

2000

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James H. Peck

University of Arkansas at Little Rock

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Recommended Citation

Peck, James H. (2000) "Floristic Status of Log Ferns (*Dryopteris*) in Arkansas," *Journal of the Arkansas Academy of Science*: Vol. 54 , Article 16.

Available at: <http://scholarworks.uark.edu/jaas/vol54/iss1/16>

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Floristic Status of Log Ferns (*Dryopteris*) in Arkansas

James H. Peck

Biology Department
University of Arkansas at Little Rock
2801 S. University Ave.
Little Rock, AR 72204

Abstract

The fern flora of Arkansas consists of 96 taxa, including five species and three hybrids of the Log Fern genus *Dryopteris*. This report summarizes a twenty year floristic and ecologic study of their distribution and abundance in Arkansas. Historical data are presented to review the slow accumulation of taxa reported in floras of Arkansas from early collectors to 1980 and the rapid accumulation of taxa since 1980 employing modern field techniques. Chorological data and floristic data are presented based on field, herbarium, and literature studies to correct the record and document the known localities of the eight Arkansas taxa: *Dryopteris carthusiana* at three localities in three counties; *Dryopteris celsa* at 23 localities in five counties; *Dryopteris goldiana* at one locality in one county; *Dryopteris ludoviciana* at one locality in one county; *Dryopteris marginalis* at numerous localities in 38 counties; *Dryopteris Xaustralis* at nine localities in four counties; *Dryopteris Xleedsii* at two localities in two counties; *Dryopteris celsa Xgoldiana* at one locality in one county. Floristic data are presented to exclude from the state flora two species and two hybrids of the genus *Dryopteris*: *D. cristata*, *D. intermedia*, *D. Xneo-wherryi*, and *D. Xseparabilis*. Arkansas has more localities and county occurrences of *Dryopteris Xaustralis* than any state in the hybrid's range. One locality in Baxter Co. supports a genus community of *Dryopteris* comprised of three species and three hybrids.

Introduction

The fern genus *Dryopteris* includes the Shield Ferns, Wood Ferns, and Log Ferns, comprising 13 temperate species in North America north of Mexico (Carlson and Wagner, 1982; Montgomery and Paulton, 1981; Montgomery and Wagner, 1993; Wagner, 1971). The species were problematic historically, but are reasonably well known now as a result of the application of modern systematic approaches. Hybridization and polyploidy among these species has produced 27 of a possible 78 interspecific hybrids (Montgomery, 1982; Wagner, 1971; Wagner and Musselman, 1979). The identification of hybrid plants in Arkansas and elsewhere previously contributed to considerable confusion in *Dryopteris* nomenclature and floristics.

The first modern summary of Log Ferns in Arkansas was by Taylor (1976), who reviewed herbarium specimens, conducted field studies to relocate old collection sites, produced a modern fern flora for Arkansas (Taylor and Demaree, 1979), and published a useful field guide (Taylor, 1984). Taylor (1984) reported three species and one hybrid *Dryopteris* as part of the fern flora of Arkansas; this information was restated by Smith (1988). Within weeks of the publication of Taylor's Manual, another *Dryopteris* species and one extremely rare hybrid were discovered in Arkansas (Peck et al., 1985, 1987). Subsequent field surveys were conducted to describe the status of these recently discovered populations and their reproductive biology in Arkansas

(Peck and Peck, 1988). Contract surveys supported by state, federal, and private organizations to inventory these and other plants of biological concern on federal lands in the Ouachita Mountain region of Arkansas (Bates, 1988-1992) revealed additional localities, but these were reported without herbarium specimen vouchers. Ten years after Taylor's Manual, a new summary of county-level floristic records of Arkansas ferns (Peck and Taylor, 1995) reported four species and two hybrid *Dryopteris* in the Arkansas flora, with five of the six showing increased distributional data. Since then, additional field work has added another *Dryopteris* species and an extremely rare hybrid to the Arkansas fern flora (Peck et al., 2000). Additional field study added new localities and county records through intensive field search of appropriate microhabitats in promising regions of the state.

At present, the fern flora of Arkansas consists of 96 taxa, including five species and three hybrids of the Log Fern genus *Dryopteris*. Since the last summation (Peck and Peck, 1988), much new locality-level information has accumulated from field, herbarium, and literature study. Thus, it was deemed appropriate to prepare a new summary with interpretation and to provide a key to species plus hybrids. Detailed discussions of the importance of specimen records to validate present and past literature are presented to point out the critical role Arkansas' *Dryopteris* have played in a regional and national understanding of hybridization in Log Ferns.

Methods

Since 1981, efforts were made to re-locate, re-collect, and re-voucher the Log Fern flora of Arkansas to provide a better evidentiary basis to the extent of their state occurrence. Herbarium searches at national herbaria, including MO, US, NY, PHIL, along with specimen review of in-state and out-of-state folders at UARK, were conducted to augment earlier searches of the ten Arkansas herbaria [UARK, LRU, UCAC, STAR, UAM, HSU, HDX, APCR, Harding, Lyons]. Literature at national, regional, and state levels was searched for passages referring to Arkansas *Dryopteris* floristics. New records and new locality reports were noted and followed by a search for and examination of herbarium vouchers to validate those published findings. Published findings, unsupported with specimen records, required duplicative work to provide vouchers. Field work targeted appropriate regions of 10 counties (Baxter, Bradley, Garland, Lawrence, Logan, Montgomery, Polk, Stone, Van Buren, and Yell counties) to locate additional populations of rare *Dryopteris*. This field work was combined with supplemental general collecting across the northwestern one-half of the state to obtain recent vouchers for *Dryopteris marginalis*. Lastly, a review of national electronic distribution maps on the Arkansas flora [such as that of Smith (1988) maintained by the Bioinformatics Project at Texas A&M and

national distribution maps of FONAP, the Flora of North America Project, and BONAP, the Biota of North America Project, with the latter now available as a CD (Kartesz and Meacham, 1999)] was undertaken to assess their accuracy. County dot maps, a key to species and hybrids, and a summary of localities were prepared to document and summarize Log Fern floristic data.

Results and Discussion

General Floristics.—The accumulation of taxonomic and floristic information on the genus *Dryopteris* in Arkansas is summarized in Table 1. The general trend shows a slow increase in taxa, reflecting past difficulty in the survey and inventory of a biodiverse, topographically rugged state, by relatively and proportionately few botanists with limited means of transportation. Yet, from 1860 until 1943 each major collector wrote a fern flora for Arkansas, providing a rich literature trail to the floristic data and herbarium specimen vouchers. This floristic documentation difficulty was compounded by the slow realization by fern experts of the hidden diversity within southern representatives of *Dryopteris* and a painfully slow process to separate southern species from forms, varieties, and hybrids within a genus with reticulate species formation that incorporated interspecific hybridization, polypoidy, and backcrossing to form a

Table 1. Incremental increase in floristic knowledge about pteridophytes in general and taxa of the genus *Dryopteris* in particular in the Arkansas vascular plant flora: floras cited by their author and year of publication, # pteridophyte taxa (species plus hybrids), # *Dryopteris* taxa (species plus hybrids) reported, and scored for eight known plus one excluded Arkansas taxa [*D. cristata*]. Floras cited in bibliography. Taxon key: ca = *D. carthusiana*, ce = *D. celsa*, cr = *D. cristata*, go = *D. goldiana*, lu = *D. ludoviciana*, ma = *D. marginalis*, Xau = *D. Xaustralis*, Xle = *D. Xleedsii*, Xcg = *D. celsa* X *goldiana*.

Flora: Author (Year)	# ferns and fern allies	# Log Fern	species					hybrids				
			ca	ce	cr	go	lu	ma	Xau	Xle	Xcg	
1. Nuttall (1835)	23	1							ma			
2. Lesquereux (1860)	35	3	ca		cr				ma			
3. Harvey (1881)	39	3	ca		cr				ma			
4. Branner and Coville (1891)	47	3	ca		cr				ma			
5. Buchholz (1924)	49	2			cr				ma			
6. Buchholz and Palmer (1926)	51	3	ca		cr				ma			
7. Moore (1940)	67	4	ca		cr				ma	Xle		
8. Demaree (1943)	70	4	ca		cr				ma	Xle		
9. Taylor (1976)	70	4	ca	ce					ma	Xle		
10. Smith (1978)	70	4	ca	ce					ma	Xle		
11. Taylor and Demaree (1979)	73	4	ca	ce					ma	Xle		
12. Taylor (1984)	72	4	ca	ce					ma	Xle		
13. Peck, Peck and Taylor (1987)	87	6	ca	ce				lu	ma	Xau	Xle	
14. Smith (1988)	78	6	ca	ce				lu	ma	Xau	Xle	
15. Peck and Taylor (1995)	92	6	ca	ce				lu	ma	Xau	Xle	
16. Peck, Hendrix, and Witsell (2000)	96	8	ca	ce		go		lu	ma	Xau	Xle	Xcg

Table 2. Correct name, cytomorphotype, range, Arkansas distribution, synonymy [S=] for Arkansas *Dryopteris*, and misapplied names [M=] used in literature or on herbarium specimens.

1. *Dryopteris carthusiana* (Villars) H. P. Fuchs
Tetraploid, North America and Europe
Arkansas: Two localities in two counties
S=*Polypodium carthusianum* Villars
S=*Polypodium spinulosum* O. F. Muell.
S=*Polystichum spinulosum* (O. F. Muell.) Lam.
S=*Aspidium spinulosum* (O. F. Muell.) Sw.
S=*Nephrodium spinulosum* (O. F. Muell.) Strempl
S=*Lastrea spinulosa* (O. F. Muell.) Presl.
S=*Thelypteris spinulosa* (O. F. Muell.) Nieuwl.
S=*Dryopteris austriaca* var. *spinulosa* (O. F. Muell.) Fiore
S=*Dryopteris spinulosa* (O. F. Muell.) Watt
2. *Dryopteris celsa* (Palmer) Palmer, Knowlton & Pollard
Tetraploid, North American endemic
Arkansas: Twenty-three localities in five counties
S=*Dryopteris goldiana* subsp. *celsa* Palmer
S=*Aspidium goldianum* f. *celsum* (Palmer) Clute
S=*Nephrodium goldianum* var. *celsum* (Palmer) Waters
S=*Aspidium goldianum* var. *celsum* (Palmer) Robinson
S=*Dryopteris goldiana* f. *celsa* (Palmer) Clute
M=*Dryopteris atropalustris* Small
M=*Dryopteris clintoniana* X *goldiana* [sensu Shaver]
S=*Dryopteris goldiana* X *ludoviciana* [sensu Small]
M=*Dryopteris ludoviciana* X *marginalis* [sensu Klekowski]
S=*Dryopteris xcelsa* [sensu Small]
3. *Dryopteris cristata* (L.) A. Gray
Tetraploid, Northern North America and Europe
Excluded from Arkansas flora
S=*Polypodium cristatum* L.
S=*Polystichum cristatum* (L.) Roth.
S=*Aspidium cristatum* (L.) Sw.
S=*Nephrodium cristatum* (L.) Michx.
S=*Lastrea cristata* (L.) C. Presl
S=*Thelypteris cristata* (L.) Nieuwl.
S=*ludoviciana* X "*semicristata*" [sensu Wagner]
M=*Dryopteris goldiana* X *ludoviciana* [sensu Klekowski]
4. *Dryopteris goldiana* (Hook.) A. Gray
Diploid, North American endemic
Arkansas: One locality in one county
S=*Aspidium goldianum* Hook. ex Goldie
S=*Nephrodium goldianum* (Hook.) Hook. & Grev.
S=*Lastrea goldianana* (Hook.) Presl
S=*Polystichum goldianum* (Hook.) Keyserl.
S=*Aspidium filix-mas* var. *goldiana* (Hook.) Christ
S=*Filix goldiana* (Hook.) Farw.
S=*Filix-mas goldiana* (Hook.) Farw.
S=*Thelypteris goldiana* (Hook.) Nieuwl.
5. *Dryopteris intermedia* (Muhl. ex Willd.) A. Gray
Tetraploid, North American Endemic
Excluded from Arkansas flora
S=*Aspidium intermedium* Muhlenberg ex Willd.
S=*Dryopteris austriaca* var. *intermedia* (Muhl. ex Willd.)
Morton
S=*Dryopteris spinulosa* var. *intermedia* (Muhl. ex Willd.)
Underw.
6. *Dryopteris ludoviciana* (Kunze) Small
Diploid, North American endemic
Arkansas: One locality in one county, possibly extirpated
S=*Aspidium ludovicianum* Kunze
S=*Nephrodium floridanum* Hook.
S=*Aspidium floridanum* (Hook.) D. C. Eat. ex Chapm.
S=*Aspidium cristatum* var. *floridanum* (Hook.) D. C.
Eaton ex Mann
S=*Lastrea floridana* (Hook.) Kunze
S=*Dryopteris floridana* (Hook.) Farw.
7. *Dryopteris marginalis* (L.) A. Gray
Diploid, North American endemic
Arkansas: many localities in 38 counties
S=*Polypodium marginale* L.
S=*Aspidium marginale* (L.) Sw.
S=*Nephrodium marginale* (L.) Michx.
S=*Lastrea marginalis* (L.) C. Presl
S=*Polystichum marginale* (L.) Keyserl.
S=*Thelypteris marginalis* (L.) Nieuwl.
S=*Filix marginalis* (L.) Farw.
S=*Filix-mas marginalis* (L.) Farw.
8. *Dryopteris Xaustralis* Small
Triploid, "sterile", North American endemic
Arkansas: Nine localities in four counties
M=*Aspidium cristatum* var. *clintonianum* D. C. Eaton in
A. Gray
M=*Dryopteris cristata* var. *clintoniana*
(D. C. Eat.) Underw.
M=*Thelypteris cristata* var. *clintoniana* (D. C. Eat.) Weath.
M=*Thelypteris clintoniana* (D. C. Eat.) House
M=*Dryopteris clintoniana* (D. C. Eat.) Dowell
S=*Dryopteris cristata* var. *australis* (Wherry) Bloomquist &
Correll
S=*Dryopteris clintoniana* var. *australis* Wherry
S=*Dryopteris australis* (Wherry) Small
9. *Dryopteris Xleedsii* Wherry
Triploid, "sterile", North American endemic
Arkansas: Two localities in two counties
M=*Dryopteris cristata* (L.) A. Gray
M=*Dryopteris celsa* (Palmer) Palmer, Knowlton & Pollard
M=*Dryopteris celsa* X *D. spinulosa* [sensu Morton]
M=*Dryopteris marginalis* (L.) A. Gray
M=*Dryopteris celsa* X ? [by Crane]
M=*Dryopteris separabilis* Small
M=*Dryopteris goldiana* f. *arkansana*
[annotation by Wherry but never published]
M=*Dryopteris clintoniana* var. *australis* Wherry
M=*Dryopteris australis* (Wherry) Small
M=*Dryopteris wherryi* Crane
M=*Dryopteris goldiana* X *marginalis* [sensu Wherry]
M=*Dryopteris Xneo-wherryi* Wagner
[sensu Montgomery]
S=*Dryopteris celsa* X *marginalis*
10. *Dryopteris celsa* X *goldiana*
Triploid, sterile, North American endemic
Arkansas: One locality in one county
11. *Dryopteris Xneo-wherryi* Wagner
Diploid, sterile, North American endemic,
Excluded from Arkansas flora
S=*D. goldiana* X *marginalis*
12. *Dryopteris Xseparabilis* Small
Triploid, sterile, North American endemic,
Excluded from Arkansas flora
S=*D. intermedia* X *marginalis*

genus of 13 compilospecies with 27 hybrids in North America (Table 2). This process of taxon recognition lasted into the 1970s. For example, although *Dryopteris celsa* was collected from Arkansas in 1924 and the herbarium specimen voucher was annotated correctly by 1935, it was not reported from Arkansas until Taylor (1976). Although only three *Dryopteris* taxa were reported correctly from Arkansas until 1976, since then five more taxa were added in less than one-fourth the time based primarily on the ability to check herbarium specimen vouchers.

County dot maps prepared for each species and hybrid (Figs. 1 - 8) show that Log Ferns generally occur in the northwestern one-half of Arkansas. Only *Dryopteris marginalis* is common and widely distributed. All other species and hybrids are rare in Arkansas. Maps useful for the national distribution of Arkansas's fern flora were provided by the Flora of North America Project (FONAP) including species maps [www.fna.org] that accurately reported the distribution of Arkansas' four species. The convenience of using these data must be tempered with a high amount of caution. County dot maps for Arkansas ferns based on data provided by Smith (1988) were placed on the Internet by the Bioinformatics Center at Texas A&M [www.tamu.edu]. National state distribution maps were posted by the Biota of North America Project (BONAP) [www.bonap.org]. These maps provide state-wide and national coverage for *Dryopteris* in Arkansas, but two maps are incorrect. The map for *Dryopteris Xleedsii* has six states incorrectly mapped. The map for *Dryopteris Xneo-wherryii* includes Arkansas where the hybrid has not been found. In addition, electronic flora compilers only recognize hybrids reported with a collective binomial, thus under-reporting the biodiversity of a genus and the flora of Arkansas by one taxa.

A key to Arkansas Log Ferns, species and hybrids, was included in this report. Keys to ferns generally do not include keys to hybrids (Lellinger, 1984; Smith, 1994), but such plants are relatively easy to detect with use of a compound microscope to discern whether the plant has the uniform, viable spores of a species or the irregular size and shape of non-viable spore products produced by primary hybrids (Montgomery, 1982).

Species Distribution and Chorology

***Dryopteris carthusiana* in Arkansas.**--The Spinulose Woodfern *Dryopteris carthusiana* (Villars) H. P. Fuchs is a circumboreal, fertile, allotetraploid species ($4n = 164$), denoted by the genome code IISS (Table 2). The species is generally thought to be the result of hybridization between two diploids, *Dryopteris intermedia* (II) and an unknown species "semicristata" (SS), followed by polyploidy, chromosome doubling, to produce the fertile allotetraploid species *Dryopteris carthusiana*. This species occurs in Arkansas at the

extreme southwestern edge of its range (Fig. 1). *Dryopteris carthusiana* is known from two special microhabitats and one common microhabitat. It occurs around the entrance to a cool, blowing-air cave, near the top of the tallest mountain in the state, and along a shaded stream bank.

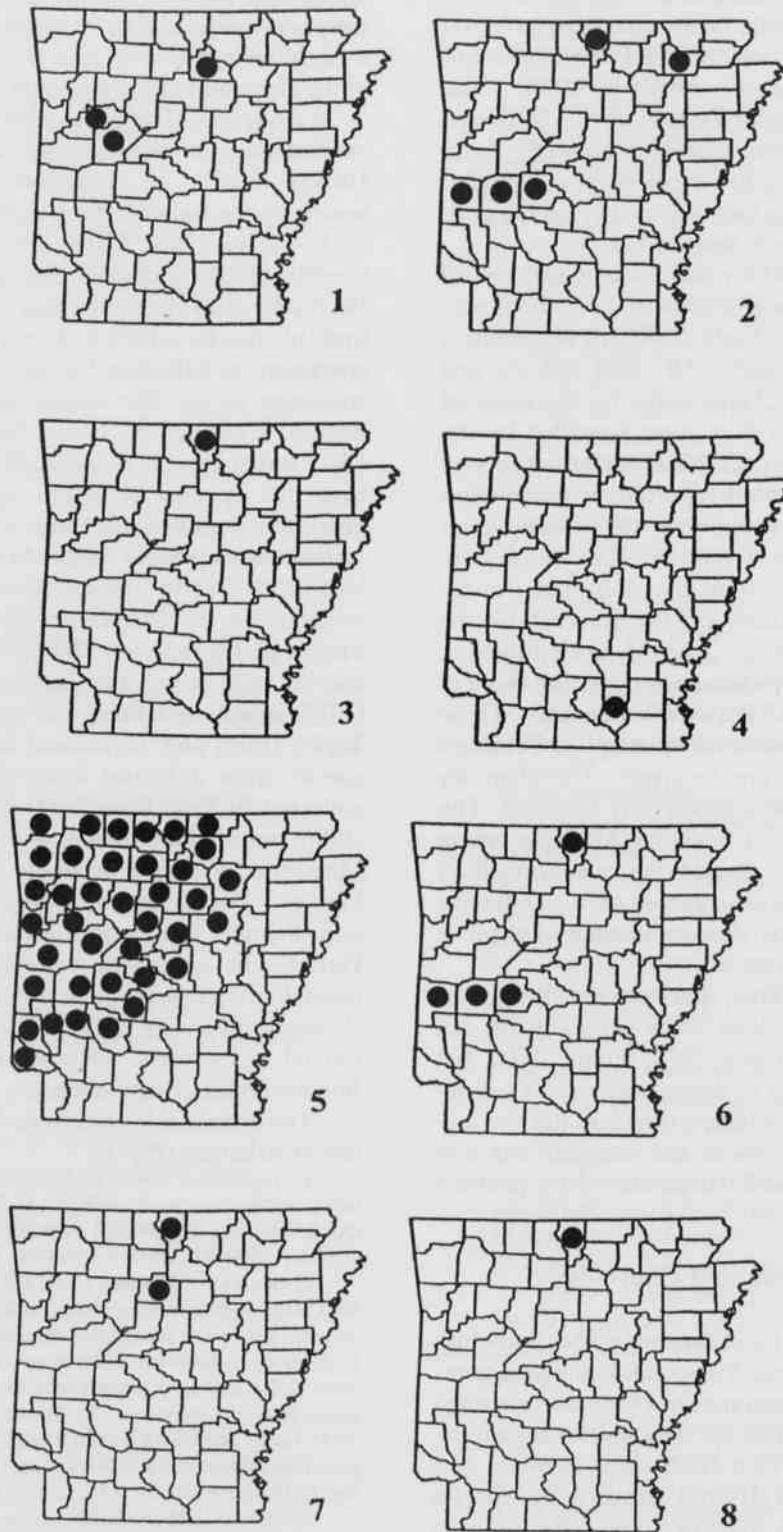
Lesquereux (1860) provided the first report of *Dryopteris carthusiana* from the "woods" of Arkansas. According to Harvey (1881), *D. carthusiana* was "said to grow in rich woods by the Botanist [Lesquereux] of the Ark. [Geological] Surv. I have not found any specimens." Branner and Coville (1891) included this species without comment. Buchholz (1924) indicated that 1) his field searches failed to find this species where it should occur, 2) that he found no specimen in Arkansas herbaria, and 3) that he found no specimen in the five largest national herbaria located in Boston, Chicago, St. Louis, New York, and Washington, DC. Buchholz (1924) concluded that it was "very doubtful" that this species is found as far south as Arkansas. Surprisingly, Buchholz and Palmer (1926) reported *D. carthusiana* as present in the Arkansas flora based on a collection in 1924 by Dwight Moore near the summit on the north slope of Magazine Mountain in Logan County. Moore (1940) reported *Dryopteris carthusiana* in Arkansas as known only from that location. However, when Taylor (1976) sought out that voucher, it could not be located. Taylor (1976) and Taylor and Demaree (1979) reported this species from Arkansas based only on a specimen Moore collected in 1960 from Stone Co. at Rowland Cave. Peck (1986) reported the rediscovery of 4 plants of this species on Magazine Mountain, probably having relocated the Moore location. The *D. carthusiana* specimens cited in Buchholz and Palmer (1926) and Moore (1940) remain missing. Perhaps the specimens were included in exchanges with other herbaria, a practice noted by Buchholz and Palmer (1926) or they were discarded when Herbarium UARK was moved in the early 1970s from Old Main Building to the Botany-Engineering Building.

The species is known from three localities in three counties in Arkansas (Fig. 1):

1) Logan Co.: below Brown Springs, Magazine Mountain, Rd 308, below summit on north facing side, T6N R25W S22, Blue Mountain Quad., 4 plants. Specimens: Peck 85105 (LRU) on 5 Oct 1985; Young A-1 (LRU) on 10 Nov 1990; observed by Peck in 1993.

2) Stone Co.: Rowland Cave, 1 mi N Fifty Six, T15N R12W S1, Fifty Six Quad., organic humus, moist, cool, at cave entrance and on limestone outcrops above and adjacent to entrance. Taylor (1976) reported 10 plants; Peck (1986) reported two dozen plants. Hyatt in 1990 observed 20 plants. Now under increased protective management; Peck observed over 100 plants in 1999. Specimens: D. Moore 60-54, 2 sheets, (UARK) on 7 Aug 1960; Taylor 2894 (SIU, UARK) on 28 Sep 1975; Peck 81089 (LRU) on 18 June 1981; Hyatt 352.69 (UARK) on 23 Aug 1990; Crank 92022 (HSU) on Sep 10 1992; Peck 99401 (LRU) on 20 July 1999.

3) Yell Co.: Danville Mt., along Ark 27, 0.5 mi down from power station, T5N R22W S6, Danville Mountain Quad., a few plants. Specimens: T. Kelly 14 (LRU) on 18 Nov 1990.



Figs. 1-8. Map 1. *Dryopteris carthusiana*. Map 2. *Dryopteris celsa*. Map 3. *Dryopteris goldiana*. Map 4. *Dryopteris ludoviciana*. Map 5. *Dryopteris marginalis*. Map 6. *Dryopteris Xaustralis*. Map 7. *Dryopteris Xleedsii*. Map 8. *Dryopteris celsa X goldiana*.

***Dryopteris celsa* in Arkansas.**--The Log Fern *Dryopteris celsa* (Palmer) Palmer, Knowlton & Pollard is a North American endemic, fertile, allotetraploid species ($4n = 164$) denoted by the genome code GGLL (Table 2). This species was formed as the result of multiple events of two diploid species hybridizing: *Dryopteris goldiana* (GG) and *Dryopteris ludoviciana* (LL) to form sterile GL which became fertile through polyploidy, chromosome doubling, to become the allotetraploid GGLL (Werth, 1991). This is a much misunderstood taxon. It was one of the last *Dryopteris* species to be recognized in North America. Recognition and separation of this species from other winter-green species required the efforts of many pteridologists, who concluded (Wagner, 1972) "that the main reason for the confusion is the continuum of cytomorphotypes in *Dryopteris* that renders cluster analysis moot". For many years and for many fern experts, *D. celsa* was erroneously considered to be *D. clintoniana* X *goldiana*, an incorrect position that held sway into the 1960s (Shaver, 1954; Walker, 1962a; Wagner, 1971).

Compounding the systematic problem, the geographic range of *D. celsa* was underestimated as well. Small (1938) reported that *D. celsa* was restricted to the Coastal Plain and Piedmont adjacent to the Great Dismal Swamp of North Carolina and Virginia north to Delaware to Maryland. Small (1938) explicitly stated "this log fern seems not to have spread into the Mississippi Valley", but noted that "there is a somewhat closely related fern on the other side of the Mississippi River in Arkansas" (a reference to the Palmer fern at Shirley now called *D. Xleedsii*). Mysteriously, Small (1938) did not mention the voucher specimen of *D. celsa* collected in 1924 from Imboden, Lawrence Co., Arkansas, and housed at the Smithsonian Institution Herbarium in Washington, DC, where it was correctly named by Maxon; it is important to note that 16 years later, Moore (1940) did not list *Dryopteris celsa* as occurring in Arkansas.

Wagner (1972) summarized the status of *Dryopteris* in the Southern Appalachians and Southeastern United States, commenting extensively on *D. celsa* and its relatives. Based on specimens collected from Arkansas in the early 1950s by Jewel Moore, Aileen McWilliams, and later by Dwight Moore and Hugh Iltis, and determined to be *Dryopteris celsa* by W. H. Wagner, Wherry (1972) noted that the range of *D. celsa* was now much wider than previously suspected. The range was now "South Carolina to North Carolina in Coastal Plain swamps, in uplands from Georgia to North Carolina, in the Gulf Coastal Plain and Mid-south Interior Highlands of Illinois and Missouri, recently known from New Jersey to New York, westward to Michigan, and in the south, across the Gulf States to Texas and Arkansas". Plants in Michigan, New York, Louisiana, Texas, Missouri, and Illinois were old collections, originally mis-identified and mis-reported as *D. cristata*. These voucher specimens were

slowly being recognized and annotated as southern plants of *D. celsa* (Wagner and Wagner 1965; Wagner et al., 1969; Thomas et al., 1973; Peck and Peck, 1988).

Taylor (1976) was the first to report *D. celsa* in Arkansas, although its state occurrence was vouchered in 1924. Localities continued to be found; Peck and Peck (1988) reported eight localities in four counties: one in Lawrence Co., one in Garland Co., two in Montgomery Co., and four in Polk Co. Bates (1988-1992) surveyed the Ouachita National Forest under contract and reported without vouchers the occurrence of *D. celsa* at seeps and springs in Garland, Montgomery, and Polk counties, but failed to note all cytomorphotypes present. Hyatt located a population of *D. celsa* in the north-central region of Arkansas in Baxter Co., but too late to be included in the published county flora (Hyatt, 1993). Extensive efforts were made to re-locate and collect voucher specimens of this species.

Twenty-three localities of *D. celsa* are known to occur in five Arkansas counties (Fig. 2):

- 1) Baxter Co.: Merrill Ridge Blowing Cave, For. Serv. Rd. 1127, Merrill Ridge Road, 17N R12W S30, Norfolk SE Quad., in a spring on south side of main creek feeding into Stewart Fork, a collapsed blowing cave with spring and large breakdown rocks at entrance covering 10 x 20 m, approximately 100 plants. Hyatt voucher incorrectly locates the site at R13W; relocated by Earl Hendrix USFS-ONF in 1999. Specimens: Hyatt 494703 (UARK) collected on 1 July 1992; Peck 99404 (LRU) on 20 July 1999.
- 2) Baxter Co.: Caroline Gap sink, For. Serv. Rd. 73, Push Mt. Rd, T17N R12W S19, Norfolk SE Quad., organic humus in sink hole, drying out, population greatly reduced, now 6 adults and 2 juvenile plants, discovered by Earl Hendrix USFS-ONF. Specimens: Peck 99403 (LRU) on 20 July 1999.
- 3) Garland Co.: Meyer Creek, along For. Serv. Rd. 386; seepage bog and stream bank along road, with *D. australis*, T3SR22W S16/17, Pearcy Quad., Over 100 plants mainly to the east of the creek. Specimens: Peck 84690 (LRU) on 27 Oct 1984; Peck 91150 (LRU) on 3 June 1991; Peck 99187 (LRU) on 15 Jun 1999.
- 4) Garland Co.: Walnut Fork Creek, N of Charleton Campground by trail or W of Crystal Springs on For. Serv. Rd. 47 to ford of creek to seepage, with *D. Xaustralis*, T2S R22W S29, Crystal Springs Quad. Two dozen plants. Specimens: Peck 88433 (LRU) on 16 Aug 1988; Peck 91150 (LRU) on 8 June 1991; Crank 92003 (HSU) on Nov 2, 1992; Peck 95452 (LRU) on 20 Nov 1995; Peck 99242 (LRU) on 4 July 1999.
- 5) Lawrence Co.: York Springs, on old York estate, 3.5 mi S of Imboden, T18N R2W S35, Imboden Quad. Spring now a concrete box marked with name "York Spring" above stock pond in cleared and overgrazed pasture, no longer supports fern population; fern extirpation and spring location verified by Steve Orzell, Arkansas Dept. Natural Heritage, in November 1984. Specimen: B. C. Marshall #9 (US) on 24 May 1925. Specimen sent to W. Maxon at US for identification. Annotated as Lawrence Co. by Morton. Named *D. celsa* by E. T. Wherry in 1935. Identification confirmed by F. W. Crane in 1956. Identification confirmed by W. H. Wagner in 1974. No other specimen of this fern from this locality exists.
- 6) Montgomery Co.: Wehunt Creek seep, W of Norman on AR 8, S on For. Serv. Rd. 43 to wooded seep on W side of gravel road in stand of Equisetum with *D. Xaustralis*, T3S R27W S33, Big Fork Quad. Population declining, stressed from road development and canopy loss; approximately 200 plants in 1981; 50 plants in 1999. Specimens: Taylor 2845 (SIU, UARK) and Taylor 2846 (UARK) on 21 Aug 1975; Peck 81128 (LRU) on 7 June 1981; Peck 84715 (UARK) and Peck 84717 (LRU) on 3 Nov 1984;

Peck 99125 (LRU) on 4 July 1999.

7) Montgomery Co.: Montgomery Creek, W of Collier Springs, For. Serv. Rd. 117, alder thicket and springs, T3S R24W S18, Caddo Gap Quad., 11-30 plants present. Specimens: Peck 92186 (LRU) on 21 Aug 1992; Peck 99454 (LRU) on 11 Sep 1999.

8) Montgomery Co.: Buttermilk Springs, T4S R24W S6, Caddo Gap Quad., about 25 plants according to Bates (1988). Witsell noted 200 plants in 1999, including 100 fertile adults and 100 smaller juvenile plants. Peck estimated population size was similar to Witsell's description. Specimens: Bouffard, Bates & Wood 25523 (MO) on 10 May 1991; Peck 92180 (LRU) on 21 Aug 1992; Witsell 99083 (LRU) on 11 Aug 1999; Peck 99450 (LRU) on 11 Sep 1999.

9) Montgomery Co.: Bates Spring, T4S R25W S5, Norman Quad., SW Norman on For. Serv. Rd., S Mine Creek Rd. on C65A. Four plants found. Specimens: Peck 99451 (LRU) on 11 Sep 1999.

10) Montgomery Co.: Little Missouri River tributary creek seep, NW of Little Missouri Falls along Mine Creek Rd., creek and spring. T4S R27W S6, Big Fork Quad., Sixteen plants found. Specimens: Peck 92204 (LRU) on 21 Aug 1992; Peck 99463 (LRU) on 11 Sep 1999.

11) Montgomery Co.: Singing Springs, E Norman on For. Serv. Rd. 208, N of road along trail to seepage coming out of box canyon and along stream below with *D. Xaustralis*. T3S R24W S22, Caddo Gap Quad. Less than two dozen plants observed. Specimens: Peck 95097 (LRU) on 27 Apr 1995.

12) Montgomery Co.: Box Springs, W of Norman on AR 8, S on For. Serv. Rd. 73, spring and creek flowage on E side of road, with numerous plants of *D. Xaustralis*. T4S R26W S33, Polk Creek Mtn. Quad. Fewer than 10 plants observed. Specimens: Peck 95125 (LRU) on 18 Aug 1995; Peck 99121 (LRU) on 4 July 1999; Witsell 99041 (LRU) on 3 Aug 1999.

13) Montgomery Co.: Lick Creek Seep, T4S R26W S22, Polk Creek Mtn. Quad. Twenty-two plants counted. Specimens: Peck 92195 (LRU) on 21 Aug 1992; Peck 99458 (LRU) on 11 Sep 1999.

14) Montgomery Co.: Collier Springs wooded seep and bog, along For. Serv. Rd. 177, W side of road, N and above springs. T3S R24W S17 NW1/4, Caddo Gap Quad. Six plants counted. Specimens: Peck 99142 (LRU) on 4 July 1999.

15) Montgomery Co.: Collier Springs Creek, along For. Serv. 177, E side of road, S of Collier Springs with *D. Xaustralis*. T3S R24W S17, se 1/4, Caddo Gap Quad. Fewer than one dozen plants observed. Specimens: Peck 99140 (LRU) on 4 July 1999.

16) Montgomery Co.: Albert Pike area, swamp woods, T4S R27W S27, Athens/Langley Quads. Specimens: Jewel Moore & Aileen McWilliams 3149 (UCAC) on 1 Aug 1951. Originally determined as *D. goldiana*; corrected to *Dryopteris celsa* by W. H. Wagner. This specimen was anonymously and erroneously annotated as "Polk Co.", but the area is in Montgomery County. Furthermore, this specimen complements the J. Moore 3142 (UCAC) specimen of *Dryopteris marginalis* from "Albert Pike Area near camp" collected on 28 July 1951, and correctly located in Montgomery Co. on Moore's original specimen label. Specimens not relocated nor re-collected by Peck.

17) Polk Co.: SE Big Fork, swamp, Big Fork Quad. Specimens: McWilliams sn (UCAC) collected on 1 June 1951. First determined as *D. goldiana* by collector. Annotated by J. Moore in 1983 as *D. celsa*. Locality is uncertain; warrants relocation efforts. Not re-collected by Peck.

18) Polk Co.: Big Fork St. Sci. Area, valley of Big Fork Creek, N side of Missouri Mountain, NNW Big Fork, spring over gravel outwash. T3S R2W S10 SE 1/4, Big Fork Quad. Specimens: D. Moore 520840 (MO, UARK) collected with A. McWilliams and H. H. Itis on 12 Oct 1952.; E. B. Smith 739 (UARK) on 6 May 1978; Peck 84700, 84702 (LRU) on 3 Nov 1984; Peck 99484 (LRU) on 12 Aug 1992. Peck noted six plants in 1984. Bates noted three plants in 1988. Peck noted same six plants in 1999. Original determination as *D. australis*, annotated by F. W. Crane in 1956 as *D. celsa*; annotated by E. B. Smith as *D. clintoniana*; determined as *D. Xaustralis* by W.C. Taylor in 1973; determined as *D. celsa* by W.C. Taylor in

1974; determined *D. celsa* by E. B. Smith in 1978; determined *D. celsa* by J. H. Peck in 1985.

19) Polk Co.: Kates Creek, T3S R7W S18, Big Fork Quad, alder thicket, weedy site overgrown and brushy. Bates observed numerous plants on 20 Feb 1990; Peck noted 30 plants in 1992. Specimens: Peck 92234 (LRU) on 21 Aug 1992; Peck 99468 (LRU) on 12 Sep 1999.

20) Polk Co.: Polk Co. Rd. 38, SW of Abernathy Springs. T3S R28W S26, Big Fork Quad. Eight plants seen. Specimens: Peck 92268 (LRU) on 22 Aug 1992; Peck 99488 (LRU) on 12 Sep 1999.

21) Polk Co.: Polk Co. Rd 38, SW Abernathy Springs on Athen Road, Big Fork Creek Seep, T3S R28W S34, Big Fork Quad. Twelve plants found. Specimens: Peck 99512 (LRU) on 24 Sep 1999.

22) Polk Co.: Heath Valley Rd, W Big Fork on Polk Co. 61, hillside seep, T3S R28W S15, Big Fork Quad. Fourteen plants observed. Specimens: Peck 92244 (LRU) on 22 Aug 1992; Peck 99475 (LRU) on 12 Sep 1999.

23) Polk Co.: Highway 8 seep, NW of Big Fork, rocky bluff with hillside seep into alder-willow thicket, T3S R28W S10, Big Fork Quad. Four plants seen. Specimens: Peck 92258 (LRU) on 12 Aug 1992; Peck 99479 (LRU) on 12 Sep 1999.

Dryopteris cristata-excluded from Arkansas Flora.--

The Crested Woodfern *Dryopteris cristata* (L.) A. Gray is a fertile, circumboreal, allotetraploid species ($4n = 164$) denoted with the genome code of LLSS (Table 2). It occurs most abundantly in the Pleistocene-glaciated Great Lakes Region of North America, westward part-way across Canada, and eastward into Europe. It was reported mistakenly from lowlands in the Southeastern United States, usually only later being recognized as a name being misapplied to plants of *D. celsa* or *D. ludoviciana* (Thomas et al., 1973; Peck and Peck, 1988). *Dryopteris cristata* is not known to occur in Arkansas, but it was reported continuously (Table 1) from Arkansas in the state literature from 1860 to 1943 and was first excluded by Taylor (1976). Indeed, no Arkansas specimen exists to support the original or subsequent claims.

In 1848, Asa Gray made the combination *Dryopteris cristata*. Lesquereux (1860) was the first to report *D. cristata* from Arkansas, reporting that it occurred in "swamps and woods" of southeastern Arkansas. Harvey (1881) and Branner and Coville (1891) continued to report this species from Arkansas. Interestingly, Harvey (1881) reported that there were specimens of this species. While no specimens were seen by subsequent workers, trades of Harvey herbarium materials were made with other institutions (Buchholz and Palmer, 1926) leaving few specimens at UARK.

The absence of the older voucher specimens is a common problem in interpreting the older Arkansas literature. It was originally reported as *Aspidium cristatum*, now an early synonym of *Dryopteris cristata*. Harvey (1881) reported the following: "occurs in S.E. Arkansas...We have specimens from near Pine Bluff found growing in swamps by Mr. G. E. Lytle." This voucher has yet to be found to substantiate that this fern or any other *Dryopteris* grows "near Pine Bluff." Buchholz (1924) challenged the Arkansas presence of *D. carthusiana* in lists prior to his because he did not see a voucher, and yet, he did not challenge the voucherless

presence of *D. cristata* in Arkansas lists. Based on their present ranges, *Dryopteris cristata* is much less likely to be found as far south as Arkansas than *D. carthusiana*. Next, Moore (1940) reported that *D. cristata* occurred in the "swamps of southeastern Arkansas."

The confusion within the Arkansas state fern literature was then transferred and further distorted in the national fern literature. Clute (1901, 1938), in the most popular fern manual of the early 20th century, noted *D. cristata* as present in Arkansas, being the southwesternmost station. Broun (1938), in his index of all North American pteridophytes, reported "*D. cristata* from Newfoundland to Idaho, south to southeastern Virginia, and northern Arkansas; Europe." Small (1938) in his authoritative manual to the pteridophytes of the Southeastern United States reported *D. cristata* from "North Carolina to Arkansas and in Canada from Saskatchewan to Ontario and Newfoundland." Shaver (1954) in his excellent manual to the ferns of Tennessee noted that *D. cristata* occurred in Tennessee only in the extreme northeastern corner of the state in a bog at high elevation; then Shaver cites Broun (1938), noting its occurrence in "northern Arkansas." The very popular illustrated flora of Illinois included a volume on ferns by Mohlenbrock (1967) that reported *D. cristata* as ranging from "Newfoundland south to Nebraska, Arkansas, and Virginia." Mickel (1969) in his "How-to-Know" manual provides a distribution map of *D. cristata* that includes the northeast corner of Arkansas. Wherry (1972, p. 144) reported *D. cristata* in the southern lowlands from "Rapides Parish, La., to SE Ark. and NE Tex., in swampy habitats." The Louisiana and Texas plants were misidentified specimens of *D. celsa*. Wherry (1972, p. 301), in reference to ferns of the southern uplands, also reported *D. cristata* "in the Mississippi River lowlands of La. and Ark." Wherry (1972) noted the Louisiana plants were based on fragmentary collections of *D. ludoviciana*; the Arkansas plants were "unattributed," with Wherry commenting that the Arkansas material "has apparently never been rediscovered here in recent times," an apparent reference to the Palmer fern at Shirley, Arkansas, which is *D. Xleedsii*. Thomas et al. (1973) in clarifying the situation in Louisiana stated that reports of *D. cristata* in "southeastern Arkansas," as well as Louisiana and Texas are "extremely dubious."

Therefore, Taylor (1976), Taylor and Demaree (1979), Taylor (1984), Peck, Taylor, and Peck (1987), Peck and Peck (1988), and Peck and Taylor (1995) excluded *D. cristata* from the Arkansas flora. These workers indicated that all reports unsupported by vouchers; no specimens exist now that suggest a misidentification was the basis, and no one has found the enigmatic specimens by Lytle who had found *D. cristata* "SE of Pine Bluff." These important vouchers were lost in herbarium specimen trades of specimens as noted by Buchholz and Palmer (1926). Alternatively, they were lost

as late as the early 1970s when Herbarium UARK was moved from Old Main Building to the Botany-Engineering Building, at which time many old specimens and duplicates were culled and destroyed. Enigmatically, three specimens of *Dryopteris cristata* from Lyman H. Hoysradt of Pine Plains, NY, collected on 18 July 1878, given as a gift to F. Leroy Harvey, and deposited at UARK, still exist in UARK's out-of-state folders and have survived such trades and compaction efforts. Until valid specimens are located, *Dryopteris cristata* remains excluded from the pteridophyte flora of Arkansas.

***Dryopteris goldiana* in One County.**--The Giant Logfern *Dryopteris goldiana* (Hook.) A. Gray is a diploid, fertile, North American endemic, denoted with the genome code GG (Table 2). This species was discovered as new to Arkansas in 1999. Relocating a *D. celsa* locality found by Phil Hyatt in Baxter Co., Earl Hendrix, staff botanist for the Ozark National Forest discovered that the original location on the Hyatt specimen was incorrect. After finding the correct locality, Hendrix noticed that the locality contained "more than just *D. celsa*." Peck joined Hendrix on 20 July 1999 to survey the locality and collect specimens. C. T. Witsell, now of Arkansas Dept. Natural Heritage, collected late fall specimens in September and November 1999 to confirm species-hybrid identities, which differ in their response to the approach of winter. Peck et al. (2000) reported five plants of *Dryopteris goldiana* (Hook.) A. Gray in the midst of a *Dryopteris* genus community containing *Dryopteris celsa*, *Dryopteris marginalis*, *D. Xaustralis*, *D. Xleedsii*, and *D. goldiana* X *celsa*. The locality is in a remote part of the Ozark National Forest in Baxter Co. (Map 3). The complexity of the populations at this locality warrants additional inventory and development of management plans to protect all of the rare taxa in this watershed. The locality is disjunct by 100 km from localities in southern Missouri, but no more so than are disjuncts in Minnesota and in western Missouri from their metropolis regions (Iffrig, 1979; Wagner, 1972; Werth, 1991).

One locality in one county:

1) Baxter Co.: Merrill Ridge Blowing Cave, For. Serv. Rd. 1127 or Merrill Ridge Rd., T17N R12W S30, Norfolk SE Quad., in the slope above and below the blowing cave and spring entering Stewart Fork Creek, 10 x 20 m area. Five plants counted. Specimens: Peck 99417 (LRU).

***Dryopteris intermedia* excluded from Arkansas Flora.**--The Intermediate Log Fern *Dryopteris intermedia* (Muhl. ex Willd.) A. Gray is a North American endemic, fertile, diploid species denoted with the genome code II (Table 2). Smith (1994) included *Dryopteris intermedia* (Muell. ex Willd.) A. Gray in Smith's key to the species of *Dryopteris* in the vascular flora of Arkansas. He annotated the name with an asterisk, meaning that this and another 300 some species were added to his book as "possible addition" plants. This meant that they were not yet known in Arkansas, but that they might be found in Arkansas. Unfortunately, the dis-

claimer was not noticed by most biogeographers. Since 1994, I have received over a dozen inquiries regarding this species's occurrence in Arkansas. Therefore, it is important to explicitly exclude this species from the state flora. The species has never been reported from Arkansas nor has any herbarium specimen been collected. The species occurs to the north in Missouri and northeast in Illinois as very rare and local populations. Perhaps field efforts in northeastern Arkansas might locate it around seeps, springs, or north-facing slopes, particularly on sandy soils or sandstone cliff faces. *Dryopteris intermedia* is sometimes confused with *D. carthusiana* as they are similar in general morphology, but readily distinguished based on uniform pinnule symmetry and size, presence of glandular hairs, and smaller spores of the former and unequal pinnules, lack of glandular hairs, and larger spores of the latter.

***D. ludoviciana* in One County.**--The Southern Log Fern *Dryopteris ludoviciana* (Kunze) Small is a North American endemic, fertile, diploid, species denoted with genome code LL (Table 2). This was the first of the evergreen *Dryopteris* species of the "cristata" group known from the lowland coastal plain of the Southeastern United States. It was known first from and named from very limited populations in Louisiana, but was later found to be more widespread and abundant in Florida. There are two reports from Texas. In 1931 it was discovered as far north as North Carolina. It was reported from one locality (Fig. 4) in Arkansas (Peck et al., 1985; Peck et al., 1985). The field status of this population was discussed in Peck and Peck (1988) who noted that there were many juvenile, non-sporiferous plants, suggesting a young population or one that is not reproducing itself. Werth (1991) analyzed allozymes of this species, including Arkansas material collected in 1985, and provided a distribution map that shows clearly that the Arkansas material is the most northwestern in the species range.

In 1982, *D. ludoviciana* was discovered for the first time in Arkansas at Warren Prairie State Scientific Area by Sundell and McIntyre who found plants in the central wooded area on the south side of the property. Others plants were located by Peck in 1984 to the east of that location. Peck and Peck (1988) reported 70 plants in two plots with only eight sporiferous adults in the eastern population at Warren Prairie.

According to a Trip File Report by Lance Peacock, dated 4 May 1988, on file at Arkansas Dept. Natural Heritage, the area of Warren Prairie was severely impacted by "an arson-fire" set on 7 November 1987 by deer hunters mad at Georgia-Pacific for leasing lands to some hunters and excluding other hunters. This fire may have contributed to the decline of this species at Warren Prairie. The eastern population may have been eliminated directly as a result of the fire, as plants have not been seen there since. In a Trip

File Report by Bob Steinauer to Lance Peacock and Nancy DeLamar, dated 23 Apr 1991, on file at Arkansas Dept. Natural Heritage, Steinauer reported the following: "I checked the *Dryopteris* population and it looked fine. There is a fair amount of low growing honeysuckle in the area that needs to be watched. It is currently not overtopping any of the ferns but a problem may develop in the future. The area to the east on which Jim Peck had previously found *Dryopteris* was also searched but no plants were found. It seems as if the wildfire of 1987 has eliminated this [Peck's eastern] population." The eastern area is now overgrown with *Rubus*. Since 1991, no one has seen the western plants. With both the eastern and western plants unfindable, the species is now considered extirpated at Warren Prairie. No additional Arkansas locations are known.

Specimens of one Arkansas locality in one county:

1) Bradley Co.: Warren Prairie St. Sci. Area, T13S R7W S13, Wilmar South Quad. In willow "pin" oak and sweetgum woods adjacent to cypress at edge of forest adjacent to salt-duripan prairie. Peck noted more than 100 plants in 1984. Possibly extirpated by fire in 1987. Specimens: Sundell & McIntyre 2864 (UAM) on 18 Sept 1982; Peck 84641 (LRU, MIL, MICH, UARK) on 14 Oct 1984; Peck 85014 (LRU) on 8 June 1985.

***Dryopteris marginalis* in 38 Counties.**--The Marginal Shield Fern *Dryopteris marginalis* (L.) A. Gray is a North American endemic, fertile, diploid species ($2n = 82$) denoted with the genome code as MM (Table 2). *Dryopteris marginalis* was reported by Nuttall (1835- 1836) and by all subsequent authors of Arkansas pteridophyte floras (Table 1). Harvey (1881) reported it as "quite common upon shaded moist cliffs in the mountains of Arkansas. Grows very large. Inland and along streams." Moore (1940) reported *D. marginalis* "as common, in rocky woods and on ledges." *Dryopteris marginalis* occurs in 38 of the 75 Arkansas counties (Fig. 5), being common across the northwestern one-half of the state with rock outcrops, present in localities too numerous to enumerate and in abundances too extensive to census.

Hybrid Distribution and Chorology

***Dryopteris Xaustralis* in Four Counties.**--Wagner and Musselman (1982) reported the known national distribution of the extremely rare hybrid *Dryopteris Xaustralis* as being from eight localities in four states: including two localities in Alabama, two localities in Louisiana, three localities in North Carolina, and one in South Carolina. Of these eight localities, five were extirpated. Peck et al. (1985) reported one locality in Arkansas. Werth et al. (1988) reported five new localities in four new states: one locality in Virginia, two localities in Tennessee, one locality in Mississippi, and one locality in Georgia, with only the last considered extirpated. Taylor (1984) added a second locality in Arkansas. Redman (1992, 1999) reported three localities from Maryland. Thus, this North American endemic hybrid was

known from 18 localities in 17 counties in 10 states with six historical localities already extirpated.

The issue of *Dryopteris Xaustralis* in the Arkansas flora is now settled. Moore (1940) reported this taxon in Arkansas for the first time using the name *Dryopteris clintoniana* var. *australis*, but applied it to the Palmer fern at Shirley Arkansas, which it is not. On this basis, Taylor and Demaree (1979) excluded from the Arkansas pteridophyte flora the name *Dryopteris clintoniana* var. *australis*. The first correct inclusion of this fern in the Arkansas flora came about in 1984 when Steve Orzell discovered it along Meyer Creek, Garland Co. (Orzell and Peck, 1985; Peck et al., 1985). Since then it was found at a second locality in Garland Co, five localities in Montgomery Co, and one locality each in Baxter and Polk counties. At present, *Dryopteris Xaustralis* is known from nine populations in four counties of Arkansas (Table 3).

This report adds seven new localities and the third and fourth Arkansas county records from Baxter and Polk counties. The national range of this hybrid consists now of 25 localities in 19 counties in 10 states. With six of 25 localities extirpated, leaving 19 extant, the importance of Arkansas' nine extant localities can be appreciated. Furthermore, Arkansas has four counties in which the hybrid is known (Fig. 6), whereas, Maryland and North Carolina each have three counties in which the hybrid is known. A few localities exist in seven other states. No county and no state other than has more localities than the five known from Montgomery Co., Arkansas.

The nine localities in four Arkansas counties:

- 1) Baxter Co.: Stewart Fork Creek collapsed blowing cave and permanent seepage spring, Merrill Ridge Road, T17N R12W S31, Norfolk SE Quad., wooded oak forest at toe-slope of steep hillside, a dozen plants with *Dryopteris celsa*, *D. goldiana*, *D. marginalis*, *D. Xleedsii*, and *D. goldiana* X *D. celsa*. Specimens: Peck 99701 (LRU) on 20 July 1999.
- 2) Garland Co.: Meyer Creek wooded seep, along For. Serv. Rd. 386, T3S R22W Sec 16, Percy Quad., wooded acid seep over firm mineral soil with *D. celsa*. Several hundred plants. Specimens: Orzell 1392, 1394 (MIL) on 26 July 1984; Orzell 1492 (MIL) on 20 Sep 1984; Orzell 1566 (MIL) on 27 Oct 1984; Peck 84680 (LRU) and Peck 84682 (UARK) on 27 Oct 1984; Peck 91150 (LRU) on 3 June 1991; Crank 92004 (HSU) on 25 June 1992; Crank s.n. (MO) on 27 Sep 1993; Peck 95462 (LRU) on 20 Nov 1995; Peck 99186 (LRU) on 15 June 1999; Witsell 99074 (LRU) on 11 Aug 1999.
- 3) Garland Co.: Walnut Creek, W of Crystal Springs on For. Serv. Rd. 47, S along Walnut Creek to seep with *D. celsa*. T2S R22W S29, Crystal Springs Quad. Peck observed two hundred plants in 1981. Peck observed fewer than 24 in 1999. Specimens: Peck 88434 (LRU) on 16 Aug 1988; Pittman 9298811 (LRU) on 29 Sept 1988; Peck 91151 (LRU) on 3 June 1991; Crank 92004 (HSU) on 18 Aug 1992; Peck 95452 (LRU) on 20 Nov 1995; Peck 99243 (LRU) on 4 July 1999.
- 4) Montgomery Co.: Box Springs wooded seep, W of Norman, For. Serv. Rd. 73, S of AR 8, with *D. celsa*. T4S R26W S33, Polk Creek Mt. Quad. Sixty plants counted. Specimens: Peck 95126 (LRU) on 18 Aug 1995; Peck 99120 (LRU) on 4 July 1999; Witsell 99044 (LRU) on 3 Aug 1999.
- 5) Montgomery Co.: Collier Springs Creek, along For. Serv. Rd. 177, S of Spring in Collier Creek on E side of road, with *D. celsa*. T3S R24W S17,

Caddo Gap Quad. Ten plants seen. Specimens: Peck 99141 (LRU) on 4 July 1999.

- 6) Montgomery Co.: Singing Springs wooded seep and creek, E of Norman, N of For. Serv. Rd. 208, with *D. celsa*. T3S R24W S22, Caddo Gap Quad. Twelve plants observed. Specimens: Peck 95096 (LRU) on 27 Apr 1995.
- 7) Montgomery Co.: Buttermilk Springs, T4S R24W S6, Caddo Gap Quad.. Twenty-five plants reported in 1988 by Bates, but Witsell in 1999 observed 50 plants; Peck noted 38 plants in 1999. Specimens: Witsell 99091 (LRU) on 11 Aug 1999; Peck 99451 (LRU) on 11 Sep 1999.
- 8) Montgomery Co.: Wehunt Seep, W of Norman on AR 8, S on For. Serv. Rd. 43, T3S R27W S33, Big Fork Quad. Locality in decline from road building and removal of canopy trees. Three plants with *D. celsa*. Specimens: Peck 81129 (LRU) on 7 June 1981; Peck 84721 (LRU) on 3 Nov 1984; Peck 91237 (LRU) on 18 Jun 1991; Peck 99124 (LRU) on 4 July 1999.
- 9). Polk Co.: Big Fork Creek seep, SW of Abernathy Springs on Polk Co. 38, Athens Road, along Big Fork Creek, hillside acid seep over hard mineral soils, T3S R28W S34, Big Fork Quad. Seven plants observed. Specimens: Peck 99513 (LRU) on 24 Sep 1999.

***Dryopteris Xleedsii* in Two Counties.**--This rare *Dryopteris* hybrid is a North American endemic known from only six localities in four states [Arkansas, Maryland, New York, and Pennsylvania], with the Arkansas locality some 1000 km disjunct from the other populations on the eastern coastal plain (Wagner and Taylor, 1976). The first locality to be discovered was in Arkansas. However, it was not recognized initially as that taxon at the time that Wherry (1942) named the hybrid using plants discovered by A. N. Leeds along the Susquehanna River in Harford Co., Maryland. This was reasonable, as the Arkansas Palmer fern was no longer locateable by botanists, having been seen last in 1935. The history of the Arkansas *Dryopteris* is central to an understanding of the confusion surrounding many other hybrid *Dryopteris* plants, and this confusion persisted into the 1970s among fern experts. Therefore, it is instructive to analyze the chorology of this hybrid to understand how a fern plant could be given 12 incorrect names by fern experts and for most of its known existence be "lost" to the same experts (Table 2).

On 30 March 1928, E. J. Palmer [Palmer 33216 (NY, US)] with Delzie Demaree collected and identified as *Dryopteris cristata* (L.) Gray a large and unusual *Dryopteris* from the base of sandstone bluffs near Shirley in Van Buren Co., Arkansas. The ragged, coarsely-lobed appearance of the specimens indicates that these fronds were late fronds formed in 1927 that overwintered and lodged before collection in spring of 1928. Later collections were of normal fronds, more regular and finely lobed. Interestingly, this was not the first time Palmer visited this locality; four years earlier on 28 May 1924, both Palmer and Delzie Demaree collected a specimen of *Dryopteris marginalis* [Palmer 25170 (UARK); Demaree 25170 (MO)] from the same partially shaded, sandstone north-facing bluff of the Little Red River near Shirley, Arkansas, Van Buren Co. It is not known whether they noticed this plant in 1924, and then returned specifically to collect it when they appreciated its impor-

tance. If it was overlooked and first noticed in the spring of 1928, it is not known why they returned to an old locality four years later when the fronds were at their worst. The specimens Palmer collected in 1928 were problematic, reflected by the series of conflicting annotations left on specimens by subsequent workers. They were annotated as *D. celsa* by E. T. Wherry in 1935 and as *D. celsa X spinulosa* by F. W. Crane in 1953. They were correctly determined as *D. Xleedsii* in 1979 by W. H. Wagner, Jr.

Additional insight can be derived from inspection of correspondence kept with specimens in herbaria. In 1931, Palmer wrote about this fern to Dr. William Maxon at U.S. Maxon wrote back to Palmer asking if additional material could be sent to him. Palmer wrote to Delzie Demaree asking him to collect more material for Maxon. Demaree did so in 1932. Maxon deposited some specimens at US, sent additional material to E. T. Wherry (now at PH), and returned some to Demaree. Demaree wrote a letter to J. K. Small in 1933 explaining this sequence of events (letter of 22 June 1933 at NY). On 4 Nov 1932, Demaree collected 3 sheets with shoot apices and a living rhizome and sent them to Maxon at US; all were labeled as *Dryopteris* sp. to US [Demaree 10089, 3 sheets (US; SMU)]. The label data indicated: "Go up railroad from Shirley to railroad bridge across river, cross bridge, turn left, and go straight across a small field to bluff; fern common at base of bluff and part way up, region very rocky, but soil very fertile, well wooded; some fronds 3 feet long." In 1935, E. T. Wherry annotated Demaree's specimens as *D. celsa*. During the 1950s, F. W. Crane annotated them as "*D. celsa X*?" The specimen sent to SMU was originally determined as *D. marginalis*. It is important to note that there is no way one can fail to find these plants by following the simple directions on the specimen label. In hindsight, it is difficult to comprehend how this plant could be lost for 40 years.

On 10 Nov 1932, Palmer wrote to Demaree, that "I have just had a letter from Dr. Maxon asking about a *Dryopteris* collected [at Shirley]....He seems interested in it and thinks that it is an undescribed species." William Maxon planted and grew the Demaree rhizome of the Palmer fern at his home in Washington, DC (Wagner and Taylor, 1976). The following year Maxon corresponded with Demaree [in litt., 20 Sep 1933.... "Your Arkansas *Dryopteris* has done remarkably well....it is an exceptionally attractive fern in cultivation"]. No specimens exist at Herbarium US to support the letter.

On 3 Nov 1935, D. Moore collected specimens with E. T. Wherry and both collectors labeled the plants *D. goldiana* f. *arkansas*, coming from "Shirley, Arkansas, shady, moist, rocky woods," and they both called the specimens "Arkansas Goldi Fern." Specimens were distributed to several herbaria, including MO, UARK, UCA, NY, PHIL, US (2 sheets). At US, they were annotated by F. W. Crane as

"*D. celsa X marginalis*?"; at PHIL a specimen was annotated by J. K. Small as *D. separabilis* (see this report below). W. H. Wagner, Jr. annotated Wherry 350441 (MO) as *D. Xleedsii* in 1971; W. C. Taylor annotated the specimens at UCAC and UARK as *D. Xleedsii* on 21 Aug 1974.

After this visit in November 1935, the Palmer Fern was not seen and the location became "lost" until 1974. In 1936, E. T. Wherry returned to Shirley, Arkansas, on 5 September 1936 and noted "Trip to Shirley, Ark., for *Dryopteris arkansana* was a flop. The cows had eaten what the drought had left." The note with this statement by E. T. Wherry, filed with the Demaree letter to Small of 22 June 1932, is preserved on a literature herbarium sheet at NY.

Wherry (1937) published a new species he called *D. clintoniana* var. *australis*, referring to a plant in Forney, Alabama (now known as *D. Xaustralis*), but noted that a plant from Shirley, Arkansas, was very similar or also that species. Small (1938) renamed the Forney plant *D. australis* and referred to the Palmer fern as *D. australis* or "being very close to this." Small (1938) also named *D. separabilis* based on material from the Great Dismal Swamp; he also referred to the Palmer Fern as similar to if not that of *D. separabilis*.

Moore (1940) reported the discovery of the Palmer Fern incorrectly, leading to problems among the two leading botanists of the Arkansas flora. According to Moore (1940), "An unusual colony of *Dryopteris* was discovered in 1931, near Shirley, Van Buren County, by a party including E. J. Palmer, Delzie Demaree, and the writer [Dwight Moore]. It was growing in a moist rocky wood associated with *Dryopteris marginalis*. Its sori, however, instead of being marginal, were midway between the margin and the midveins of the pinnules. It showed resemblance to *D. clintoniana* and some to *D. celsa*. After considerable study it was designated by Dr. E. T. Wherry (1937) as *D. clintoniana* var. *australis*." Consequently, Moore (1940) referred to the Palmer Fern as *D. clintoniana* var. *australis* Wherry, the Southern Clinton's Shield Fern, meaning *D. Xaustralis* (Wherry) Small. Interestingly, Moore (1940) referred to *D. celsa* as not being present at Shirley and failed to report it from anywhere within Arkansas. Moore seemed to be unaware of its discovery in Arkansas in 1924.

Based on the plants discovered by A. N. Leeds in Maryland, Wherry (1942) named the hybrid *D. Xleedsii*, noting it occurred in large populations with many size classes. At the time, *D. goldiana* was believed to be the other parent with *D. marginalis* although *D. goldiana* was not present at the Maryland locality. The other parent *D. celsa*, mentioned as being present at the Maryland locality, was not considered as a potential parent until much later. S. Walker (1962b) examined the cytology of *Dryopteris* plants at Leeds' locality in Maryland. He noted size classes, diploid and triploid plants with anomalous spores, along with fertile diploid and tetraploid plants in the mixed collections sent to him by E.

T. Wherry. Walker (1962b) postulated a hybrid origin for Leed's Fern from diploids *D. goldiana* and *D. marginalis*. Believing that Walker's report raised more questions than answers, Wagner and Wherry revisited the Susquehanna location in 1963 and noted the presence of the tetraploid *D. celsa*. This find accounted for a "diploid X tetraploid" origin of the sterile triploid hybrid, Leeds' Fern and a report was published (Wagner and Wagner, 1965). In 1964, Wagner, Demaree, and Redfearn attempted to rediscover the Palmer Fern in Arkansas, but without success, searching mainly around the Leslie area. In 1966, the sterile diploid at the Maryland locality was determined to be *D. goldiana* X *marginalis* and then was given a collective binomial (*D. Xneowherryi* Wagner (Wagner and Wagner, 1966) to honor E. T. Wherry.

While studying the Arkansas fern flora as his dissertation research, W. C. Taylor traveled with Delzie Demaree on several trips to relocate the Palmer Fern, first again near Leslie and then near Shirley. On 18 Aug 1974, Taylor and Demaree drove through the town of Shirley, Arkansas, in Van Buren Co. Demaree knew instantly that this was the correct location. Taylor crossed the river and found the fern. The locality was soon visited by Warren Wagner, Jr., Florence Wagner, Paul Redfearn, Alice Redfearn, Carl Taylor, Jerry Taylor, and Jewel Moore. Wagner and Taylor prepared two reports of the discovery (Wagner and Taylor, 1976; Taylor, 1982).

After all of this trouble, it is indeed unfortunate that the range of this hybrid was mapped incorrectly by the Biota of North America Project [www.bonap.org], with the map showing the four states in which it does occur (Arkansas, Maryland, New York, and Pennsylvania) and five states where it does not (Michigan, New Jersey, Virginia, Georgia, and Tennessee).

A second Arkansas locality with five plants of *D. Xleedsii* was recently discovered in Baxter Co. (Fig. 7). The discovery of this locality was reported in Peck et al. (2000) and discussed in the section on *Dryopteris goldiana*.

There are two localities in two Arkansas counties (Fig. 7):

- 1). Baxter County: Stewart Fork Creek collapsed blowing cave and permanent seepage spring, Merrill Ridge Road, T17N R12W S31, Norfolk SE Quad. Five plants present along with *D. celsa*, *goldiana*, *marginalis*, *Xaustralis*, and *D. celsa* X *goldiana*. Discovered by Earl Hendrix, botanist, Ozark National Forest. Specimens: Peck 99704 (LRU) on 20 July 1999.
- 2). Van Buren Co.: Palmer Fern, Shirley, Arkansas: Atoka sandstone rubble, on north-facing rocky slope, along Middle Fork of Little Red River, SW of Shirley, AR, T12N R13W S24, Shirley Quad. Discovered by E. J. Palmer in 1928; location lost after 1935; rediscovered by Demaree and Taylor on 18 Aug 1974; Twelve apices in 1981 through 1999, similar in appearance to photo taken in 1935. Specimens: E. J. Palmer 33216 (NY, US) on 30 March 1928; D. Demaree 10089 (NY, US-3 sheets, SMU) on 4 Nov 1932; D. Moore 350441 (MO, NY, PHIL, UARK, UCA, US-2 sheets) on 3 Nov 1935; Wherry 350441 (UCA, UARK) on 3 Nov 1935; W. C. Taylor 2597 (SIU) on 18 Aug 1974; F. S. Wagner & W. H. Wagner, Jr. 74164 (MICH); J. & W. C. Taylor 2597 (MICH); A. P. Redfearn 29403

(MICH); J. Moore sn (UCAC) on 13 Sep 1974; W. C. Taylor 24419 (UARK) on 11 Dec 1974; Peck 81116 (LRU) on 14 June 1981; Peck 88249 (LRU) on 18 June 1988; Crank 92019 (HSU) on 18 Aug 1992; Peck 92435 (LRU) on 18 Aug 1992; Peck 99130 (LRU) on 12 June 1999. At MO, the Moore specimen collected in 1935 is accompanied by MO #1102531, a B&W photograph of the plant next to a tree, still recognizable today, verifying the expanded plant of today as the plant from which material was collected in 1935.

***Dryopteris celsa* X *goldiana* in Arkansas.**--The Logfern-Giant Logfern Hybrid, *Dryopteris celsa* X *goldiana* is a sterile triploid, North American endemic, denoted with the genome code GGL (Table 2). Until recently, it was not known from Arkansas. It was discovered while attempting to relocate a locality in Baxter County discovered by Phil Hyatt that had *Dryopteris celsa*. Details are presented in the discussion of *Dryopteris goldiana* in this report.

One locality in one county (Fig. 8):

- 1) Baxter Co.: Merrill Ridge Blowing Cave, on For. Serv. Rd. 1127, Merrill Ridge Rd. T17N R12W S30, Norfolk SE Quad., Three plants were counted. Specimens: Peck 994254 (LRU) on 20 July 1999.

***D. Xneowherryi* Wagner-excluded from Arkansas Flora.**--The New-Wherry Hybrid Log Fern *Dryopteris Xneowherryi* Wagner is a North American endemic, sterile, diploid hybrid with the genome code GM, being the non-polyploid hybrid between *D. goldiana* and *D. marginalis* (Table 2). In 1908 Dowell located the *Dryopteris* hybrid *D. goldiana* X *marginalis* at a locality in Harford Co., Maryland. Wherry (1961a,b) commented on this hybrid and noted that as both parents are diploid, the hybrid should likewise be diploid, but sterile. A few plants at the Harford site had normal fertile spores and some were tetraploid, leading Crane in 1961 to naming them Wherry's Woodfern, *Dryopteris wherryi* Crane. Unfortunately, these plants were *Dryopteris celsa*, making this combination illegitimate. Walker (1962b) studied 12 plants from the type locality of *D. Xleedsii* in Harford Co., Maryland, and reported three cytological entities, a sterile diploid, and sterile triploid, and a tetraploid. Wherry had originally interpreted *D. Xleedsii* to be *D. goldiana* X *marginalis*. In the Southern Fern Guide, Wherry (1972) did not report the presence of *D. Xneowherryi* in the south, particularly Arkansas. Wagner (1971) reported that *Dryopteris Xleedsii* (*D. celsa* X *marginalis*) and *D. Xneowherryi* (*D. goldiana* X *marginalis*) are sufficiently similar to have caused considerable confusion, but their relationships are now fairly well understood.

However, in summaries of *Dryopteris* species and hybrids (Montgomery and Paulton, 1981; Montgomery, 1982), the range of hybrid *D. goldiana* X *marginalis* was described as "Ontario, Vermont, New York, New Jersey, south to West Virginia, and western North Carolina, west to Arkansas and Illinois." The reference to Arkansas is incorrect, reflecting a confusion at that time over the identify of the Palmer *Dryopteris* at Shirley, Arkansas, which is now known to be *D. Xleedsii*. The difference between the sterile triploid *D. Xleedsii* (GLM) and the sterile diploid *D.*

Xneowherryi (GM) is the presence of the "L" genome of *D. ludoviciana* (Wagner and Wagner, 1965, 1966). This error was perpetuated in Montgomery and Fairbrothers (1992) who reported *D. Xneo-wherryi* to range from Vermont, New York, and Ontario, south to West Virginia and western North Carolina, west to Arkansas [incorrectly] and Illinois. The Biota of North America Project (BONAP) electronic mapping project [www.bonap.org] reproduced this range and accordingly, *D. Xneo-wherryi* was mapped for Arkansas where it does not grow. Literature errors were difficult to correct; now electronic mistakes perpetuate past errors.

***Dryopteris Xseparabilis* Small-excluded from Arkansas Flora.**--The Separated Hybrid Log Fern *Dryopteris Xseparabilis* Small is a North American endemic, sterile triploid hybrid denoted with the genome code GIL (Table 2). Montgomery (1982) notes that the hybrid has a glandular indusium of *D. celsa* and the basal stipe scales of *D. intermedia*. The present known distribution is New York, Maryland, SE Virginia, NE and W. North Carolina, and Michigan.

Small (1938) named this taxon as a species based on a 22 Nov 1935 collection by A. N. Leeds from the Lake Drummond region of the Great Dismal Swamp in Virginia. Small noted affinities with *D. cristata*, *goldiana*, and *ludoviciana*. The range was reported from Virginia and North Carolina, Great Dismal Swamp, but "also moist rocky woods and bases of bluffs, Ouachita Co., AR." In the discussion, Small (1938, p. 284-286) states "In 1928 imperfect specimens of a large fern were collected in Arkansas. These were distributed to various herbaria. On November 3, 1935, better specimens were collected in the same region"...clearly a reference to the Palmer Fern located at Shirley, which is *D. Xleedsii*. Small (1938) continued, "Then on November 22, 1935, the fern was found in the Great Dismal Swamp, Virginia," documented with the following voucher A. N. Leeds 3583 (PHIL). Small (1938) concluded, "If at one time, it flourished in the Atlantic seaboard and the Mississippi Valley, it now remains to us, as far as we know, in only two outposts, retreats as it were, one the Dismal Swamp, the other the hills of Arkansas." All literature references are in error, being comments on what is today known as *D. Xleedsii*. There are no known localities of this hybrid in Arkansas.

Key to *Dryopteris* Species and Hybrids

- 1. Spores uniform in size and shape (using compound microscope).....2
- 1. Spore irregular in size and shape (using compound microscope)6
- 2. Sori submarginal, near edges of pinnules; blade leathery.....
.....*Dryopteris marginalis*

- 2. Sori medial, away from edges of pinnule; blade papery.....3
- 3. Fronds bipinnate-pinnatifid; pinnules toothed, basal pinnule 2-3x longer than upper counter pinnule of same basal pinna; pinnae triangular.....*Dryopteris carthusiana*
- 3. Fronds pinnate to bipinnate; pinnules not toothed, uniform size and shape; pinnae elongate, lanceolate.....4
- 4. Fertile pinnae narrower than sterile pinnae, occupying distal 1/2 blade; scales uniformly tan.....*Dryopteris ludoviciana*
- 4. Fertile pinnae same width as vegetative pinnae, occupying distal 1/2 to nearly entire blade; scales dark brown with black center.....5
- 5. Frond gradually tapering at distal end; scales dull, 1/2 brown/black.....*Dryopteris celsa*
- 5. Frond abruptly tapering at distal end; scales glossy, mostly black.....*Dryopteris goldiana*
- 6. Sori about midway between midrib and margin or closer to margin; blade gradually narrowing to tip and to base, 3-6th pinnae longest; basal pinnae lanceolate, 2x as long as wide or less; scales dark glossy brown with pale border.....
.....*Dryopteris Xleedsii*
- 6. Sori nearer midrib than margin; blade 2-3x longer than wide; scales dull usually dark brown to nearly black with pale margins7
- 7. Fertile upper pinnae contracted, with pinnae narrower and more widely spaced than lower pinnae without sori; blade 3x longer or more than wide; scales dull dark brown.....
.....*Dryopteris Xaustralis*
- 7. Fertile pinnae not contracted, blade 2x longer than wide, gradually narrowed to the tip; basal pinnae elongated, at least 3x longer than wide; scales nearly black with pale margins.....*Dryopteris celsa X goldiana*

ACKNOWLEDGMENTS.—The following individuals are thanked for materially contributing to the preparation of this report over the last 20 years through field work, herbarium curation, chorology, library loans, document searches, or sharing essential floristic knowledge with the author: C. Amason, V. Bates, J. Bray, W. Crank, P. Dozhier, J. Gentry, T. Gulden, G. Heidt, E. Hendrix, E. Hudson, P. Hyatt, D. Lellingner, D. Marsh, J. Mickel, J. Montgomery, J. Moore, R. Moran, S. Orzell, L. Peacock, C. J. Peck, W. Shepherd, E. Sundell, W. C. Taylor, K. Tinkle, G. Tucker, F. S. Wagner, W. H. Wagner, Jr., C. T. Witsell, and G. Yatskievych. The following organizations also assisted the author: Arkansas Field Office - The Nature Conservancy; Arkansas Natural Heritage Commission, Department of Natural Heritage; Ouachita National Forest and Ozark National Forest, US Forest Service. Without the assistance and help of these

individuals and organizations, this unfunded project would have taken longer and could not have been as complete.

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