SOIL ACIDITY AT THE ROOTS OF SOME TENNESSEE PTERIDOPHYTES[1]

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INTRODUCTION

This investigation is a study of soil reaction of some ferns and fern allies found in the vicinity of Nashville, on three trips to the Cumberland Mountains in Putnam and White Counties, on a four-day trip to the Smoky Mountains in Sevier County and on a two-day trip into Henry and Chester Counties; all collections being made in Tennessee. The time of study was limited to the period of time between March 29 and July 7, 1935.

The reaction of the soil was taken by standard methods with the Leeds and Northrup Portable Potentiometer No. 183,149 connected with the Leeds and Northrup Quinhydrone-Calomel Electrode Assembly No. 7,701-A-1 manufactured by Leeds and Northrup Company, Philadelphia, Pa., until the potentiometer broke. After that the Youden pH Outfit No. 5,270, manufactured by W. M. Welch Manufacturing Company, Chicago, was used.

The limit of error of the Leeds and Northrup potentiometer is given by the manufacturer as 0.01 pH but the actual calibration is given as better than 0.005 pH for temperatures around 25 degrees Centigrade.

Soil samples were collected in the field in numbered soil sample cans and, in a few cases, in one-ounce stoppered bottles properly labeled, and brought to the laboratory for testing. This plan was followed due to the inconvenience of transporting apparatus to individual field stations and due to the fact that wider sampling could be obtained by the above method.

The plants studied were loosened by means of a trowel or knife and removed from the ground. The dirt adhering to the roots was shaken off and collected as the sample. In some cases the soil was removed by digging around the roots. This was done when the plant was rare or very scarce in the given locality. The soil was tested as a rule within twenty-four to thirty-six hours after collecting, but in two exceptional cases six days elapsed before the soil was tested. Soil has been kept in the laboratory for longer periods with little or no acidity change (Baver, 1926). The test was made on a soil-water mixture with the ratio from 1:3 to 1:5.

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Duplicate samples were not run on every sample. As a rule two or more samples were collected from the same locality for each species. Duplicate testings were made on the rarer plant samples where the amount of soil collected permitted.

Stations Studied

Station A was studied on March 29. This location is on the Cumberland River Bluff east of Nashville in Davidson County, along McGavock Lane about two miles west of Donelson. The bluff is north-facing and quite shady.

Station B was in the Cedar Glades 14.6 miles southwest of Nashville on the Murfreesboro Road, in Davidson County. Collections were made just off the Hobson Road about two hundred feet south of the Murfreesboro Road. This was *Substation a.* Samples were also procured on the Couchville Road about five miles north of the Murfreesboro Road (U. S. Highway 70 S). This was *Substation b.* The date was March 31.

Station C was located south of Nashville on the Otter Creek Road, about three-quarters of a mile west of the Franklin Road. The locality is known as Overton Hills. The particular area studied was on the north side of the hills lying adjacent to the Otter Creek Road. This was in Davidson County. The time was April 2, 1935.

Station D was at the junction of Maxie Lane and the Cumberland River in the suburbs of East Nashville, Davidson County. Collections were made along a small creek entering the river just north of the road and along the bluff just south of the road. Specimens were secured on April 6.

Station E was on the Granny White Road at and back of Granny White's Grave, southwest of Nashville, Davidson County. Collections were made along the small stream, on the west side near the top and on the east side of the hill back of the grave on April 6.

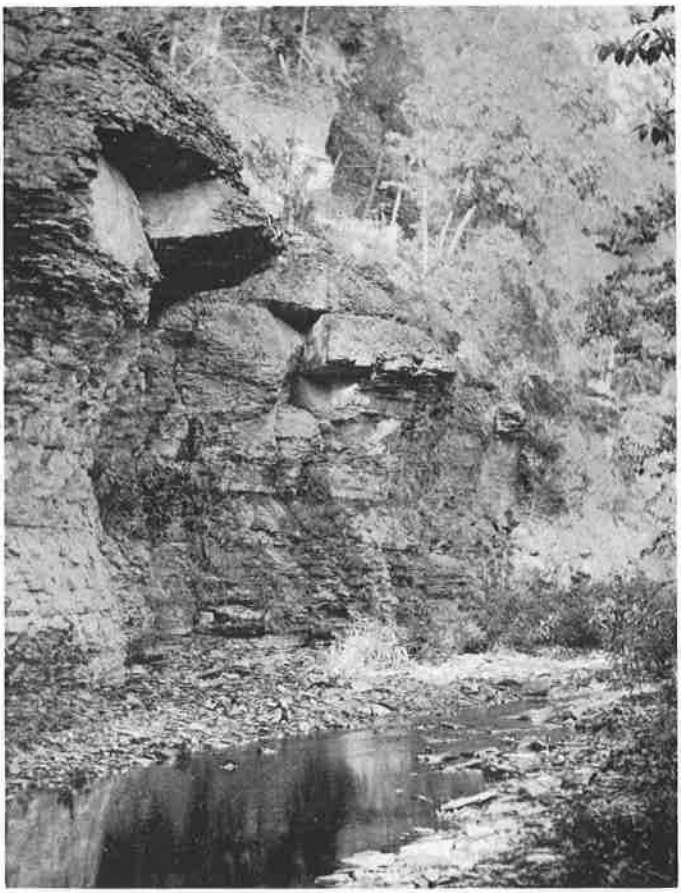
Station F was on a bluff and hill along White's Creek, about two and one-half miles east of the village of White's Creek. This is north of Nashville in Davidson County. Collections were made on April 8.

Station G was on Highway No. 12 (the old Ashland City Road) about thirteen miles from Nashville at the foot of the big U turn. Collections were made at the foot and side of the hill between the curve. The date was April 19.

Station H was situated on the Bull Run Creek Road 1½ miles from Highway No. 12 on the hill lying south of the road. Collections were made on the north side of the hill. This is northwest of Nashville in Davidson County. The date was April 19.

Station I, studied on April 21, was on Due West Drive north of the road, on the north slope of the first hill east of Dickerson Road. This is northeast of Nashville in Davidson County.

Station J was situated by a large spring on the bank of a small stream on the Brick Church Road about four miles south of Goodlettsville, in Davidson County. The date was April 21. This was *Substation a*. *Substation b* was located about 2½ miles from Goodlettsville on the bank of the same small stream.



Photograph by Dr. Jesse M. Shaver.

Fig. 1. The south-facing bluff over Little Marrowbone Creek near Station Rb. On and near the bluff at this place were *Cheilanthes lanosa, Pellea atropurpurea, Asplenium resiliens, Asplenium cryptolepis, Asplenium platyneuron, Camptosorus rhizophyllus,* and *Polypodium polypodioides.*

Station K included two substations: *Substation a,* the ravine on the north side of the hill at Strickland School, on the Bull Run Creek Road in Davidson County, was studied on April 23. *Substation b* was on the Bull Run Creek Road about five miles off Highway No. 12.

Station M was in Wilkerson Hollow just south of the main road and east from Joelton in Davidson County. The study was carried out on both sides of the road and both banks of the stream in that locality. One investigation was on April 30 and the other on May 10.

Station N was 1½ miles from Adams, Robertson County, on Red River. Collections were made in a ravine about ½ mile long, located between the road and river, in an old railroad bed, and on the bluffs on the south side of the river, both east and west of the highway. Specimens were taken on May 3 and 4.

Station O included two substations: *Substation a,* studied May 7, was on a roadside bank by the schoolhouse at Pegram, Cheatham County. *Substation b* was off the Nashville-Memphis Highway on the opposite side of the railroad from the road on the Kingston Springs Road. Specimens were collected on the bluff of the small stream there, on May 7.

Station P was located on a bluff about fifty yards north of the Kingston Springs Road bridge over the Harpeth River, in Cheatham County. Studies were made here on May 7 and 17.

Station Q was situated just east of Kingston Springs on the bluff over the Harpeth River by the road. Collections were made on May 7.

Station R was located along Little Marrowbone Creek Road from 12.3 miles to about 18 miles north of Nashville in Davidson County. *Substation a* was a hill 12.3 miles from George Peabody College. It lay parallel to the road and also the creek and was a north-facing slope. This location was particularly interesting as it yielded twenty species, the largest number for any one locality. *Substation b* was 0.1 mile from *Substation a* on a bluff near the ford of the creek. This was south-facing. *Substation c* lay 3.7 miles from *Substation b* on a creek bluff in Big Hollow. *Substation d* was located 16.2 miles from Peabody College on Little Marrowbone Creek, up a small ravine with a spring near its head. *Substation e* was 1.8 miles farther down the Little Marrowbone Creek Road. It was in a hollow extending northwest of the road. Collections were made May 10.

Station S included two substations: *Substation a,* in Cookeville, Putnam County, was in a wood lot on Pearl Street, by a small stream. *Substation b,* in Putnam County, was 15.3 miles from Cookeville on Highway 24 in a swamp adjacent to the road. The collections were made May 12.

Station T was below Bee Rock, two miles east of Monterey and about ½ mile south of Highway 24 and up Stamp's Hollow to Stamp's Falls and return. The distance covered was about five miles each way. The date was May 12.

Station U was located in the second hollow east of Monterey, Highway 24, and north of the road. The dates were May 12 and July 7. This was in Putnam County.

Station V included two substations: *Substation a* was situated west of Kingston Springs on the Kingston Springs Road, about seventy-five feet upstream from the Turnbull Creek bridge. *Substation b* was still further west of Kingston Springs but off the same road about one hundred and fifty yards in a marsh on the north side of the Nashville, Chattanooga & St. Louis Railroad. Collections were taken May 17. Both places were in Cheatham County.

Station W was in Chester County, the samples being collected on June 28. *Substation a* was located on the South Fork of the Forked Deer River, east of Henderson, on State Road 100. Collections were made south along the river bank and swamp. *Substation b* was situated 10.5 miles west of Henderson on Farmer Hearn's farm on the Deanburg Road. The samples were taken on the north side of the road. *Substation c* was off Center Point Road (a branch road from State Highway 100) on S. J. Thompson's farm in the ravines north and northeast of the house. *Substation d* was three miles out the Enville Road from State Highway 100, at the long bridge, collections being secured just south of the road. *Substation e* was 10.3 miles east of Henderson on the south side of State Highway 100. *Substation f* was in Tull Bottum off the Mifflin Road. *Substation g* was 12.5 miles from Henderson on Mifflin Road. Collections were made east of the road. *Substation h* was 11.5 miles from Henderson on the Mifflin Road; specimens were chosen from both sides of the road.

Station X was situated in Henry County three quarters of a mile southwest of Paris at the Windy Waters Springs. Samples were taken in the ravine at the springs. The collection was made June 29.

Station Y was at Rock Island in Warren County. Collections were made along the Tennessee Electric Power Company's dam and power house path. The date was July 4.

Station Z was located in White County on U. S. Highway 70 S, 113.2 miles from Nashville by Murfreesboro and Rock Island, on the side of Cumberland Mountain. Samples were chosen from the woods around and back of the spring. The date was July 4.

Station AA was situated by a swamp in White County near Bon Air on U. S. Highway 70 S. The date was July 4.

Station BB was 130 miles from Nashville by Murfreesboro and Rock Island, on U. S. Highway 70 S on the bank of the Caney Fork River, in Cumberland County. The date was July 4.

Station CC was along the Cherokee Orchard Trail up Mt. LeConte in the Smoky Mountains, out from Gatlinburg, Sevier County. The trail was about seven miles from the Orchard to the top of the mountain, a rise of over four thousand feet in altitude. The date was July 5.

Station DD included all collections in New Found Gap, on the LeConte Trail from New Found Gap and on the Sky Line Drive in the Smoky Mountain National Park, Sevier County. The date was July 6.

Results

The data are tabulated under individual species. The pH is recorded in groups of 0.1 pH intervals. The frequency of a given reading is recorded in the second column. In the third column are listed the stations or substations and the number of specimens from each. It is to be noted above that each location was lettered: these letters are used to designate the stations or substations. These letters are those given for the stations and substations in the first part of this paper. If the letter of the station or substation appears without a

Woodsia obtusa (Spreng.) Torr. (Common Woodsia)

TABLE 1. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
5.20—5.29	2	E, I	7.40—7.49	4	D, E (2), Oa
5.30—5.69	0	.....	7.50—7.59	1	N
5.70—5.79	2	H, Wg	7.60—7.69	4	E (2), H, N
5.80—5.89	1	Wg	7.70—7.79	3	A, N, Q
5.90—6.19	0	.....	7.80—7.89	4	Ba, E, H, N
6.20—6.29	1	E	7.90—7.99	6	Ba (2), E (2), D, I
6.30—6.39	1	D			
6.40—6.59	0	.....	8.00—8.09	8	A (2), Ba, Bb, H, Jb, Ba, Ob
6.60—6.69	1	D			
6.70—6.79	2	A, Oa	8.10—8.19	5	Ba, E (3), N
6.80—6.89	1	A	8.20—8.29	3	A, D, F
6.90—6.99	0	.....	8.30—8.39	5	Bb, D (2), H, N
7.00—7.09	1	H			
7.10—7.19	2	E, H	8.40—8.49*	3	A (2), N
7.20—7.29	3	A, H, Re	8.50—8.59	0	.....
7.30—7.39	1	Ra	8.60—8.69	2	N, F

Range pH 8.69-5.28 Ave. pH 7.90
Number of specimens 66 Number of stations and substations 20

*Acidities above pH 8.40 cannot be accurately determined by the quinhydrone-calomel electrode. Nevertheless they are included in this and the following tables for what they are worth. The author attempted to check these low acidities with the La Motte colorimetric comparator sets but was not able to secure any results of value because of suspended clay particles which interferred with color comparisons.

numeral in parenthesis, there occurred only one specimen in that range of pH. The numbers present correspond to the number of times the station, which precedes it, gave samples occurring in that range.

The scientific names of the ferns are those given by W. A. Anderson, Jr. (1930-1931), and the common names follow those given by Durand (1928). For the species not given by Durand, the first common name in Britton and Brown (1913) is used. The names used for the fern allies are those given by Brown and Britton (1913).

Cystopteris bulbifera (L.) Bernh. (Berry Bladderfern)

TABLE 2. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
6.30—6.39	1	T	7.80—7.89	1	Va
6.40—6.59	0	.....	7.90—8.19	0	.....
6.60—6.69	1	T	8.20—8.29	1	Ra
6.70—6.79	1	T	8.30—8.39	0	.....
6.80—7.29	0	.....	8.40—8.49	1	F
7.30—7.39	1	T	8.50—8.69	3	F (3)
7.40—7.59	0	.....	8.70—8.79	1	F
7.60—7.69	1	Va	8.80—8.89	0	.....
7.70—7.79	1	Va	9.00—9.09	1	F

Range pH 9.05-6.38 Ave. pH 8.41
Number of specimens 15 Number of stations and substations 4

The average and mean pH were determined for each pteridophyte. The pH was changed into actual acidity for these calculations. The necessity of this for arithmetical averages, as Wherry (1927) has indicated, is due to the fact that pH numbers are logarithmic values. These averages of acidity were then converted back to pH values. The range of pH, the number of specimens, and the number of habitats are indicated for each species.

Cystopteris fragilis (L.) Bernh. (Brittle Fern)

TABLE 3. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
6.60—6.69	1	Ob	7.70—7.79	4	C (2), E, G
6.70—6.89	0	.....	7.80—7.89	4	C, E (2), Rb
6.90—6.99	4	C (2), Ja (2)	7.90—7.99	4	C (3), Kb
7.00—7.09	3	C (2), G	8.00—8.09	4	C (2), E, Ja
7.10—7.19	2	C, Ob	8.10—8.19	2	C, E
7.20—7.29	2	C, (2)	8.20—8.29	1	C
7.30—7.39	3	Ka, Ob, T	8.30—8.39	3	C, E, N
7.40—7.49	6	C, E (2), G, Ka (2)	8.40—8.49	1	E
			8.50—8.59	2	E, N
7.50—7.59	6	C (3), E, Ka, T	8.60—8.69	1	N
7.60—7.69	4	C (2), E, Ka			

Range pH 8.68-6.65 Ave. pH 7.85
Number of specimens 57 Number of stations and substations 10

Onoclea sensibilis L. (Sensitive Fern)

TABLE 4. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
4.60—4.69	1	Wa	6.50—6.59	2	Vb (2)
4.70—5.29	0	.....	6.60—6.69	1	Vb
5.30—5.39	2	Wh (2)	6.70—6.89	0	.....
5.40—5.59	0	.....	6.90—6.99	1	M
5.60—5.69	1	Wh	7.00—7.19	0	.....
5.70—5.79	0	.....	7.20—7.29	1	M
5.80—5.89	1	Wc	7.30—7.39	1	M
5.90—5.99	0	.....	7.40—7.49	0	.....
6.00—6.09	2	Vb, Wc	7.50—7.59	3	M (3)
6.10—6.29	0	.....	7.60—7.69	1	M
6.30—6.39	1	Y	7.70—7.79	0	.....
6.40—6.49	1	Vb	7.80—7.89	1	M

Range pH 7.89-4.62 Ave. pH 5.78
Number of specimens 20 Number of stations and substations 6

Discussion and Conclusions

There are some notable works in the field of soil reaction pertaining to the reactions of the fern soils. Among these works are those of Wherry, Craw, and Robinove and La Rue. It seems fitting to compare the data obtained by the above writers with the data which were secured in this investigation.

In Table 42 a comparison of the species found both in the data given in Craw's papers and in the data of this investigation is made;

Thelypteris palustris (Salisb.) Schott. var. pubescens (Lawson) Fernald

TABLE 5. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
5.50—5.59	1	Wb	7.40—7.49	0	.....
5.60—5.79	0	.....	7.50—7.59	1	Va
5.80—5.89	1	Wb	7.60—7.69	0	.....
5.90—5.99	1	Wb	7.70—7.79	1	Va
6.00—6.69	0	.....	7.80—7.89	1	Va
6.70—6.79	1	Va	7.90—7.99	0	.....
6.80—7.09	0	.....	8.00—8.09	1	Va
7.10—7.19	1	Va	8.10—8.19	0	.....
7.20—7.29	0	.....	8.20—8.29	1	Va
7.30—7.39	2	Va (2)			

Range pH 8.26-5.53 Ave. pH 6.96
Number of specimens 12 Number of stations and substations 2

Thelypteris noveboracensis (L.) Nieuwl. (New York Fern)

TABLE 6. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
3.90—3.99....	1	U	5.90—5.99....	1	Wa
4.00—4.19....	0	.....	6.00—6.09....	0	.....
4.20—4.29....	1	CC	6.10—6.19....	2	Ra, Sb
4.30—4.69....	0	.....	6.20—6.29....	1	T
4.70—4.79....	4	Wa,Wc,CC,Wf	6.30—6.39....	1	We
4.80—4.89....	1	BB	6.40—6.59....	0	.....
4.90—4.99....	3	Sb, Na, AA	6.60—6.69....	1	Wc
5.00—5.09....	1	U	6.70—6.79....	1	T
5.10—5.19....	3	T, U, CC	6.80—6.99....	0	.....
5.20—5.29....	1	Wa	7.00—7.09....	1	Ra
5.30—5.39....	1	Wa	7.10—8.19....	0	.....
5.40—5.89....	0	.....	8.20—8.29....	1	T

Range pH 8.29-3.98 Ave. pH 4.76
Number of specimens 25 Number of stations and substations 10

Photograph by Dr. Jesse M. Shaver.

Fig. 2. Large *Athyrium angustifolium* in the trough of a north-facing ravine, *Station Rd,* Davidson County, Tenn.

Thelypteris marginalis (L.) Nieuwl. (Leather Woodfern)

TABLE 7. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
4.10—4.19....	2	CC (2)	5.80—6.09....	0	.....
4.20—4.29....	0	.....	6.10—6.19....	1	Sa
4.30—4.39....	1	CC	6.20—6.99....	0	.....
4.40—4.49....	0	.....	7.00—7.09....	2	Z (2)
4.50—4.59....	1	Sb	7.10—7.19....	1	Rb
4.60—4.69....	0	.....	7.20—7.49....	0	.....
4.70—4.79....	1	Sa	7.50—7.59....	1	Rb
4.80—5.39....	0	.....	7.60—7.69....	1	Rb
5.40—5.49....	1	BB	7.70—7.79....	0	.....
5.50—5.69....	0	.....	7.80—7.89....	2	Rb, T
5.70—5.79....	1	T			

Range pH 7.87-4.11 Ave. pH 4.78
Number of specimens 15 Number of stations and substations 7

there are twenty such species. Nine species present in this investigation were not studied by Craw. These species were compared with data obtained from Wherry (1920b, 1927a). Craw's table contains data from Robinove and La Rue (1928) and Wherry (1920a, 1921).

The data are presented (Table 42) 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

Thelypteris Goldiana (Hooker) Nieuwl. (Goldie Fern)

TABLE 8. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
6.50—6.59....	1	Z	7.20—7.29....	0	.....
6.60—6.99....	0	.....	7.30—7.39....	1	Z
7.00—7.09....	1	T	7.40—7.59....	0	.....
7.10—7.19....	1	T	7.60—7.69....	1	T

Range pH 7.63-6.50 Ave. pH 7.07
Number of specimens 5 Number of stations and substations 2

Thelypteris spinulosa (O. F. Muell.) Nieuwl. var. americana (Fischer) Weatherby (Toothed Woodfern)

TABLE 9. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
4.10—4.19	1	DD	4.70—5.09	0	.....
4.20—4.39	0	.....	5.10—5.19	2	CC (2)
4.40—4.49	2	CC, DD	5.20—6.79	0	.....
4.50—4.59	0	.....	6.80—6.89	1	T
4.60—4.69	1	CC			

Range pH 6.87-4.13 Ave. pH 4.58
Number of specimens 7 Number of stations and substations 3

Photograph by Dr. Jesse M. Shaver.

Thelypteris spinulosa (O. F. Muell.) Nieuwl. var. intermedia (Muhl.) Nieuwl. (Common Woodfern)

TABLE 10. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
4.50—4.59....	3	T (2), CC	5.30—5.39....	1	T
4.60—4.69....	1	CC	5.40—6.79....	0	.....
4.70—5.29....	0	.....	6.80—6.89....	1	T

Range pH 6.80-4.51 Ave. pH 4.72
Number of specimens 6 Number of stations and substations 2

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 in-

Thelypteris hexagonoptera (Michx.) Weatherby (Winged Beech Fern)

TABLE 11. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
4.30—4.39....	1	Wa	6.30—6.49....	0	.....
4.40—4.79....	0	.....	6.50—6.59....	1	M
4.80—4.89....	1	X	6.60—6.89....	0	.....
4.90—4.99....	1	Re	6.90—6.99....	1	Re
5.00—5.09....	0	.....	7.00—7.09....	2	Ka, T
5.10—5.19....	2	We, X	7.10—7.19....	2	Re, X
5.20—5.49....	0	.....	7.20—7.29....	1	M
5.50—5.59....	4	Ra, Wa, We, X	7.30—7.39....	0	.....
5.60—5.69....	0	.....	7.40—7.49....	1	Re
5.70—5.79....	1	Ra	7.50—7.59....	4	M, Ra, T (2)
5.80—6.19....	0	.....	7.60—7.79....	0	.....
6.20—6.29....	2	Ka, M	7.80—7.89....	1	T

Range pH 7.80-4.35 Ave. pH 5.42
Number of specimens 25 Number of stations and substations 11

Fig. 3. A large mat of *Comptosorus rhizophyllus* hanging over the edge of a small bluff by the Little Marrowbone Creek, Davidson County, Tenn.

Polystichum acrostichoides (Michx). Schott. (Christmas Fern)

TABLE 12. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
4.70—4.79	1	X	6.70—6.79	2	Ra, T
4.80—4.89	2	Ra, CC	6.80—6.89	3	Ja, Re, Z
4.90—4.99	0	.....	6.90—6.99	0	.....
5.00—5.09	1	Wb	7.00—7.09	2	Ka, M
5.10—5.19	0	.....	7.10—7.19	0	.....
5.20—5.29	1	CC	7.20—7.29	2	Ka, N
5.30—5.39	1	H	7.30—7.39	0	.....
5.40—5.49	0	.....	7.40—7.49	5	G(2),M(2)? Re
5.50—5.59	2	G, Wa	7.50—7.59	1	Ka, N
5.60—6.09	0	.....	7.60—7.69	1	N
6.10—6.19	1	N	7.70—7.79	1	Ka
6.20—6.29	2	Kb, M	7.80—7.89	1	Re
6.30—6.39	1	Wb	7.90—7.99	0	.....
6.40—6.49	3	J (2) M	8.00—8.09	1	Ja
6.50—6.59	5	Ka,M,N,Wa(2)	8.10—8.19	1	G
6.60—6.69	2	Jb, Ka			

Range pH 8.14-4.71 Ave. pH 5.78
Number of specimens 42 Number of stations and substations 16

vestigator. 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.

Dennstaedtia punctilobula (Michx.) Moore (Hay-scented Fern)

TABLE 13. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
3.40—3.49	1	CC	5.00—5.09	3	AA (2), CC
3.50—4.59	0	.....	5.10—5.39	0	.....
4.60—4.69	1	AA	5.40—5.49	1	BB
4.70—4.79	1	CC	5.50—5.59	0	.....
4.80—4.89	0	.....	5.60—5.69	1	BB
4.90—4.99	1	CC			

Range pH 5.60-3.45 Ave. pH 4.31
Number of specimens 9 Number of stations and substations 4

Athyrium angustifolium (Michx.) Milde (Narrowleaf Spleenwort)[2]

TABLE 14. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
7.00—7.09	1	M	7.70—7.79	0	.....
7.10—7.19	1	T	7.80—7.89	1	N
7.20—7.49	0	.....	7.90—7.99	1	Re
7.50—7.59	2	N (2)	8.00—8.09	0	.....
7.60—7.69	3	N, Re, T	8.10—8.19	2	Ra, M

Range pH 8.17-7.07 Ave. pH 7.79
Number of specimens 11 Number of stations and substations 5

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.

Athyrium acrostichoides (Sw.) Diels. (Silvery Spleenwort)

TABLE 15. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
4.70—4.79	1	CC	7.00—7.09	2	Ra, T
4.80—5.39	0	.....	7.10—7.19	1	Re
5.40—5.49	1	CC	7.20—7.29	0	.....
5.50—6.69	0	.....	7.30—7.39	1	T
6.70—6.79	1	Re	7.40—7.49	2	Re (2)
6.80—6.89	0	.....	7.50—7.79	0	.....
6.90—6.99	1	Re	7.80—7.89	1	Re

Range pH 7.82-4.79 Ave. pH 5.78
Number of specimens 11 Number of stations and substations 4

[2]The writer has retained the fern common names of the books, as indicated earlier in this paper, despite the inappropriateness of many of them (Wherry, 1935, pp. 63-64).

Athyrium asplenioides (Michx.) Desv. (Lowland Lady Fern)

TABLE 16. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
4.10—4.19	1	Wa	6.30—6.59	0	.....
4.20—4.29	2	T, Wa	6.60—6.69	1	M
4.30—4.49	0	.....	6.70—6.79	0	.....
4.50—4.59	3	Wb, CC (2)	6.80—6.89	2	M (2)
4.60—4.69	1	Wa	6.90—6.99	1	M
4.70—4.79	2	Wa (2)	7.00—7.09	1	M
4.80—4.89	2	X, Wa	7.10—7.19	4	M, Ra (2), Z
4.90—4.99	0	.....	7.20—7.29	0	.....
5.00—5.09	1	AA	7.30—7.39	1	N
5.10—5.19	0	.....	7.40—7.49	2	M, Re (2)
5.20—5.29	2	X, CC	7.50—7.59	0	.....
5.30—5.49	0	.....	7.60—7.69	1	N
5.50—5.59	2	Wa, Wc	7.70—7.79	1	N
5.60—5.69	0	.....	7.80—7.89	1	Rb
5.70—5.79	1	We	7.90—8.19	0	.....
5.80—5.89	1	Wa	8.20—8.29	1	N
5.90—5.99	1	Re	8.30—8.39	0	.....
6.00—6.09	1	We	8.40—8.49	1	N
6.10—6.19	0	.....	8.50—8.59	1	N
6.20—6.29	1	Z	8.60—8.69	1	N

Range pH 8.63-4.18 Ave. pH 5.07
Number of specimens 40 Number of stations and substations 13

Camptosorus rhizophyllus (L) Link (Walking Fern)

TABLE 17. *Soil acidity*

pH	Frequency of Occurrence	Stations and Substations	pH	Frequency of Occurrence	Stations and Substations
6.50—6.59	1	Ra	7.50—7.59	0	.....
6.60—6.69	0	.....	7.60—7.69	1	N
6.70—6.79	1	T	7.70—7.79	1	Rb
6.80—6.89	0	.....	7.80—7.89	0	.....
6.90—6.99	1	T	7.90—7.99	1	N
7.00—7.39	0	.....	3.00—8.49	0	.....
7.40—7.49	2	Ra, T	3.50—8.59	1	N

Range pH 8.50-6.55 Ave. pH 7.88
Number of specimens 9 Number of stations and substations 4

(To be continued in the January Journal)