

SOIL ACIDITY AT THE ROOTS OF SOME TENNESSEE PTERIDOPHYTES

(Continued from the October number)

NATHAN H. WOODRUFF

Donelson High School, Donelson, Tennessee

Asplenium resiliens Kze. (Small Spleenwort)

TABLE 18. Soil acidity

pH	FRE-QUENCY OF OCCUR-RENCE	STATIONS AND SUB-STATIONS	pH	FRE-QUENCY OF OCCUR-RENCE	STATIONS AND SUB-STATIONS
6.30—6.39..	2	T (2)	7.70—7.79..	2	Rb, Y
6.40—7.29..	0	.....	7.80—7.89..	1	Rb
7.30—7.39..	1	P	7.90—7.99..	2	A, T
7.40—7.69..	0	.....		

Range pH 7.99-6.39
Number of specimens 8

Ave. pH 7.59
Number of stations and substations 5

Asplenium platyneuron (L.) Oakes (Ebony Spleenwort)

TABLE 19. Soil acidity

pH	FRE-QUENCY OF OCCUR-RENCE	STATIONS AND SUB-STATIONS	pH	FRE-QUENCY OF OCCUR-RENCE	STATIONS AND SUB-STATIONS
5.10—5.19..	1	T	7.00—7.09..	1	N
5.20—5.39..	0	.....	7.10—7.19..	3	O, Oa, Q
5.40—5.49..	2	Ba (2)	7.20—7.29..	2	D, I
5.50—5.59..	2	H, Vb	7.30—7.39..	4	E (3), Oa
5.60—5.69..	2	H, Wg	7.40—7.49..	6	D, E, I, Ja, Kb, N
5.70—5.79..	0	.....		
5.80—5.89..	1	Wa	7.50—7.59..	6	Ba, E (2), N, Ra, T
5.90—5.99..	0	.....		
6.00—6.09..	1	Ha	7.60—7.69..	2	Ba, N
6.10—6.19..	2	Wb, BB	7.70—7.79..	5	A, E, N (2), Rb
6.20—6.29..	2	I, Ka	7.80—7.89..	1	E
6.30—6.39..	0	.....	7.90—7.99..	4	A, Bb, Ka, N
6.40—6.49..	2	C, I	8.00—8.09..	3	Ba (3)
6.50—5.59..	0	.....	8.10—8.19..	1	Bb
6.60—6.69..	2	E, H	8.20—8.29..	1	N
6.70—6.79..	1	E	8.30—8.49..	0	.....
6.80—6.89..	0	.....	8.50—8.59..	1	F
6.90—6.99..	4	E, H, I, Rd			

Range pH 8.51-5.18
Number of specimens 61

Ave. pH 6.99
Number of stations and substations 24

Asplenium montanum Willd. (Mountain Splenwort)TABLE 20. *Soil acidity*

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
3.90—3.99..	2	DD (2)	4.50—4.59..	2	T, U
4.00—4.29..	0	.....	4.60—4.69..	1	U
4.30—4.39..	1	BB	4.70—4.79..	1	BB
4.40—4.49..	1	BB	4.80—4.89..	1	U

Range pH 4.87-3.90
Number of specimens 9

Ave. pH 4.43
Number of stations and substations 4

Asplenium cryptolepis Fernald (Wall Rue Splenwort)TABLE 21. *Soil acidity*

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
7.30—7.39..	1	Rb	7.80—7.89..	1	Rb
7.40—7.79..	0	.....	7.90—7.99..	1	Rb

Range pH 7.38-7.95
Number of specimens 3

Ave. pH 7.78
Number of stations and substations 1

Woodwardia areolata (L.) Presl. (Narrowleaf Chainfern)TABLE 22. *Soil acidity*

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
3.80—3.89..	1	Wc	4.80—4.89..	0	.....
3.90—3.99..	1	Sb	4.90—4.99..	2	Sb (2)
4.00—4.09..	1	X	5.00—5.09..	1	Wc
4.10—4.19..	0	.....	5.10—5.19..	4	Sb (2), Wb, Wf
4.20—4.29..	1	X	5.20—5.99..	0	.....
4.30—4.69..	0	.....	6.00—6.09..	2	Wa (2)
4.70—4.79..	1	Wa	6.10—6.19..	1	X

Range pH 6.16-3.88
Number of specimens 15

Ave. pH 4.52
Number of stations and substations 6

Pellea atropurpurea (L.) Link. (Purple Cliffbrake)

TABLE 23. Soil acidity

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
6.50—6.59	1	E	7.90—7.99	3	A, N, P
6.60—6.89	0	-----	8.00—8.09	6	A, D, N(2), P, Q
6.90—6.99	1	D	8.10—8.19	1	T
7.00—7.29	0	-----	8.20—8.29	5	A (3), D, N
7.30—7.39	1	Rb	8.30—8.39	3	A, D, N
7.40—7.59	0	-----	8.40—8.49	2	N (2)
7.60—7.69	1	D	8.50—8.89	0	-----
7.70—7.79	1	T	8.90—8.99	1	D
7.80—7.89	2	P (2)			

Range pH 8.96-6.57
Number of specimens 28

Ave. pH 8.20
Number of stations and substations 8



Photograph by Dr. Jesse M. Shaver

Fig. 4. *Asplenium cryptolepis* on a moss-covered rock near Station Rb, Little Marrowbone Creek, Davidson County, Tenn.

Cheilanthes alabamensis (Buckley) Kunze (Alabama Lipfern)

TABLE 24. Soil acidity

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
6.90—6.99..	1	P	7.10—7.19..	1	P
7.00—7.09..	0	.....		

Range pH 7.11-6.94
Number of specimens 2

Ave. pH 7.05
Number of stations and substations 1

Cheilanthes lanosa (Michx.) Watt. (Hairy Lipfern)

TABLE 25. Soil acidity

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
6.90—6.99..	1	Rb	7.40—7.49..	2	P (2)
7.00—7.09..	0	.....	7.50—7.69..	0	.....
7.10—7.19..	2	P (2)	7.70—7.79..	1	Rb
7.20—7.29..	0	.....	7.80—8.39..	0	.....
7.30—7.39..	1	Rb	8.40—8.49..	1	Rb

Range pH 8.43-6.94
Number of specimens 8

Ave. pH 7.72
Number of stations and substations 3

Adiantum pedatum L. (Maiden Hair Fern)

TABLE 26. Soil acidity

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
6.10—6.19..	2	M, We	7.40—7.49..	1	Ka
6.20—6.29..	0	.....	7.50—7.59..	1	T, Ka
6.30—6.39..	1	M	7.60—7.69..	1	H, Ka
6.40—6.49..	2	Rd	7.70—7.79..	1	Kb
6.50—6.59..	3	M, T (2)	7.80—7.89..	3	M (2), N
6.60—6.69..	3	Ra, Rb, We	7.90—7.99..	1	Rb
6.70—6.89..	0	.....	8.00—8.09..	1	Ka
6.90—6.99..	2	Rd, T	8.10—8.39..	0	.....
7.00—7.09..	2	Ka, We	8.40—8.49..	1	N
7.10—7.19..	2	G, Rd	8.50—8.69..	0	.....
7.20—7.29..	4	M, Ra, We, Z	8.70—8.79..	1	N
7.30—7.39..	0	.....		

Range pH 8.75-6.13
Number of specimens 32

Ave. pH 7.59
Number of stations and substations 10

Adiantum Capillus-Veneris L. (Southern Maidenhair)

TABLE 27. Soil acidity

pH	FREQUENCY OF OCCURRENCE	STATIONS AND SUBSTATIONS
7.52.....	1	Y

Pteridium latiusculum (Desv.) Hieron. var. *pseudocaudatum* (Clute) Maxon (Bracken)

TABLE 28. Soil acidity

pH	FREQUENCY OF OCCURRENCE	STATIONS AND SUBSTATIONS	pH	FREQUENCY OF OCCURRENCE	STATIONS AND SUBSTATIONS
3.60—3.69..	1	Re	4.90—4.99..	0	.....
3.70—3.79..	0	.....	5.00—5.09..	2	Rb, Wc
3.80—3.89..	1	CC	5.10—5.19..	2	Re, Wb
3.90—3.99..	1	BB	5.20—5.29..	1	T
4.00—4.09..	1	CC	5.30—5.59..	0	.....
4.10—4.19..	1	T	5.60—5.69..	1	Wa
4.20—4.29..	1	CC	5.70—5.79..	1	Rb
4.30—4.59..	0	.....	5.80—5.89..	1	Rb
4.60—4.69..	1	Rb	5.90—5.99..	2	Wa (2)
4.70—4.79..	0	.....	6.00—7.09..	0	.....
4.80—4.89..	1	CC	7.10—7.19..	1	Rb

Range pH 7.19-3.67
Number of specimens 19

Ave. pH 4.40
Number of stations and substations 8

Polypodium virginianum L. (Common Polypody)

TABLE 29. Soil acidity

pH	FREQUENCY OF OCCURRENCE	STATIONS AND SUBSTATIONS	pH	FREQUENCY OF OCCURRENCE	STATIONS AND SUBSTATIONS
3.90—3.99..	1	DD	5.00—5.09..	1	BB
4.00—4.79..	0	.....	5.10—5.59..	0	.....
4.80—4.89..	1	T	5.60—5.69..	2	T, BB
4.90—4.99..	1	CC	5.70—5.79..	2	T, BB

Range pH 5.79-3.95
Number of specimens 8

Ave. pH 4.72
Number of stations and substations 4

Polypodium polypodioides (L.) Watt. (Resurrection Fern)

TABLE 30. Soil acidity

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
4.80—4.89..	1	Q	6.90—6.99..	1	Wd
4.90—5.99..	0	.....	7.00—7.09..	0	.....
6.00—6.09..	1	T	7.10—7.19..	1	Ba
6.10—6.19..	0	.....	7.20—7.39..	0	.....
6.20—6.29..	2	Ba, Wd	7.40—7.49..	1	Ba
6.30—6.39..	0	.....	7.50—7.59..	0	.....
6.40—6.49..	1	T	7.60—7.69..	1	Q
6.50—6.59..	1	Ba	7.70—7.79..	0	.....
6.60—6.69..	1	Rb	7.80—7.89..	1	A
6.70—6.79..	3	Ba (3)	7.90—7.99..	1	Wd
6.80—6.89..	0	.....		

Range pH 7.95-4.86
Number of specimens 16

Ave. pH 6.01
Number of stations and substations 6



Photograph by Dr. Jesse M. Shaver

Fig. 5. A mat of Maidenhair fern (*Adiantum pedatum*) in a small ravine, Little Marrowbone Creek region, Davidson County, Tenn.

Lygodium palmatum (Bernh.) Sw. (Climbing Fern)

TABLE 31. Soil acidity

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
4.60—4.69..	1	U	4.90—4.99..	1	BB
4.70—4.79..	1	U	5.00—5.09..	1	BB
4.80—4.89..	1	U			

Range pH 5.09-4.62
Number of specimens 5

Ave. pH 4.83
Number of stations and substations 2



Photograph by Dr. Jesse M. Shaver

Fig. 6. The Resurrection Fern (*Polypodium polypodioides*) on a rock in Warner Park, Davidson County, Tenn.

Osmunda regalis L. (Royal Fern)TABLE 32. *Soil acidity*

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
4.00—4.09..	1	Wc	5.00—5.09..	1	AA
4.10—4.19..	3	T (3)	5.10—5.19..	1	Wb
4.20—4.29..	0	.....	5.20—6.29..	0	.....
4.30—4.39..	1	Wc	6.30—6.39..	1	Vb
4.40—4.49..	0	.....	6.40—7.19..	0	.....
4.50—4.59..	1	Wb	7.20—7.29..	1	Rd
4.60—4.69..	1	Wb	7.30—7.39..	2	Rd (2)
4.70—4.79..	1	AA	7.40—7.49..	0	.....
4.80—4.99..	0	.....	7.50—7.59..	2	Rd (2)

Range pH 7.53-4.03

Number of specimens 16

Ave. pH 4.55

Number of stations and substations 6

Osmunda Claytoniana L. (Interrupted Fern)TABLE 33. *Soil acidity*

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
7.20—7.29..	1	Ra	7.50—7.59..	0	.....
7.30—7.39..	0	.....	7.60—7.69..	1	Ra
7.40—7.49..	1	Ra	7.70—7.79..	1	Ra

Range pH 7.73-7.20

Number of specimens 4

Ave. pH 7.57

Number of stations and substations 1

Osmunda cinnamomea L. (Cinnamon Fern)TABLE 34. *Soil acidity*

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
3.50—3.59..	1	Wc	4.70—4.79..	2	Wa, M
3.60—3.69..	0	.....	4.80—4.89..	1	Wa
3.70—3.79..	1	Sb	4.90—4.99..	1	Z
3.80—4.19..	0	.....	5.00—5.09..	1	AA
4.20—4.29..	1	Sb	5.10—5.19..	0	.....
4.30—4.39..	3	Sb, U, Wa	5.20—5.29..	1	Wb
4.40—4.69..	0	.....	5.30—5.39..	1	Wf

Range pH 5.30-3.54

Number of specimens 12

Ave. pH 4.25

Number of stations and substations 9

**Botrychium dissectum Spreng. var. obliquum (Muhl.) Clute
(Grapefern)**TABLE 35. *Soil acidity*

pH	FREQUENCY OF OCCURRENCE	STATIONS AND SUBSTATIONS
5.35	1	Wf

Botrychium virginianum (L.) Sw. (Rattlesnake Fern)TABLE 36. *Soil acidity*

pH	FREQUENCY OF OCCURRENCE	STATIONS AND SUBSTATIONS	pH	FREQUENCY OF OCCURRENCE	STATIONS AND SUBSTATIONS
4.60—4.69	1	Wc	7.50—7.59	1	G
4.70—5.89	0	.....	7.60—7.69	3	G, M (2)
5.90—5.99	1	Ra	7.70—7.79	4	C, Ka, N (2)
6.00—7.29	0	.....	7.80—7.89	1	C
6.30—6.39	1	Ra	7.90—7.99	1	C
6.40—6.49	3	Ra, Wb (2)	8.00—8.09	3	C (2), N
6.50—6.79	0	.....	8.10—8.19	0	.....
6.80—6.89	1	M	8.20—8.29	1	Ra
6.90—6.99	1	Ra	8.30—8.39	1	F
7.00—7.19	0	.....	8.40—8.49	0	.....
7.20—7.29	1	M	8.50—8.59	1	F
7.30—7.39	1	G	8.60—8.69	1	F
7.40—7.49	1	M			

Range pH 8.68-4.66
Number of specimens 28

Ave. pH 6.99
Number of stations and substations 10

Equisetum arvense L. (Field Horsetail)TABLE 37. *Soil acidity*

pH	FREQUENCY OF OCCURRENCE	STATIONS AND SUBSTATIONS	pH	FREQUENCY OF OCCURRENCE	STATIONS AND SUBSTATIONS
6.70—6.79	1	BB	7.40—7.49	0	.....
6.80—6.89	0	.....	7.50—7.59	1	Va
6.90—6.99	1	BB	7.60—7.89	0	.....
7.00—7.29	0	.....	7.90—7.99	1	Va
7.30—7.39	1	Va	8.00—8.99	2	Va (2)

Range pH 8.09-6.79
Number of specimens 7

Ave. pH 7.71
Number of stations and substations 2

Selaginella apus (L.) Spring. (Creeping Selaginella)

TABLE 38. Soil acidity

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
7.00—7.09..	1	Ra	8.30—8.39..	1	Ra
7.10—8.29..	0	.....		

Range pH 7.01-8.34
Number of specimens 2

Ave. pH 8.06
Number of stations and substations 1

Lycopodium lucidulum Michx. (Shining Club-moss)

TABLE 39. Soil acidity

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
4.00—4.09..	1	DD	4.20—4.29..	1	DD
4.10—4.19..	1	DD			

Range pH 4.08-4.20
Number of specimens 3

Ave. pH 4.12
Number of stations and substations 1

Lycopodium obscurum L. (Ground-pine)

TABLE 40. Soil acidity

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
4.00—4.09..	1	BB	4.70—4.79..	2	U, BB
4.10—4.49..	0	.....	4.80—4.99..	0	.....
4.50—4.59..	1	U	5.00—5.09..	1	U
4.60—4.69..	0	.....		

Range pH 5.06-4.07
Number of specimens 5

Ave. pH 4.51
Number of stations and substations 2

Lycopodium porophyllum Lloyd and Underw. (Lloyd's Club-moss)TABLE 41. *Soil acidity*

pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS	pH	FRE- QUENCY OF OCCUR- RENCE	STATIONS AND SUB- STATIONS
4.50—4.59	1	U	4.90—4.99	2	CC (2)
4.60—4.89	0				

Range pH 4.97-4.52
Number of specimens 3

Ave. pH 4.77
Number of stations and substations 2

The data in table 42 are presented in the following manner: In the first column is listed the species under consideration; the second column contains a number indicating the number of specimens studied, if known, and an abbreviation of the name of the investigator as follows: Wo, indicates Woodruff's data; C, Craw's data; Wh, Wherry's data; and R, Robinove and La Rue's data. Under the next column "Range of pH," the data are grouped into columns of pH 0.5, as pH 3.5, pH 4.0, pH 4.5, etc. The midpoint between two adjacent groups was determined by changing the pH values into arithmetical values (Wherry, 1927) and noting the midpoint. This midpoint thus determined was converted back into pH values. The midpoint between each pH 0.5 column having been determined, all pH values lying between the midpoints of, for example, pH 6.0, are grouped under the 6.0 column. For instance, both pH 5.91 and pH 6.09 are grouped under the 6.0 column. The divisions of the pH range in which less than ten per cent of the reactions of each species tested appear are designated by the small letter "x" and the division which includes the most frequently observed reaction for each species is indicated by the large letter X. All columns in which specimens tested appear between these two classifications are indicated by xx. The last column indicates the average pH when given by the investigator. The term "circumneutral" as used in one place in the table is taken from studies by Wherry (1920) and means the range of pH values around pH 7.00.

In Robinove and La Rue's study the data were not given in the form used by Wherry; these authors gave the highest pH, the lowest pH, and the average pH only. In the following table these three pH values are used for Robinove and La Rue's data instead of the notation used for the other investigator's work.

Woodsia obtusa shows a very wide range in two of the studies listed above, Wherry's and the present study, a range from pH 5.5 to 8.5 in the first and from pH 5.0 to 8.5 in the latter. The results of Craw give only a small range, but this is possibly due to the small number of samples studied. All samples of Craw lie about the middle of the range as given by the other two investigators. It is interesting to note that most of the readings occur in the 6.0 pH range in the Wherry study, in the 7.0 pH range in the Craw study, and in the 8.0 pH range in Woodruff's study. The averages of the Craw and Woodruff studies agree relatively closely. From the above data the species appears as one preferring a neutral or nearly neutral soil.

Cystopteris bulbifera has a pH range from 6.5 to 9.0 in Woodruff's study. Its range is chiefly alkaline. Craw's, Wherry's, Robinove and La Rue's studies give an average pH range varying from 5.0 to 8.0. Most samples in Wherry's, Craw's, Robinove and La Rue's, and Woodruff's studies were found in the pH groups of 7.0, 7.5, 8.0, and 8.5, respectively. The averages of the three studies (Robinove and La Rue's, Craw's, and Woodruff's) lie between pH's of 7.8 and 8.4. These studies show this species to be definitely alkaphilous.

Cystopteris fragilis gave a pH range from 6.5 to 8.5 in this investigation. The other studies (Wherry's and Craw's) extend the acid side of the scale. There were fifty-seven samples in Woodruff's study and only thirty in the Wherry study. The species seems not to have any preference so long as the soil is neither too acid nor too alkaline.

Onoclea sensibilis had a pH range from 4.5 to 8.0 in Wherry's, Robinove and La Rue's, and Woodruff's studies. In the Craw study the pH range was limited to a pH of 7.5 on the alkaline side, but the averages from Craw, Robinove and La Rue, and the present investigator lie between pH 5.3 and pH 6.1. The most common group in Robinove and La Rue's, and Wherry's investigations was a pH of 6.0 and in Craw and Woodruff, a pH of 6.5. There is very good agreement throughout the studies on this particular species. The species shows a slight preference for acid soils.

Thelypteris noveboracensis is one of the species in the present investigation which has its most common group in the acid side. The range in Woodruff's study is very large—from pH 4.0 to pH 8.0, but the most common groups are all on the acid side, being either a pH of 5.5 or 5.0. The general features of the three studies agree relatively well. This species prefers acid soil but will grow in alkaline.

Thelypteris marginalis offers a contrast between the present and previous studies. The previous studies agree in the most common groups with one study giving a higher alkaline range than the other. The range in this investigation extends to pH 4.0, while the previous ones gave a range to pH 5.0. Yet the most common reaction in the present study was pH 7.5. Previous studies found the most common group as pH 6.0. From the above data the species appears acidophilous.

In *Thelypteris Goldiana* the studies are relatively few: Wherry had ten specimens, Craw fourteen, and Woodruff only five. This

5.35
6.00
x
X
x
xx
1
12 C
Botrychium dissectum var. obliquum

scarcity may be due to the rarity of the species. Wherry's and Craw's studies gave the most common group as neutral (pH 7.0). Wherry's range extended up to pH 6.0 and down to 8.0, while Craw's range extended only from the acid side down to pH 5.0. The five samples of Woodruff are limited to a pH from 6.5 to 7.5. This species appears to prefer neutral soils with a leaning to the acid side in some places, as shown by Craw's work.

Thelypteris hexagonoptera has a pH range from 4.5 to 7.5 in Woodruff's study and a pH range from 5.5 to 8.0 in both Wherry's and Craw's studies. The most common groups vary from pH 6.0 to pH 7.0. The range of the species is wide, but it seems to have a preference for slightly acid soils.

Polystichum acrostichoides varied from a pH of 5.0 to 8.0 with the most common group lying in the neutral zone, but the average pH is 5.78 in Woodruff's results. Wherry found the fern to have a range from pH 4.5 to pH 8.0, while Craw gave the range from pH 5.0 to pH 7.5. Both of the latter results gave the most common group as pH 6.0. The species leans to an acid soil habitat.

This investigation gives *Dennstaedtia punctilobula* a pH range from 3.5 to 5.5. Craw's three specimens fell in the pH 5.0 group, but Wherry's data gave the pH range from 4.5 to 8.0 with the most common group at pH 6.5. All studies agree that the species prefers an acid condition of the soil. The limited range in the first cases, in Woodruff's and Craw's studies, possibly was due to the few specimens and habitats found.

For *Athyrium angustifolium*, Wherry's range from pH 5.5 to pH 8.0 includes the range obtained by Woodruff. Woodruff's study, however, places most specimens in the neutral and alkaline part of the above range with the specimens frequenting the pH range of 7.5 most common. The most common group in Wherry's investigation was pH 6.5. This species prefers neutral and nearly neutral soils.

Athyrium acrostichoides has a wide range in both Wherry's and Woodruff's studies with the most common groups at pH 6.0 and pH 7.0. The specimens are quite well scattered over the entire range from pH 5.0 to pH 8.0. Within the above limits the species seems to grow without any particular preference for any one soil reaction.

Athyrium asplenioides has one of the widest ranges of any species compared in this study. Woodruff's study gives the range from pH 4.0 to pH 8.5, Wherry's range was from pH 4.5 to pH 8.0. This species seems to grow equally well under any part of the above range and is not limited to any particular soil reaction.

Wherry's studies of *Camptosorus rhizophyllus* gave it the widest range of any study listed here, the pH range being from 5.0 to 8.5. Woodruff's study gave the limits from pH 6.0 to pH 8.0. The most common group of Wherry's study is listed as neutral (pH 7.0), of Woodruff's study as pH 7.5, and of Craw's work as pH 6.0. This species appears to have a definite preference for neutral or nearly neutral soils.

Asplenium resiliens prefers nearly neutral or alkaline soils as indicated by both the Wherry and Woodruff investigations. Wherry gave the pH range from 6.5 to 8.5 while Woodruff gave it from pH 6.5 to pH 8.0. The majority of the specimens gave an alkaline soil reaction. The species is alkaphilous.

In the species, *Asplenium platyneuron*, the ranges in the three studies—Wherry, Craw, and Woodruff—are very similar, but the most common or the most frequent groups differ very greatly: Wherry gave it as pH 4.5; Craw, as pH 6.5; and Woodruff, as pH 7.5. This species seems to be able to grow and flourish in either acid or alkaline soils.

Asplenium montanum is a decidedly acidophilous species. Wherry gave the range from pH 4.5 to pH 6.0, while Woodruff's results varied from a pH of 4.0 to pH 5.0. The most common groups of the respective studies are pH 5.0 and pH 4.5.

Wherry's data limited *Woodwardia areolata* to a pH range from 4.5 to 5.0, but the Woodruff results extended the acid range to pH 4.0 and the lower end of the acidity scale at pH 6.0. This species in both investigations preferred decidedly acid soils. No specimens were found below the pH 6.0 limit in either study. The species was limited in distribution, in the present study, to marshy regions.

Pellea atropurpurea was studied in both Craw's and Woodruff's work. This is a definitely alkaphilous plant. The range in the present study is from pH 6.5 to pH 9.0 with the most common group as pH 8.0. The results of Craw ranged from pH 7.5 to pH 8.5, with the most common group at pH 8.5. This species has a preference for limestone rock.

The data on *Cheilanthes lanosa* offer less agreement than any other species included in this study. Wherry found the range to be from pH 5.0 to pH 7.0, but Woodruff's investigation found the range to be from pH 7.0 to pH 8.5. One is an acid reaction and the other alkaline. Collections in the present study were made at limestone stations and therefore the alkalinity was high. Perhaps the true range of pH is from pH 5.0 to pH 8.0, as indicated by the data of the combined studies.

Adiantum pedatum ranges from pH 6.0 to pH 8.5 in Woodruff's study with the most common group as pH 7.0, and from pH 4.5 to pH 7.5 in Craw's study with the most common group pH 6.5. Wherry's samples ranged from pH 5.5 to pH 8.0 with the most common group pH 6.5. The above data show that the species is neutral or slightly acid in its soil preferences.

Woodruff's study gave a decidedly acid range (from pH 4.0 to pH 5.5) for *Polypodium virginianum* while the other two investigators gave the species a more alkaline range, especially Wherry, who gave the range from pH 5.0 to pH 8.5 with the most common group as pH 6.0. The collections reported in this paper were made entirely in acid places with none being found in the alkaline stations around Nashville, Tennessee. The species seems to have a preference for acid soils but occurs also in alkaline locations as noted from Wherry's

studies. Craw's data supports the acidophilous trait noted in Woodruff's investigation.

In *Polypodium polypodioides* the pH range and the most common group are very different in the two studies, as indicated by Table 42. Wherry gave the pH range from 4.5 to 7.0, strictly an acid-neutral one. The present data give the pH range from 5.0 to 8.0, showing the presence of species on both the acid and alkaline sides of the neutral point. The pH 4.5 group was most common in Wherry's studies, while the neutral group (pH 7.0) is most frequent in the present study. The above results suggest a wide range of soil reaction for the species.

The narrowest range of any species found in the Woodruff and Wherry investigations was that of *Lygodium palmatum*. Both studies gave identical pH ranges, from 4.5 to 5.0, but the most common group in the present study is pH 5.0, and in Wherry's study, 4.5. This species is an acidophilous one and is limited to the most acid soils.

Osmunda regalis has a much larger range in Woodruff's investigation than in the other three studies listed in this paper. The three previous workers gave the range from pH 4.5 to pH 6.5 with the most common groups occurring at pH 4.5 (in the case of Wherry's and Craw's results). The most common group in Woodruff's study is pH 4.0. The species is acidophilous and prefers the more acid soil habitats.

Osmunda Claytoniana was represented by only four specimens in Woodruff's study. All specimens were taken from one locality and had a pH range from 7.0 to 7.5. The other studies (Wherry's and Craw's) gave the species a much wider range extending from pH 7.5 to pH 4.5 (Wherry) and from pH 7.0 to pH 5.5 (Craw). The limited range found in Woodruff's study was probably due to the scarcity of the species.

Osmunda cinnamomea is only found in acid soils according to the data of Wherry, Craw, Robinove and La Rue, and Woodruff. The range is from pH 3.5 to pH 5.5 in Woodruff's study. The previous data gave the ranges from pH 4.5 to pH 6.5 (Wherry and Craw) and from pH 4.2 to pH 5.0 (Robinove and La Rue). The most common groups are either the pH 4.5 or pH 5.0 groups. This species is much more acid in its soil preference than the kindred species, *Osmunda Claytoniana*.

In *Botrychium virginianum*, the range found in Woodruff's study exceeded those of the previous investigators on both ends of the scale, the range of Woodruff being from pH 4.5 to pH 8.5. The other studies (Wherry's and Craw's) indicate that the fern is circum-neutral in its reaction preference, while Robinove and La Rue's data gave the range from pH 5.2 to pH 8.0. The most common group (pH 7.5), however, in the present study indicates a preference for slightly alkaline soils, while Craw gives the most common group as pH 6.5.

From Woodruff's study, no conclusion may be drawn from the data on *Botrychium dissectum* var. *obliquum*, as only one soil speci-

men was studied with a pH of 5.35. This fits into the ranges, from pH 5.5 to pH 6.5, given by Craw (twelve samples).

In Table 43 are listed the species for which no comparisons were made as the necessary data for such comparisons were not found. In this group appear the five fern allies considered in this paper and the seven ferns not listed in Table 42.

Equisetum arvense in this investigation had a neutral to alkaline range from pH 7.0 to pH 8.0, with the most common group at pH 8.0. There were only seven specimens from two habitats. It appears to be an alkaphilous species from the data here presented.

Lycopodium lucidulum, *Lycopodium porophilum*, and *Lycopodium obscurum* gave practically the same range of pH from 4.0 to 5.0. They are decidedly acidophilous in their habitats. There are not sufficient data to make any conclusions concerning the soil preferences of the three species.

Selaginella apus, represented by two soil samples from the same station, gave a soil reaction range from pH 7.0 to pH 8.0. No conclusions may be drawn except that the species does occur in the above range.

Thelypteris palustris var. *pubescens* has a range from pH 5.5 to pH 8.0 with the most common group pH 7.5. The species shows a wide pH range with little preference for any specific soil reaction.

Thelypteris spinulosa var. *americana* was studied only seven times in Woodruff's investigation, but the range obtained varied from a pH of 4.0 to 7.0.

From the four specimens of *Thelypteris spinulosa* var. *intermedia* the data indicate that the species prefers acid soil.

Asplenium cryptolepis is known as a calciphilous species and this study supports this view since the three specimens tested were found in the pH groups from 7.5 to 8.0. This species was studied in one habitat only.

Cheilanthes alabamensis is found in the neutral group, but only two soil samples were studied.

Adiantum Capillus-Veneris was represented by only one soil sample in this study. The reaction was pH 7.52.

Pteridium latiusculum var. *pseudocaudatum* has a range from pH 3.5 to 7.0. All specimens indicated that the species prefers acid soils.

SUMMARY

1. The hydrogen-ion concentration of the soils around the roots of thirty-six species of ferns, one *Equisetum*, one *Selaginella*, and three species of *Lycopodium*, found in Tennessee, mainly in the vicinity of Nashville, were determined electrometrically. Altogether 672 soil samples were collected and tested.

2. *Athyrium angustifolium*, *Cheilanthes lanosa*, *Equisetum arvense*, *Selaginella apus*, *Asplenium cryptolepis*, *Adiantum Capillus-Veneris* grew in neutral or alkaline soil.

TABLE 43. Species studied in this investigation but not given in Table 42

Name of species	No. of Specimens	Range of pH										Ave. pH				
		3.0	3.5	4.0	4.5	5.0	5.5	6.0	6.5	7.0	7.5		8.0			
<i>Equisetum arvense</i>	7			xx	x								xx	xx	X	7.71
<i>Lycopodium lucidulum</i>	3			x	x											4.21
<i>Lycopodium obscurum</i>	5			xx	x			X								4.51
<i>Lycopodium porophyllum</i>	3			xx	x			xx								4.77
<i>Selaginella apus</i>	2															8.06
<i>Thelypteris palustris</i> var. <i>pubescens</i> ..	12										x	xx				6.96
<i>Thelypteris spinulosa</i> var. <i>americana</i>	7															4.58
<i>Thelypteris spinulosa</i> var. <i>intermedia</i>	4		xx													4.72
<i>Asplenium cryptolepis</i>	3													x		7.78
<i>Cheilanthes alabamensis</i>	2													x		7.05
<i>Adiantum Capillus-Veneris</i>	1															7.52
<i>Pteridium latiusculum</i> var. <i>pseudocaudatum</i>	9	x		xx	xx			X			x	xx		x		4.40

3. *Thelypteris spinulosa* var. *americana*, *Dennstaedtia punctilobula*, *Asplenium montanum*, *Woodwardia areolata*, *Polypodium virginianum*, *Lygodium palmatum*, *Osmunda cinnamomea*, *Botrychium obliquum*, *Lycopodium lucidulum*, *Lycopodium obscurum*, *Lycopodium porophyllum* and *Pteridium latiusculum* var. *pseudocaudatum* were only found in neutral or acid soil.

4. Most of the data presented in this paper agree with the results of Wherry, Robinove and La Rue, and Craw, whose work was done in the East, in Michigan, and Indiana, respectively.

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