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A PRELIMINARY STUDY OF THE FERNS ON THE LIMESTONE BLUFFS OF NORRIS LAKE

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ABSTRACT

The shore line of Norris Lake presents an abundance of unusual microclimates. This preliminary study of a limited area of this shore line reports fifteen species and/or varieties of ferns. Seven of these are reported for the first time in Campbell and Union counties in Tennessee. The adaptability of ferns to a variety of habitats (altitudes, temperatures, pH ranges, etc.) has led to some unusual traits, e.g., natural hybridizations between genera and species, with some of the hybrids producing viable spores, and an array of morphological variations within species. Two genera, *Asplenium* and *Camptosorus*, are abundant in the area and are outstanding in these traits. The xerophytic, mesophytic and hydrophytic nature of various fern species is well demonstrated in the area.

INTRODUCTION

Norris Lake is a multipurpose reservoir which was constructed between 1933 and 1936 by the Tennessee Valley Authority, an agency of the Federal Government created in 1933. This study is intended to be the beginning of an extensive investigation of the primitive vascular plants, especially the ferns, in the habitats created and made more accessible by the impoundment.

The storage capacity of Norris Lake is 2,281,000 acre-feet. Its shore line extends 800 miles and includes parts of Anderson, Campbell, Union, Cailborne, and Grainger Counties in Northeastern Tennessee. From the dam at Norris, the lake extends 72 miles up the Clinch River and 56 miles up the Powell River. These two rivers converge 9 miles above the dam. The shore line at spillway crest is at 1020 feet above sea level. The area between 1020 and 1040 feet above sea level is restricted so that there are no permanent buildings, therefore there is little human disturbance of the biota of this zone. My study area lies principally within this 1020-1040 belt.

The Norris Lake basin is well within an area into which, according to Small (1938) and Svenson (1941), plants migrated from three sources: the temperate-boreal region to the north, the vast antillean tropical reservoir to the south, and the Cumberland Plateau to the west. The variety of highly favorable habitats for the primitive vascular plants supports an abundance of species and varieties in this group. There are numerous valleys, ridges, and coves with a more humid atmosphere than would occur in an undissected area. Undoubtedly, also, a more humid atmosphere is provided by the impoundment of the two rivers producing two million acres of water surface. To my knowledge, no previous studies of the fern flora in this area have been done, therefore the effect of impoundment is unknown.

According to Shaver (1954), who used Fenneman's (1938) geological classification, the Norris Lake basin is a part of two provinces. A small portion is in the Appalachian Plateau, but most of it is located in the Valley and Ridge Province. The drainage basins of some of the larger tributaries of the lake are within the southern tip of the Cumberland Mountain section of the Appalachian Plateau Province. Shaver (1954) also reported that the climate of this basin is much like that of Northern Michigan and that the soils of the higher mountains are underlaid with a variety of rocks, e.g., slates, gneisses and mica schists. The intermediate area between the higher mountains and valleys have marbles and conglomerates. The Tennessee Valley in this section is underlaid with limestone, dolomite, and marble. The Valley and Ridge Province is rich in ferns because much of the soil is underlaid with limestone with many outcrops along the streams and ridges. Cultivation in the study area is restricted by the Tennessee Valley Authority. The Appalachian Plateau Province is dissected with streams, sometimes with rock-walled gorges, waterfalls, and small swampy areas and is underlaid with a clay subsoil and limestone rock. Therefore, the student of ferns and allied plants has a great number of habitats available for study.

MATERIALS AND METHODS

Rogers' Marina was used as the base station for the study which was carried out during the months of June, July, August, and September, 1967. During this time, Norris Lake fluctuated between the elevations of 1010 feet and 1019 feet, the highest it had been since 1958. This made it convenient to reach the various stations by boat.

The very limited area of Norris Lake that this study includes is shown on Figure I. This drawing including the legend characters was modified from a recreation map printed and distributed by the Tennessee Valley Authority. The study area was limited to the large and prominent limestone bluffs between the elevations of 1020 feet and 1040 feet above sea level along a twenty mile section of Davis Creek and Powell River. Within this distance twenty-one limestone bluffs were examined. These bluffs will be referred to hereafter as stations. Even numbered ones appear on the west side of the lake and the odd numbered ones on the east side. Only the ferns were collected. Collections were made from the surface of, the crevices of, and the bases of the limestone bluffs. The Herbarium of the Mid-Appalachia College Council's Teaching and Research Center of Route 2, LaFollette, Tennessee, is the depository for all of the mounted material of this study.

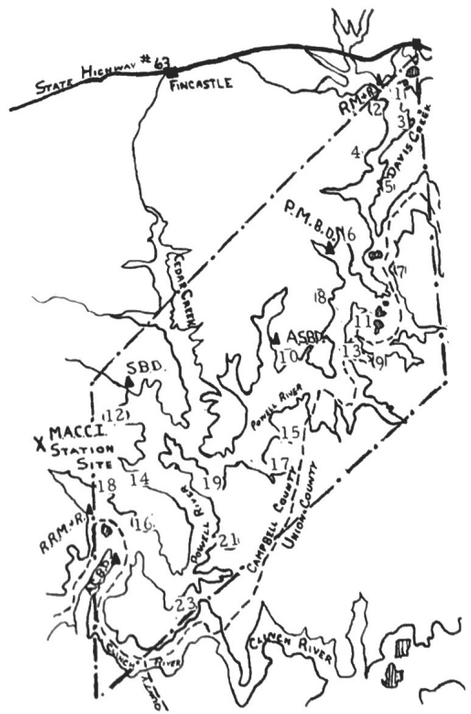

Fig. 1. Map of the area of study showing locations of study stations (numerals). A. C. B. D, Anderson County Boat Dock; A. S. B. D., Alder Springs Boat Dock; M. A. C. C. I., Mid-Appalachian College Council, Inc.; P. M. B. D., Powder Mill Boat Dock; R. M. & R., Roger's Marina and Resort; R. R. M. R., Rainbow Richlands Marina and Resort; S. B. D., Shanghai Boat Dock.

In the field the Preliminary Keys of the Genera and Species of Tennessee Ferns by Sharp (1955) and the field guide by Wherry (1942) were used. Wherry (1942) listed seventeen species of ferns to be found on limestone or circumneutral gravel.

RESULTS

Table I is an alphabetical listing by scientific name of the fifteen species or varieties included in this study and is a general summary of my findings. The first two columns show the species reported by Shaver (1954) in Campbell and Union Counties. The two middle columns show the species reported by me for the first time in these two counties. The last column shows estimates of the relative abundance of the species studied. A species was considered abundant if it was found at 70% or more of the stations studied, common if found at 30%-60%, and rare below 30%.

DISCUSSION

According to Small (1938), the temperate-boreal source has so generously supplied the lower part of the Blue Ridge with ferns that this province can claim only about six endogenous species. Since the Blue Ridge Province is immediately east and slightly north of the Norris Lake basin, most of the ferns in this area migrated southward from the temperate-boreal region (Small, 1938). He also reports that the Antillean tropics have made Peninsular Florida the richest fern area, and that these ferns are slowly migrating northward. Accordingly, the fern assemblage of the southeast represents well over fifty percent of the fern taxa found in the United States and Canada.

Svenson (1941) reported some interesting observations from ten years of plant collecting. One relating to the Norris Lake area is that the Cumberland Plateau, slightly west of this lake area, is mentioned as the place of origin of plants of the Atlantic Coastal Plain. A second is that even though the Coastal Plain Province is separated from the Highland Rim Province to the west by a wall of limestone and sandstone about one thousand feet high, the Cumberland Plateau, the flora is much the same in both provinces. Evidence like this, which would indicate the probable east-west migrations of flora, along with Small's evidence of north-south migration, make the prospect of extensive studies of the various plant groups here most exciting.

A survey of the ferns of Tennessee that was limited to limestone outcroppings was done by Endsley (1937) in parts of Decatur and Hardin Counties, south and west of the Norris Lake area. He lists eight of the species reported here. I find two items of interest in Endsley's report. First, *Cheilanthus alabamensis* was abundant in some areas, whereas I found this species to be rare in my study area. Second, no *Polypodium virginianum* was reported by him, but I found this species at two stations.

Perry (1962) reported five new stations for ferns in Washington County, Tennessee, to the northeast of my study area. The significant information here is that two species in my list, *Polypodium polypodioides* and *Polypodium virginianum*, were found in the crevices of dry sandstone ledges at elevations ranging from 1800 feet to 2100 feet. Apparently these two species are adaptable to calcareous or silicious substrates with a wide range of altitudes.

Pellaea glabella was reported by Sharp (1937) from near Morristown, Tennessee, in Hamblin County, and from Maxey's Bluff in Knox County. These two counties are east and south of Norris Lake. In the same report, Sharp mentions this species as being observed at Cumberland Falls, Kentucky, an area where the rock formations are mostly sandstone and conglomerate. This area is north of Norris Lake.

In a rather extensive ecological study on a section of the edge of the Highland Rim Province near Nashville, Davidson County, Tennessee, Frick (1939) lists four species of the *Polypodiaceae* that are included in this report. They are *Polystichum acrostichoides*, *Asplenium platyneuron*, *Pellaea atropurpurea*, and *Adiantum pedatum*. These species were all found in the rock outcrops

TABLE I

Scientific Name	Previously Reported		First Time Reported		Relative Abundance
	1*	2*	1	2	
Adiantum pedatum	x*	x	o*	o	R
Asplenium platyneuron	x	x	o	o	C
Asplenium platyneuron var. *incisum*	o	o	o	x	R
Asplenium resiliens	x	x	o	o	C
Asplenium Ruta-muraria var. *cryptolepis*	o	o	x	x	A
Asplenium Ruta-muraria var. *ohionis*	o	o	x	o	R
Asplenosorus ebenoides	x	x	o	o	C
Camptosorus rhizophyllus	x	x	o	o	C
Cystopteris bulbifera	x	x	o	o	A
Chelianthus alabamensis	o	o	x	o	R
Pellaea atropurpurea	x	x	o	o	A
Pellaea glabella	o	o	x	o	R
Polypodium polypodioides var. *Michauxianum*	x	x	o	o	C
Polypodium virginianum	x	x	o	o	R
Polystichum acrostichoides	x	x	o	o	C

*1—Campbell County
*2—Union County
*x—Yes
*o—No

**A—Abundant
C—Common
R—Rare

of the Chattanooga black shale typical of the Highland Rim, whereas in my study area the predominating soil type is chert. His studies of succession on the slope edging the Highland Rim indicates that ferns reported in this study are adapatable to a variety of habitats and moisture regimes.

Shaver (1954) reported only two stations for *Polypodium virginianum* in Campbell and Union Counties. I report two additional stations in these two counties for this species. Perhaps then one would not expect to find *Polypodium virginianum*, except rarely, in or near limestone bluffs where the pH would likely be circumneutral or alkaline. Shaver doesn't mention whether his collections at one station in each of the two counties were near limestone or sandstone. The Campbell County station was near the Scott County line and the Union County station was near Luttrell.

It should be noted that *Asplenium Ruta-muraria* var. *ohionis* was found at one station in this study area. Shaver (1954) reported it as having been collected near Knoxville, Tennessee by A. Ruth in 1895. To my knowledge, this is the second time it has been reported in the state. Verification of my specimen was done by the Curator of the University of Tennessee Herbarium.

My last major point of emphasis concerns various hybridizations among ferns. One known hybrid is reported in Table I, *Asplenosorus ebenoides*, a cross between *Asplenium platyneuron* and *Camptosorus rhizophyllus*. Several authors have written about this hybrid: Mason and Hoyt as reported by Shaver (1954) and R. R. Scott and Wherry as reported by Murrill (1947).

According to Wherry (1942) *Asplenosorus ebenoides* was discovered in Pennsylvania by R. R. Scott in 1865. It inhabited crevices of shaded rocks in association with the parent species. The soil reaction was circumneutral or subacid, and the reported range was Vermont to Missouri and Hale County, Alabama—occasionally in the uplands. Wherry claimed that since it produces viable spores it should be considered a species.

Murrill (1947) claims the discovery of *Asplenosorus evenoides* near Blacksburg, Virginia, in 1896. He reports it among a list of Virginia ferns and includes it in his taxonomic keys. Shaver (1954) gave Wherry the credit for redescribing this species, and reported it from Campbell, Davidson, Franklin, Grundy, and Smith Counties. Small (1938) gave credit to R. R. Scott for the discovery of *Asplenosorus ebenoides* along the banks of the Schuylkill River near Philadelphia, Pennsylvania. He reported it as invariably associated with its parents and attributed its origin to hybridizations.

A single plant of this species at one station in Union County was found by Mrs. Eunice Bailey. Repeated searches at this station have not produced additional plants; nor has extensive search produced any sign of one of the parents of this species, *Camptosorus rhizophyllus*, possible evidence of the viability of the spores of this hybrid.

Within the genus *Asplenium*, Wherry (1942) reported seven known hybrids. The viable hybrid species, *Asplenosorus ebenoides*, indicates hybridization between the genera *Asplenium* and *Camptosours*, so it seems to me that there are good opportunities to study hybridizations of species or genera in the Norris Lake area, since both of the above-mentioned genera are plentiful in the area studied. There are also numerous varieties available in the study area. Table I lists the ones that are reported here.

In summary, it seems apparent that studies of hybridizations and varieties among the species of several genera would be fruitful in the Norris Lake area.

The author gratefully acknowledges his indebtedness to Dr. A. Randolph Shields, Director of the Mid-Appalachia College Council's Teaching and Research Center on Norris Lake, for suggesting this study, as well as offering timely suggestions during the initial phases of the work. Thanks are also due my wife, Eunice, and my daughter, Joyce, for their assistance. Joyce also did the drawing for Figure I . Miss Sandra Keck, herbarium assistant at Lincoln Memorial University, helped mount the specimens.

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