist Giffard Pinchot, 1865--1946), RED-BERRY JUNIPER, PINCHOT'S JUNIPER, is known just w of East TX on gravelly or rocky soils, commonly limestone or gypsum (e.g., Montague and Johnson cos.) and could possiblly be found on the extreme w margin of the area; NM, OK, and TX. Large shrub or shrub-like small tree to ca. 6 m tall, usually with several trunks from near base; resprouting after cutting or burning; bark ashy-gray to brown; ovulate cones 6--10 mm long, usually not glaucous or only slightly so, sweet, not resinous; seeds 1--2, covered by hilum for ca. 1/2 their length. This species is similar to *J. ashei*, but according to Correll (1966b), the branchlets of *J. pinchotii* tend to be more slender and erect than the usually stiffish, recurved branchlets of *J. ashei*. The two species can be distinguished as follows:

1. Mature ovulate cones (seed cones) reddish or copper-colored; leaf gland often with white crystalline exudate; hilum (= attachment scar) covering seed ca. 1/2 its length ..... *J. pinchotii*
1. Mature ovulate cones blue to bluish black or bluish purple; leaf gland without exudate; hilum covering seed ca. 1/3 or less its length ..... *J. ashei*

TAXODIUM Rich. BALD-CYPRESS

A genus of a single species (sometimes divided into 3) ranging from the United States through Mexico to Guatemala; this is one of only 11 tree genera endemic to e North America (and adjacent tropical areas) (Little 1983). It is frequently segregated with related taxa into the Taxodiaceae. (*Taxus*, generic name of yew, and Greek *-oides*, like)
REFERENCES: Watson 1985, 1993; Keeland & Young 1997; Tsumura et al. 1999.

Taxodium distichum (L.) Rich. var. **distichum**, (in two ranks), BALD-CYPRESS, SOUTHERN CYPRESS, SOUTHERN BALD-CYPRESS. **State tree of Louisiana.** Monoecious (pollen cones and seed cones on the same tree), deciduous trees to 50 m tall with a swollen, often buttressed base; in frequently flooded areas often with "knees" (erect woody projections from the roots; shoots dimorphic; long shoots indeterminate; short shoots (slender leafy twigs) deciduous with the leaves in fall, pendent to horizontally spreading; leaves 2-ranked, feathery, linear, flat, 0.5--1.7 cm long, laterally divergent, the free portion contracted and twisted basally; staminate (pollen) cones ca. 2 mm in diam., in drooping panicles 10--12 cm long; ovulate (seed) cones usually nearly globose, to ca. 25 mm in diam., the scales somewhat peltate. Swamps and along water courses and lake margins; Pineywoods and Post Oak Savannah w to Red River, Upshur (BRIT), and Brazos (apparently native, M. Reed, pers. obs.) cos. and sw portion of East TX in Bexar, Bastrop, Comal, Hays, Travis (Turner & Nichols 2001) cos.; also Gulf Prairies and Marshes and e Edwards Plateau; e U.S. from NY s to FL and w to TX and MO. Pollen shed in spring; seeds in fall. This species dominates the landscape in some swampy situations and huge populations can be found (e.g., Caddo Lake, Big Thicket). BALD-CYPRESS is an important timber tree known for its decay-resistant wood, even when in contact with soil; the heartwood is so durable that it has been referred to as "the wood eternal" (Hart & Price 1990). At one time there were large numbers of huge BALD-CYPRESSES in East TX, but because of the value of the wood, most were cut for timber. However, a very few impressive, extremely old individuals escaped destruction and can still be seen in the Big Thicket National Preserve in the s part of the Pineywoods. This species is extremely long lived and individuals up to 1,700 years old have have been discovered in North Carolina (Stahle et al. 1988). According to Briand (http://faculty.ssu.edu/~biology/Briand/Research/Research.html 2001), the "function of cypress knees has long intrigued botanists. In 1819, Michaux stated – 'No cause can be assigned for their existence.', to which in 1882 Asa Gray concurred. Since the late 19th century a number of

theories have been put forward to explain their function, including aeration of the root system, vegetative reproduction, mechanical support, nutrient accumulation and carbohydrate storage. After nearly two hundred years of speculation and research, the function or functions of the knees of the cypresses still remains unclear." This species grows in a variety of situations; while wild plants are vitrually always in wet areas, BALD-CYPRESS does extremely well as a street tree and in lawns. It is currently being widely planted in East TX. While often seen growing in relatively shallow water considerable distances from the shore of lakes, the species is reported to germinate only on moist but unflooded soil (Stalter 1981).

Taxodium distichum var. *imbricatum* (Nutt.) Croom, (overlapping in regular order like tiles), [*T. ascendens* Brongniart, *T. distichum* var. *nutans* of authors, not (Aiton) Sweet---Watson 1985], POND-CYPRESS, is native in the se U.S. from NC s to FL and w as far as e LA (Watson 1993). It can be distinguished from var. *distichum* as follows: short shoots mostly ascending vertically; leaves not 2-ranked, mostly narrowly lanceolate, ca. 3--10 mm long, appressed and overlapping, the free portion neither contracted nor twisted basally (Watson 1993). While some authorities treat this taxon as a separate species (e.g., Nauman 2000), we are following Watson (1993) who treated it at as a variety. Recent molecular evidence (Tsumura et al. 1999) supports recognition of POND-CYPRESS at the varietal level.

Taxodium distichum var. *mexicanum* Gordon, (of Mexico), [*T. mucronatum* Ten.], the related MEXICAN OR MONTEZUMA BALD-CYPRESS, is famous for the "Tule Tree" of Oaxaca, one of the world's largest trees (Hall et al. 1990; Dorado et al. 1996; Debreczy & Rácz 1998). This ± evergreen variety extends as far n as s TX. According to Watson (1993), var. *mexicanum* exhibits continuous morphologic intergradation with var. *distichum* and there is some question as to whether it should be treated as a separate variety.

PINACEAE Lindl. PINE FAMILY

A primarily n hemisphere family of 10 genera and ca. 200 species. It is of great economic importance as a source of softwood timber, pulpwood, naval stores (e.g., turpentine), Christmas trees, and ornamentals. Other important genera include *Abies* (FIRS), *Picea* (SPRUCE), *Pseudotsuga*, and *Tsuga* (HEMLOCK). *Pseudotsuga menziesii* (Mirbel) Franco (DOUGLAS FIR), of w North America, with trunks 3--4 m in diam. and over 90 m tall, is one of the most important lumber trees in the world (Lipscomb 1993; Woodland 1997); an individual 133 m tall was reported to have been felled in British Columbia in 1895 (Mabberley 1987). It is frequently sold as a Christmas tree in East TX and can be recognzied by the pointed buds.
FAMILY RECOGNITION IN THE FIELD: trees with long, *needle-like leaves in bundles* of 2 or 3 (East TX species) and large woody *cones*; tissues resinous and aromatic.

REFERENCES: Dallimore & Jackson 1931; Correll 1966b; Little 1971; Price 1989; Farjon 1990; Page 1990c; Thieret 1993.

PINUS L. PINE

Monoecious (pollen cones and seed cones on the same tree), evergreen, resinous, aromatic trees to 30 m or more tall; leaves of 2 kinds; scale-like leaves subtending minute branchlets; each branchlet bearing a fascicle of 2--3 (in East TX species) elongate, needle-like foliage leaves (= needles) surrounded at the base by a membranous sheath; staminate (pollen) cones small, in clusters at the base of the current year's growth, shedding pollen late winter to spring; pollen winged (each pollen grain having 2 air-bladders); ovulate (seed) cones becoming large and woody, in East TX species taking 2 years to mature; each scale of seed cone with a thickened, exposed, apical portion (= apophysis) terminated by an umbo (= protuberance); seeds winged (in East TX species), 2 per cone scale, shed in the fall.

A genus of ca. 100 species widely distributed in the n temperate zone and in mountainous areas of the n tropics. *Pinus* has the most species of any conifer genus (Millar 1993) and has the most widespread distribution of any genus of trees in the Northern Hemisphere (Price et al. 1998). Many are cultivated for timber, pulp, and resinous products (pitch, rosin, turpentine); others are used for their edible seeds (pignons, pignolia, or pine nuts) or as ornamentals. According to Liston et al. (1999), "Modern classifications of *Pinus* recognize two major lineages: subgenus *Pinus* (diploxylon or hard pines, with two fibrovascular bundles in the needles) and subgenus *Strobus* (haploxylon or soft pines, with one fibrovascular bundle in the needle)." All species in East TX are in subgenus *Pinus*. *Pinus longaeva* D.K. Bailey (BRISTLE-CONE PINE of far w North America) is among the oldest living trees, with individuals approaching 5,000 years old. This species has been important in the development of dendrochronology (= tree-ring dating), and when dead specimens (which can last thousands of years before decaying) are used, a tree ring record of 8,200 years is available. The genus is economically important and widely cultivated in East TX as a source of wood products. While the sandy acidic soils of the Pineywoods and to some extent those of the Post Oak Savannah are ideal for PINES, the calcium-rich, basic soils of the Blackland Prairie are not well-suited for members of this genus. Although PINES in general thus do not occur naturally w of the Post Oak Savannah-Blackland Prairie boundary, they are native as far w as Lamar Co. (Fannin Co.[?] (Correll & Johnston 1970)) in the Red River drainage where they occur on sandy, more acidic alluvium associated with that river. Mycorrhizal fungi, associated with the roots, allow pines to more effectively obtain nutrients, and are apparently critical in allowing pines to utilize low-nutrient, acidic soils (Read 1998). Pines in the southeastern U.S., including East TX, are susceptible to damage by *Dendroctonus frontalis* Zimmermann (southern pine beetle), a type of bark beetle, which tunnels in the inner bark and introduces blue-stain fungi, which hasten the death of the tree by plugging the water-

conducting tissues (http://www.barkbeetles.org/ 2001). Under some circumstances, monoculture forestry contributes to bark beetle outbreaks (de Groot & Turgeon 1998). Substantial areas of East TX pine forest have been killed by such bark beetles. Because of the high resin content, pieces of pine heartwood resist decay for years and when split are quite flammable and burn with a bright light. They have been widely used for generations across the southern U.S. as kindling to start fires. In the Big Thicket before the era of flashlights, a flaming "light'd knot" had many uses including night hunting for deer by shining the light in their eyes (Owens 1973). The following treatment relies heavily on Kral (1993). (Latin: *pinus*, name for pine)
References: Shaw 1914; Ward 1974; Perry 1991; Kral 1993; Millar 1993; Krupkin et al. 1996; Price et al. 1998; Richardson 1998; Liston et al. 1999.

1. Needles (20--)25--45 cm long, 3 per bundle; terminal buds silvery white, 3--4 cm long; bundle sheaths of new needles on young twigs 25 mm or more long; seeds with body ca. 10 mm long and wing 30--40 mm long ..... **P. palustris**
1. Needles 5--23(--29) cm long, 2--3 per bundle; terminal buds brownish, 0.5--2 cm long; bundle sheaths of new needles on young twigs 20 mm or less long; seeds with body 5--7 mm long and wing 12--20 mm long.
   2. Needles (5--)7--11(--12) cm long, usually 2(--3) per bundle; bundle sheaths 5--10(--15) mm long; terminal buds 0.5--0.7(--1) cm long; mature seed cones 4--7 cm long; pollen cones 15--20 mm long at time of pollen release; bark with evident resin pockets..... **P. echinata**
   2. Needles 12--23(--29) cm long, 2--3 per bundle; bundle sheaths (10--)12--20 mm long; terminal buds 1--2 cm long; mature seed cones 6--18(--20) cm long; pollen cones 20--40 mm long at time of pollen release; bark without resin pockets.
      3. Needles almost always 3 per bundle (very rarely 2), yellowish green to grayish green, not glossy; seed cones sessile or nearly so, mostly dull yellow-brown; surface of the exposed, thickened, apical portion of each seed cone scale (= apophysis) dull; pollen cones yellow to yellow-brown; terminal buds 1--1.2(--2) cm long..... **P. taeda**
      3. Needles 2--3 per bundle, at least some bundles with 2, usually dark green, glossy; seed cones short-stalked, light chocolate brown; surface of exposed, thickened, apical portion of each seed cone scale lustrous as if varnished; pollen cones purplish; terminal buds 1.5--2 cm long ..... **P. elliottii**

Pinus echinata Mill., (spiny), SHORTLEAF PINE, SHORTLEAF YELLOW PINE, LONGTAG PINE. Bark on older stems red-brown and separated into irregular, flat, scaly plates, with evident resin pockets; new twigs greenish brown to red-brown, red-brown to gray with age, slender (ca. 5 mm or less thick); terminal buds 0.5--0.7(--1) cm long; pollen cones 15--20 mm long at time of pollen release, yellow- to pale purple-green; seed cones 4--6(--7) cm long, red-brown, aging gray, the scales with an elongate to short, stout, sharp prickle. Uplands, dry forests; native to Pineywoods and Post Oak Savannah as far w as Henderson (Correll 1966b), Red River (Little 1971), and possibly Lamar (Simpson 1988) cos.; spreading from cultivation in Fannin Co. (BRIT) in Red River drainage; e U.S. from NY s to FL and w to MO and TX. According to Kral (1993), although this species is valuable for timber and pulpwood, it is susceptible to root rot.

Pinus elliottii Engelm., (for Stephen Elliott, 1771--1831, American botanist), SLASH PINE, PITCH PINE, YELLOW SLASH PINE. Bark on older stems orange- to purple-brown, broken up into rather large flat flakes, without resin pockets; twigs orange-brown, darker brown with age, relatively slender (to 10 mm thick); terminal buds 1.5--2 cm long; pollen cones 30--40 mm long at time of pollen release, purplish; seed cones (7--)9--18(--20) cm long, light chocolate brown, the scales with a short stout prickle. Cultivated and used in reforestation, naturalized in TX mainly in the Pineywoods and Post Oak Savannah; also Gulf Prairies and Marshes and spreading from cultivation on sandy soils in Hood Co. in West Cross Timbers and in Denton and Tarrant cos. (R. O'Kennon, pers. obs.) in the East Cross Timbers; native to the se U.S. from SC s to FL and w to e LA. This species is fast growing, but is susceptible to ice damage. It is used for naval stores (e.g., turpentine) and for lumber and pulpwood, and is "much planted in subtropical and warm temperate climates worldwide, particularly in Brazil" (Kral 1993).

Pinus palustris Mill., (of marshes), LONGLEAF PINE, LONGLEAF YELLOW PINE. Bark on older stems orange-brown, of thin papery scales, usually thickly plated on large trees, without resin pockets; twigs orange-brown, darker with age, stout (to 20 mm thick); pollen cones 30--80 mm long at time of pollen release, purplish; seed cones 15--25 cm long, dull brown, the scales with a short reflexed prickle. Sandy soils; primarily s part of the Pineywoods, also Post Oak Savannah and n Gulf Prairies and Marshes; se U.S. from VA s to FL and w to AR and TX. Recurrent low-intensity fire is critical for the maintanence of forests dominated by this deep-rooted, thick-barked, fire-tolerant species. Even very young individuals can withstand fire. They pass through a "grass" stage---called this because of the resemblence 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 (Little 1980; Agee 1998). The occurrence of LONGLEAF PINE has been greatly reduced by deforestation and modern forestry practices favoring LOBLOLLY PINE. Nauman et al. (2000), based on Fernald (1948) and Fernald

and Schubert (1948), discussed problems with the scientific name of this species resulting from ambiguities in typification. Ward (1974) presented arguments in favor of using the name *P. palustris*, but as Nauman et al. (2000) indicated, "the problem remains." We are following Nauman et al. (2000) in "preserving contemporary usage until the typification can be resolved." Though much less common than previously, this is a valuable timber species, and it has been important as a source of naval stores (e.g., turpentine).

Pinus taeda L., (ancient name for resinous pines), LOBLOLLY PINE, OLD-FIELD PINE. Bark on older stems dark red-brown and divided into irregular scaly blocks, without resin pockets; twigs orangish to yellow-brown, darker brown with age, relatively slender (to 10 mm thick); terminal buds 1--1.2(--2) cm long; pollen cones 20--40 mm long at time of pollen release, yellow to yellow-brown; seed cones 6--12 cm long, mostly dull yellow-brown, the scales with a stout-based, sharp prickle. Lowlands to dry uplands, extensively cultivated because of its value for pulpwood and timber; native to East TX as far w as Bastrop Co. ("lost pines"---an area of ca. 70 square miles of pine-oak woodland isolated from the main body of East TX pines by approximately 100 miles---http://www.tpwd.state.tx.us/park/bastrop/ 2001) in sw East TX and Lamar Co. in Red River drainage (Little 1971); cultivated and escaped further w on sandy soils in Fannin (Lake Fannin) and Grayson (Buckner Preserve and Preston Peninsula) cos. (G. Diggs, pers. obs.); e U.S. from VA s to FL and w to MO and TX. Extensive plantations of fast growing forms of this species can be found throughout the Pineywoods and Post Oak Savannah. Monocultures of this species have replaced vast areas of high diversity forest throughout East TX. 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 (Little 1980). Hybrids have been reported with *P. echinata* and *P. palustris* (Kral 1993; Nauman et al. 2000).

DIVISION **CYCADOPHYTA**
CYCADS

A division of 11 genera and 145 species (Mabberley 1997) scattered mainly in the tropics and subtropics. Many are cultivated as ornamentals and a number are endangered through overcollecting. In fact, all cycad species "are now listed in Appendix II of the CITES list of rare and endangered species" (Whiting 1989). The Cycadophyta is an ancient lineage (dating from the Triassic Period onwards) whose widely scattered and restricted modern day distribution is a relict of the groups previous abundance. Cycads were so numerous during the Mesozoic that this geologic period is sometimes called the "Age of Cycads and Dinosaurs" (Raven et al. 1999). Cycads superficially resemble palms (unbranched trunks, large pinnate leaves) and are sometimes referred to as "sago palms" or "easter palms," but are clearly unrelated to palms as evidenced by numerous

characteristics including naked seeds borne in cones, multi-flagellated swimming sperm, and the sexes separate (plants dioecious). While we have no reports of them naturalizing in East TX, this brief writeup on the Cycadophyta is included due to their taxonomic interest and for use in college botany classes. ☠ The seeds of *Cycas* species (Cycadaceae) have been used as a dietary source of polysaccharides for humans in various western Pacific Islands. However, because they are known to be toxic, the seeds are cut and soaked for an extended period with periodic changes of water. The toxicity of unprocessed seeds is due to cycasin (an azoxyglycoside which is water soluble and therefore removed by soaking) which yields a toxic molecule when hydrolyzed in the human intestine. This molecule and its derivatives are reported to be carcinogenic, mutagenic, and teratogenic. On two of these Pacific islands (Guam, New Guinea), a fatal degenerative neurological disease (symptoms: lateral amyotrophic sclerosis, parkinsonism, dementia) has also been attributed by some authorities to other toxins in the flour made from *Cycas* seeds. Further, ingestion of a variety of cycads is known to cause various symptoms of poisoning (e.g., severe gastrointestinal tract disturbances, liver necrosis, neurologic symptoms---hind limb paralysis in cattle, depression in dogs) in a variety of animal species; one or two seeds have been reported to be sufficient to kill a dog (Whiting 1989; Albretsen et al. 1998; Bruneton 1999). Since cycads are widely used as ornamentals, care should be taken to limit access to the plants by animals and children. REFERENCES: Read & Solt 1986; Whiting 1989; Stevenson 1990a, 1990b, 1992; Stevenson et al. 1990.

DIVISION **GINKGOPHYTA**

MAIDEN-HAIR TREES

A division represented by a single surviving species, *Ginkgo biloba* L., GINKGO or MAIDEN-HAIR TREE (Ginkgoaceae), native of China. Fossils almost identical to modern GINKGOS are known from nearly 200 million years ago (Whetstone 1993) and the group was widespread and abundant during the middle Mesozoic Era (Scagel et al. 1984; Mauseth 1998). *Ginkgo* is "often referred to as a 'living fossil' because of its position as the sole surviving member of an ancient lineage" (Scagel et al. 1984). This relictual species is widely cultivated because of its resistance to disease and pollution and its beautiful deciduous leaves which turn yellow in fall, but is "either extinct in the wild or drastically restricted in range" (Whetstone 1993). Page (1990a) reported natural occurrence in remote valleys in China, but cultivated plants are descendants of individuals grown in temple gardens of China and Japan (Moore et al. 1998). *Ginkgo* is distinctive morphologically, having fan-shaped leaves (usually apically notched and hence the epithet *biloba*) with open dichotomous venation. Individual trees can live to 1000 years old and reach 30 m in height, with trunks to nine m in circumference (Scagel

et al. 1984; Raven et al. 1999). It is widely used as a street, yard, and ornamental tree in East TX. The species is dioecious and care should be taken to use staminate trees if possible because ovulate trees produce abundant, stalked, naked, small plum-sized seeds with a fleshy outer coat notorious for its rancid butter-like foul-smell (due to butanoic and hexanoic acids---Raven et al. 1999). The edible seeds or ginkgo nuts (minus the outer coat) are canned and sold in ethnic markets as "sal-nuts," "silver almonds," or "white nuts" (Scagel et al. 1984; Whetstone 1993). The scientific name is derived from two Chinese words meaning "silver apricot" (Moore et al. 1998). *Ginkgo* is variously used medicinally, including as a non-prescription herbal treatment for Alzheimer's disease and to increase memory and concentration. While we have no reports of GINKGO naturalizing in East TX, this brief writeup on the Ginkgophyta is included due to its taxonomic interest and for use in college botany classes.

REFERENCES: Franklin 1959; Page 1990a; Whetstone 1993.