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A Faunal Analysis of the Springs of the Ouachita Mountains, Arkansas

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ABSTRACT

A FAUNAL ANALYSIS OF THE SPRINGS OF
THE OUACHITA MOUNTAINS, ARKANSAS

Spring ecosystems in Arkansas have historically received little attention. A faunal survey was made of 33 springs located in the core area Ouachita Mountains physiographic province. The study area was 135 x 80 km extending west from Hot Springs, Arkansas to the Oklahoma line. Springs in the Ouachita Mountain physiographic province were characterized as generally faunistically poor with often a single species such as the isopod, Lirceus h. hoppinae, being the dominant faunal element both numerically and with regard to biomass. A total of 40 species of invertebrate species and eight vertebrate species were collected from the spring environs during the study. In addition, five invertebrate species (two amphipods and three caddisflies) were gleaned from a thorough literature search for a total of 53 species of aquatic invertebrates and vertebrates documented from springs in Ouachita Mountain physiographic province.

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KEYWORDS -- springs/ groundwater/ Ouachita Mountains/ aquatic faunal studies/ aquatic invertebrates/ aquatic vertebrates/ aquatic ecology/ Arkansas

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INTRODUCTION

Spring ecosystems in the United States have received relatively little attention from scientific investigators. Community metabolism in a temperate cold spring in Massachusetts was investigated by Teal (1957) while Odum (1957) studied trophic structure and productivity in his classic study of Silver Springs, Florida. Later, Tilly (1968) investigated the structure and dynamics of Cone Spring in Iowa, while closer to home, Stern and Stern (1969) conducted a limnological study of a Tennessee cold springbrook. Recently, Rayburn and Freeze (1978) studied a single Kentucky spring. Unfortunately, in Arkansas, no systematic and comprehensive study of the multitudinous springs and their associated fauna has been attempted to date. References to the state spring fauna are scattered, cursory and uneven in their treatment of the concomitant faunal components (Hubricht, 1943, 1950; Ross, 1938, 1941; Ross and Unzicker, 1965; Williams, 1954; Hubricht and Mackin, 1949; Steeves, 1966; Holsinger, 1967). Most are directed at a particular taxonomic group such as caddisflies (Trichoptera) or amphipods, for example.

It seemed judicious to undertake such a needed comprehensive examination of Arkansas springs, beginning with those situated in the Ouachita Mountain physiographic province for which baseline water quality data has been recently gathered by Wagner and Steele (1980). This study is the first part of a comprehensive examination of the springs of Arkansas by the writer. A statewide ecological survey of springs is needed as each spring is itself a unique aquatic microhabitat. Small springs afford as nearly perfect systems for the study of lotic communities as occur in nature

(Stern and Stern, 1969). Because of the uniqueness of springs, many species may be present far outside their normal geographical range because of the uniform physicochemical conditions often encountered or a spring may harbor relict species, phreatics or crenobionts (Hynes, 1976).

This investigation was initiated to detail and analyze the faunal components of the small springs which occur so profusely throughout the Ouachita Mountains physiographic province of the Interior Highlands of Arkansas. Water chemistry of the majority of these springs was detailed previously by Wagner and Steele (1980).

DESCRIPTION OF THE STUDY AREA

Foti (1974) presented an excellent portrait of the Ouachita Mountain physiographic province and it is summarized here. The Ouachita Mountain physiographic province is approximately 200 miles in length (east-west) and 100 miles in width (north-south) and lies in westcentral Arkansas and eastern Oklahoma. This area is bordered by the Arkansas River Valley to the north, the Gulf Coastal Plain on the south and east, and the Central Lowlands to the west.

The Ouachita Mountains are basically characterized by a series of east-west trending ridges and valleys that have resulted from the extensive folding and faulting of sedimentary strata of Paleozoic age. Uplift represents only a minor part in their formation. Only the southernmost part of the Ouachitas is simply an uplifted plateau. The rocks of the province range in age from the Cambrian or Ordovician through Pennsylvanian. Dominant rock types are sandstones, shales, and novaculite, although limestones, conglomerates and volcanic sediments are also present. Typically,

the Ouachitas are covered with a mixed Shortleaf-Pine-upland hardwood forest.

The study area was contained within a 135 X 80 km geographic area extending west from Hot Springs, Arkansas to the Oklahoma line and located north of the 34°42'30" N. latitude line as outlined previously by Wagner and Steele (1980). Basically the area encompassed the core of the Ouachita Mountains. Figure 1 shows the study area and the sites of the 33 springs examined.

METHODS AND MATERIALS

The basic thrust of the research was to document as fully as possible the aquatic or semi-aquatic animals utilizing the springs of the Ouachita Mountain physiographic province of the Interior Highlands of Arkansas. Many of these same springs were the subject of a water chemistry investigation by Wagner and Steele (1980). Springs were originally located with the aid of the USGS topographic maps, Wagner and Steele (1980), and discussions with local residents and individuals familiar with specific areas of spring concentrations. Table 1 lists the locations of the 33 springs sampled in the present study. In addition, in an effort to more completely document the fauna of the springs of the Ouachtia Mountains in Arkansas, literature records of animals collected from springs in the study area are included. These are noted as such.

Collecting of springs was accomplished by a variety of methods including seining, sampling with aquatic dip nets (Turtox D-frame), hand nets, turkey basters, tea strainers and a Surber sampler over a wide variety of microhabitats within individual spring ecosystems. A drift net was also used.

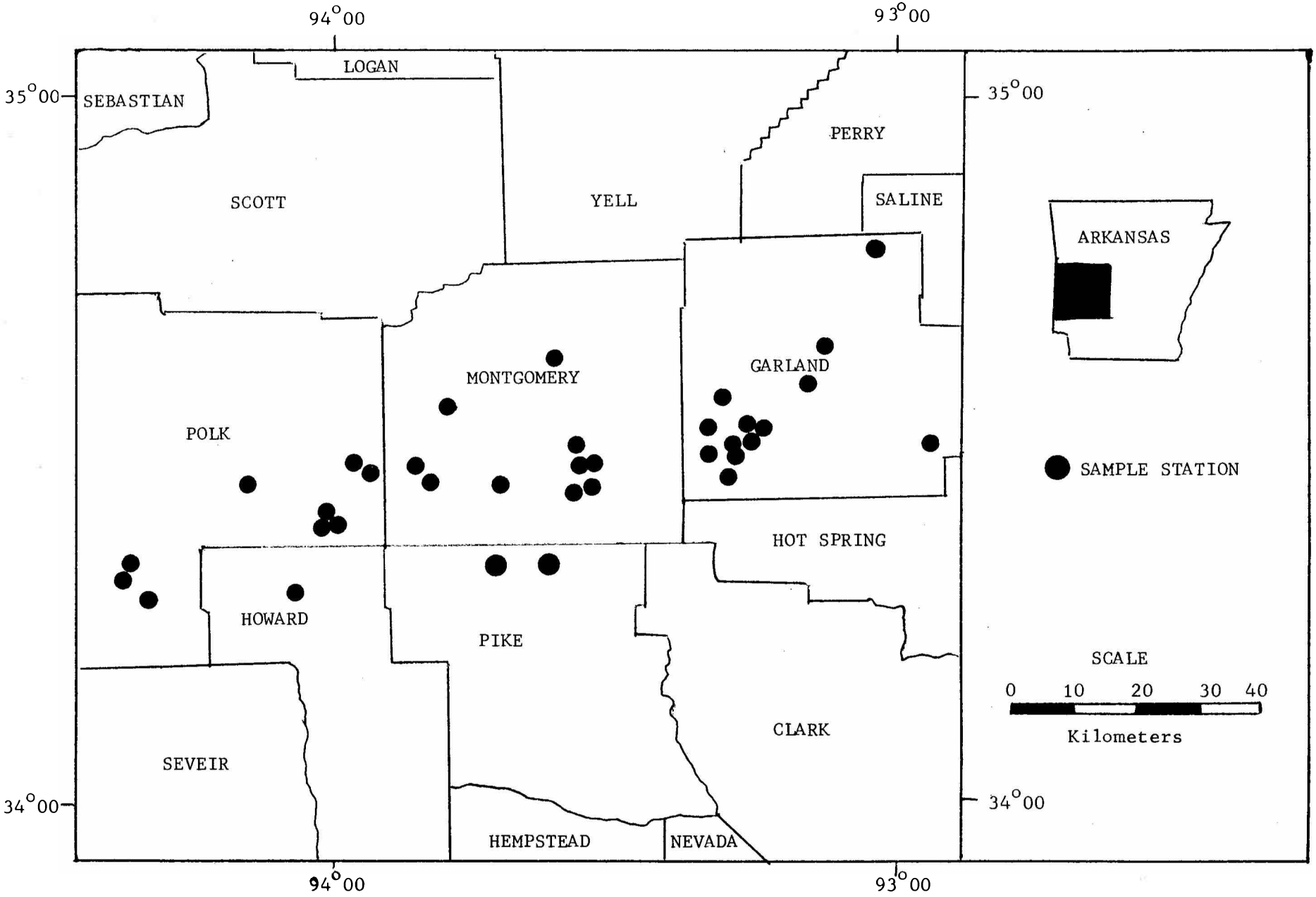

Figure 1. Map of the Ouachita Mountain Physiographic Province and Springs Sampled.

TABLE 1. Springs Sampled in the Ouachita Mountain Physiographic Region.

	Spring Name	Location
	Garland County	
1.	Meyer's Spring	Sec. 17, T2S, R22W
2.	Unnamed Spring	Sec. 25, T2S, R18W
3.	Crystal Springs	Sec. 34, T2S, R22W
4.	Rock Springs	Sec. 3, T1S, R21W
5.	Unnamed Spring	Sec. 29, T1S, R20W
6.	Iron Spring	Sec. 6, T1N, R19W
7.	Mayberry Spring	Sec. 36, T1S, R22W
8.	Unnamed Spring	Sec. 17, T2S, R22W
9.	Unnamed Spring near Crystal Springs	Sec. 33, T2S, R22W
10.	Hidden Spring	Sec. 20, T2S, R21W
11.	Bear Spring	Sec. 29, T2S, R21W
	Pike County	
12.	Dripping Springs	Sec. 11, T5S, R25W
13.	Redland Mountain	Sec. 12, T5S, R26W
	Montgomery County	
14.	Ida Sublette Cobb Spring	Sec. 13, T4S, R25W
15.	Sulfur Spring	Sec. 9, T3S, R27W
16.	Collier Spring	Sec. 17, T3S, R24W
17.	Black Spring	Sec. 30, T3S, R25W
18.	Buttermilk Spring #1	Sec. 6, T4S, R24W
19.	Buttermilk Spring #2	Sec. 6, T4S, R24W
20.	Strawn Springs	Sec. 18, T4S, R24W
21.	West Spring	Sec. 2, T2N, R25W
22.	Unnamed Spring	Sec. 31, T2S, R26W
23.	Unnamed Spring	Sec. 26, T3S, R27W
	Polk County	
24.	Twin Springs	Sec. 10, T5S, R32W
25.	Bogg Springs	Sec. 16, T5S, R32W
26.	Unnamed Spring	Sec. 22, T5S, R32W
27.	Gillham Springs	Sec. 21, T4S, R30W
28.	Bard Springs	Sec. 22, T4S, R38W
29.	Abernathy Springs	Sec. 24, T3S, R28W
30.	Unnamed Spring	Sec. 32, T3S, R29W
31.	Unnamed Spring	Sec. 23, T3S, R28W
32.	Unnamed Spring	Sec. 20, T4S, R28W
	Howard County	
33.	Unnamed Spring	Sec. 33, T5S, R29W

Collections were also taken by hand picking from stones, leaf packets, and aquatic vegetation. Since qualitative analysis of the springs was deemed of more importance than quantitative measurements in this initial research effort on these little known aquatic ecosystems, the aforementioned collecting methods seemed to suffice quite nicely to provide the desired qualitative data.

Invertebrates were preserved in 80 percent isopropyl alcohol in the field for permanent storage. Fishes were killed in 10 percent formalin. Amphibians and reptiles were preserved in 40 percent isopropyl. All organisms were returned to Southern Arkansas University and sorted and identified to the lowest possible taxon. Fishes were washed for three days, and placed in 40 percent isopropyl alcohol for permanent storage. Following preliminary identification, representative specimens were sent to specialists in the various invertebrate taxonomic groups for positive identification.

Prelimianry identifications of invertebrates were accomplished with the use of Pennak (1953), Merritt and Cummins (1978), and Wiggins (1977).

Although the collection methods did not yield absolute numerical results, they did permit the determination of relative abundance of the more commonly occurring taxa. Species were thus ranked arbitrarily as rare when fewer than 10 specimens were collected, common when 10-50 specimens were taken and abundant where more than 50 specimens were collected.

ACKNOWLEDGEMENTS

Because of the broad taxonomic approach to this study, the expertise of a number of specialists was necessary in the identification of particular taxa. I greatly appreciate the assistance of the following individuals:

Dr. G. L. Harp, Arkansas State University (aquatic insects); Dr. Michael S. Loden, Louisiana State University (aquatic oligochaetes); Mr. Jerry Lewis, University of Louisiana and Dr. Thomas Bowman, Smithsonian Institution (isopods); Dr. John R. Holsinger, Old Dominion University (amphipods), Dr. Paul D. Kittle, North Alabama University (Gerridae, Vellidae), and Dr. Roman Kenk, Smithsonian Institution (planarians).

DISCUSSION

The Spring Habitat

A spring is defined in this study as concentrated ground water issuing at the surface as a current of flowing water (Tolman, 1937). Most of the springs studied were small. Springs represent a truly unique ecological habitat. The spring habitat is generally characterized by uniform temperatures and clear, poorly oxygenated, unpolluted water displayed in a lack of species diversity due primarily to the concomitant absence of a variety of ecological niches. This reduction in niches is due to the constant or more stable environmental factors characteristic of most springs (Armstrong and Williams, 1971). Although characteristically depauperate in species diversity, mountain springs exhibit unusual, often endemic flora and fauna contained in these aquatic habitats. Many rare plant species are restricted solely to spring environs. While animals such as fishes, salamanders, flatworms, amphipods and isopods frequent springs, most are secretive and thus rarely seen. Certain faunal members manifest unique adaptations to the springs environment in which they live. For example, blindness, loss of pigmentation and/or reduction of certain sensory modalities (e.g.,

lateral line system and barbels in fishes) are several of these interesting adaptations developed by spring inhabitants.

Water Quality

A brief summary of water quality of the springs of the Ouachita Mountains is instructive and presented here to familiarize the reader with the aquatic environment supporting the aquatic fauna investigated. The groundwater of the Ouachita Mountain physiographic province of Arkansas may be classified as a calcium bicarbonate type and generally is soft to moderately hard (Hem, 1970). Median hardness for spring samples in a recent study by Wagner and Steele (1980) was 60 ppm $CaCO_3$. The median pH values for this area is 6.2. Calcium was the major element in the spring waters due to the widespread distribution of limestone and calcaeous cements ($CaCO_3$) in sedimentary rocks and ready solubility of $CaCO_3$ in waters containing carbon dioxide (CO_2).

Prior to the initiation of this study it was felt that documentation of the fauna was imperative as soon as possible due to possible pollution of the groundwater as is occurring in northern Arkansas (Wagner and Steele, 1980). That contamination of these springs is slight is seen in the findings of Wagner and Steele (1980) who reported relatively low levels of phosphate, nitrate, and amonia. High values for these three parameters are indicative of contamination.

Wagner and Steele (1980) concluded that the water from springs in the Ouachita Mountains is potable, and the major problems are those associated with taste, corrosion and staining.

Endangered and Threatened Species

In determining the use of the terms "endangered" and/or "threatened" for this report, terminology was modified from the use of these terms by the Smithsonian Institution report on plants in the United States. Definitions are repeated here.

Endangered species are those species or subspecies in danger of extinction throughout all or a significant portion of their range in Arkansas.

Threatened species are those species or subspecies which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range in Arkansas.

Special concern are those species or subspecies which must be continually monitored because eminent degrading factors, their limited distribution in Arkansas or other physical or biological characteristics may cause them to become threatened or endangered in the foreseeable future.

Previous workers have been concerned primarily with plants and vertebrates in dealing with endangered and/or threatened species in Arkansas (Robison, 1974; Arkansas Department of Planning, 1974). In this regard, little or no work has been done on state invertebrate species to determine the status of many of these groups in Arkansas (e.g. molluscs, gastropods, etc.). Our knowledge of many groups is quite limited and workers are justifiably hesitant to put status determinations on particular species because of insufficient data on many species.

In attempting to assess the possible endangered or threatened status of various faunal taxa inhabiting spring ecosystems, it was necessary to make assumptions in some cases on the basis of discussions with other

scientists more familiar with individual invertebrate groups and/or the paucity of collections of certain species.

Vertebrates inhabiting the spring ecosystems of the Ouachita Mountains physiographic province have been studied to greater degree than invertebrates. Only the paleback darter, Etheostoma pallididorsum Distler and Metcalf, among the vertebrates collected during this study of springs is considered threatened in Arkansas based on current work by the writer. In this study E. pallididorsum was collected in several unnamed springs draining into the Caddo River and a single small specimen was taken from Black Springs, all in Montgomery County. This species is a rarely encountered inhabitant of the upper Caddo River system and occurs disjunctly in Mayberry Creek Ouachita River drainage, thus the collection of E. pallididorsum was not unexpected.

Among invertebrates collected from Ouachita Mountain springs, several may eventually need to be considered on federal threatened lists based primarily on small population size and limited distributional ranges. Heading the list for consideration is the new blind asellid isopod species, Caecidotea sp. nov., discovered during this study which only inhabits Abernathy Spring in Polk County. Until further study of this species is accomplished it should be considered of special concern.

The amphipods, Stygobromus elatus and Stygobromus montanus, certainly are in need of further study due to their endemic nature, limited distribution, and rarity in collections. Both are species of special concern and a search for other populations is continuing.

Several other specimens are in the process of being studied further as they may represent additional new species. Their status will be reported upon at a later time.

ANNOTATED FAUNAL LIST

The following list of 45 benthic macroinvertebrate (Table 2) and eight vertebrate species (Table 3) were collected from a survey of 33 springs of the Ouachita Mountain physiographic province in Arkansas. In addition to these collections, a review of the scientific literature revealed additional species previously taken from spring environs in the Ouachita Mountains. In an effort to make this study as thorough as possible in light of the paucity of data on spring ecosystems in Arkansas, all species formerly collected from springs in the Ouachita Mountain province were included in the annotated faunal list. A total of 53 species were documented from this region. All species collected in spring habitats during this study have been included in the list; however, not all species are totally confined to spring habitats. For each of the species listed below, an indication of its habitat and abundance is provided.

PHYLUM PLATYHELMINTHES - FLATWORMS

Although flatworms are among the most common and characteristic invertebrates in a cold-spring habitat (Pflieger, 1974), in the Ouachita Mountain springs flatworms were generally rare except at particular spring, e.g., Abernathy Spring, where they were locally abundant.

Family Planariidae - Planarians

Dugesia doratocephala (Woodworth). This flatworm is wide-ranging in springs and spring-fed streams throughout the Ozarks (Kenk, 1970). This species was particularly abundant in Abernathy Spring, Polk County. Live specimens were shipped to Dr. Roman Kenk, Smithsonian Institution, for positive verification.

TABLE 2. A List of the Known Benthic Macroinvertebrate Fauna of Ouachita Mountain Springs, Arkansas.*

PLATYHELMINTHES - Flatworms

Dugesia doratocephala (Woodworth), flatworm

ANNELIDA - Segmented Worms

Lumbriculidae - Aquatic earthworms

Lumbriculus inconstans, aquatic earthworm

GASTROPODA - Snails

Goniobasis sp.

ISOPODA - Isopods

Asellidae

Lirceus hoppinae hoppinae, aquatic isopod
Caecidotea sp. nov., blind asellid

AMPHIPODA - Amphipods

Crangonyctidae

Stygobromus alabamensis alabamensis (Stout)
Stygobromus elatus (Holsinger)
Stygobromus montanus (Holsinger)

DECAPODA - Decapod Crustaceans

Cambaridae - Crayfishes

Orconectes acares Fitzpatrick

EPHEMEROPTERA - Mayflies

Heptageniidae

Species A.
Stenacron interpunctatum Say

TABLE 2. Cont'd.

Baetidae

Species A.

ODONATA - Dragonflies and damselflies

Aeshnidae

Aeshna umbrosa (Walker)

Corduliidae

Neurocordulia xanthosoma? (Williamson)
Somatochlora linearis? Hagen

Libellulidae

Pachydiplax longipennis Burmeister

Calopterygidae

Calopteryx (=*Agrion*) *maculata* (Beauvois)

Cordulegastridae

Cordulegaster maculata Selys

Gomphidae

Hagenius brevistylus Selys
Ophiogomphus rupinsulensis Walsh
Libellula vibrans? Fabricius

HEMIPTERA - True Bugs

Gerridae - Water striders

Gerris remigis Say

Veliidae - Broad-shouldered water striders

Rhagovelia knighti Drake and Harris

TABLE 2. Cont'd.

MEGALOPTERA - Alderflies, Dobsonflies, and Fishflies

Corydalidae - Dobsonflies and Fishflies

Chauliodes rastricornis Rambur - Fishfly

TRICHOPTERA - Caddisflies

Rhyacophilidae

Rhyacophilia lobifera Betten

Brachycentridae

Micrasema sp.

Glossosomatidae

Agapetus medicus Ross

Philopotamidae

Chimarra feria Ross

Hydropsychidae

Cheumatopsyche sp.
Hydropsyche sp.

Helicopsychidae

Helicopsyche limnella Ross

COLEOPTERA - Beetles

Elmidae - Riffle beetles

Dubiraphia sp.

Hydrophilidae - Water scavenger beetles

Cymbiodyta sp.

TABLE 2. Cont'd.

DIPTERA - True Flies

Ptychopteridae - Phantom crane flies

Bittacomorpha sp.

Tipulidae - Craneflies

Tipula sp., cranefly
Limonia sp.

Chironomidae - Non-biting midges

Chironomus sp.
Tanypus sp.
Dichrotendipes sp.
Polypedilum sp.
Diamesia sp.
Stictochironomus sp.

Tabanidae - Horseflies

Tabanus sp., horsefly

Psychodidae - Mothflies

Pericoma sp.

Culicidae - Mosquitoes

Anopheles punctipennis

*Includes both literature references and collections made during this study.

TABLE 3. A LIST OF THE VERTEBRATE FAUNA COLLECTED FROM OUACHITA MOUNTAIN SPRINGS, ARKANSAS

CYPRINIFORMES - Minnows

Cyprinidae - Minnows and Carps

Campostoma anomalum (Rafinesque) - Stoneroller
Semotilus atromaculatus (Mitchill) - Creek chub

CYPRINODONTIFORMES - Topwater Killifishes

Cyprinodontidae - Killifishes

Fundulus catenatus (Storer) - Northern studfish

PERCIFORMES - Perches

Percidae - True Perches

Etheostoma pallididorsum Distler and Metcalf - Paleback darter
Etheostoma radiosum (Hubbs and Black) - Orangebelly darter

ANURA - Frogs and Toads

Ranidae - True Frogs

Rana sphenocephala Cope - Southern leopard frog

Hylidae - Tree Frogs

Acris crepitans blanchardi Harper - Blanchard's Cricket frog

CAUDATA - Salamanders

Plethodontidae - Lungless Salamanders

Desmognathus brimleyorum Stejneger - Ouachita dusky salamander

PHYLUM ANNELIDA - SEGMENTED WORMS

Family Lumbriculidae - Aquatic Earthworms

Lubriculus inconstans. Aquatic earthworm. Aquatic earthworms were common inhabitants in the vegetation and decaying organic matter (leaves) at the edges of spring runs. This species was taken in 12 springs during the study.

PHYLUM MOLLUSCA - MOLLUSCS

CLASS GASTROPODA - Snails

Family Pleuroceridae - River Snails

Goniobasis sp. Snails were commonly found in the outflows of springs as the outflow entered an adjacent tributary. In the Ouachita Mountains snails are excessively abundant in the clear, small streams fed by springs. A larger expanded survey of the aquatic snails of the Interior Highlands has been initiated to document this poorly known element of the Arkansas aquatic fauna.

PHYLUM ARTHROPODA - JOINT-LEGGED ANIMALS

CLASS CRUSTACEA - Crustaceans

In Ouachita Mountain springs three groups of crustaceans, including isopods, amphipods, and crustaceans, occur. Isopods are particularly abundant in many outflow regions of larger springs.

ORDER ISOPODA - Isopods

Family Asellidae - Asellids

Caecidotea sp. nov. Specimens of a blind white isopod collected from

Abernathy Springs have been determined to be an undescribed species new to science. Mr. Jerry Lewis, University of Louisville, who is completing a doctoral dissertation on Caecidotea species from the Ozark and Ouachita mountain provinces confirms this preliminary finding and will describe the species formally in the near future. Rare.

Lirceus hoppinae hoppinae (Faxon). The most abundant and widespread isopod throughout the Ouachita Mountain physiographic province was Lirceus h. hoppinae. This isopod was found in 26 of the 33 springs investigated. Interestingly, a single spring usually contains only one species, thus it was quite unusual to discover the new isopod species discussed above living syntopically in Abernathy Springs with Lirceus h. hoppinae.

ORDER AMPHIPODA - Amphipods

Family Cragonyctidae

Stygonectes alabamensis alabamensis (Stout). Holsinger (1967) reported a collection from a small seep, 0.6 mi. east of The Lodge, Magazine Mountain, on May 4, 1940. A trip to Magazine Mountain in July, 1980 and a thorough search of the area both east and west of The Lodge site (since burned) did not yield any specimens. The Terrible drought conditions of this past year (Summer, 1980) were responsible for lack of seepage areas. Even springs on top of Magazine Mountain were completely dry. Mr. Ken Smith, Arkansas Natural Heritage Commission, provided the writer with specimens identified by Dr. John R. Holsinger, Old Dominion University, as this subspecies taken previously before the summer drought.

Stygobromus montanus (Holsinger). Specimens of this species originally collected by Mr. leslie Hubricht on 26 April 1936 from springs at Rich Mountain Station, Rich Mountain, Polk County were described by Holsinger (1967). These "springs", not found in this study, represent the type locality of this species as it has not been collected since. Mr. Hubricht (pers. comm.) has indicated the approximate locations of the "springs" based on recollections from his 1936 trip; however, a search of the area revealed only small seeps which did not yield any amphipod specimens. Holsinger (1972) acknowledged that there is some evidence to indicate Stygobromus montanus may be a peripherally isolated, highly aberrant form of S. alabamensis and not actually a distinct species. This suggestion must await a more complete review of the material, now underway by Dr. Holsinger.

Stygobromus elatus (Holsinger). Holsinger (1967) described material collected by Mr. Leslie Hubricht from a seep, 0.2 mi. east of The Lodge, Magazine Mountain on May 4, 1940 as a new species Stygonectes elatus, later changed to Stygobromus elatus. This locality represents the type locality and sole collecting spot as the species has not been collected since. A trip to Magazine Mountain specifically to collect S. elatus proved unfruitful as the summer drought dried up both seeps and springs on Magazine Mountain. Future collection efforts shall be directed toward this species and S. montanus.

ORDER DECAPODA - Crayfishes and Shrimps

Family Cambaridae - Crayfishes

Orconectes acares Fitzpatrick. This crayfish is one of the most abundant and widespread species in the Ouachita Uplands. Although it is typically a species inhabiting streams (Hobbs, 1974), *O. acares* wanders up spring outflows to enter springs from adjacent small tributaries. Williams (1954) recorded *O. acares* (as *O. leptogonopodus*) from Twin Springs and Gillham Springs both in Polk County. In this study *O. acares* was collected in 12 springs, usually from the spring outflow region under debris or rocks.

CLASS INSECTA - Insects

As the most successful group in the animal kingdom it should not be surprising to discover that the insects represented 36 species (86 percent) of all species collected from Ouachita Mountain springs.

ORDER COLEOPTERA - Beetles

Family Elmidae - Riffle Beetles

Dubiraphia sp. A single larval specimen of this genus was collected from an unnamed spring in the bed of the Caddo River and thus may represent a waif from the river and not a true spring inhabitant. Rare.

Family Hydrophilidae - Water scavenger beetles

Cymbiodyta sp. Seven adults of *Cymbiodyta* were collected from Black Springs in Montgomery County. Rare in springs.

ORDER DIPTERA - True Flies

Family Ptychopteridae - Phantom Crane Flies

Bittacomorpha sp. Fifty larvae of this unidentified Ptychopteridae were collected from Sulphur Springs; however, they do not precisely fit the key to the genus Bittacomorpha (Dr. George L. Harp, pers. comm.) and need further study.

Family Tipulidae - Craneflies

Tipula sp. Although this genus of the cranefly family, Tipulidae, was the most abundant dipteran form collected from Ouachita Mountain springs, difficulty in using species keys to larvae prevents a species determination. Larvae were collected from 19 spring locations. Aquatic cranefly larvae are easily identified by the spiracular disc at the extreme posterior end of the body (Pennak, 1953). This disc has a pair of functional spiracles and may be thrust up to the air-water interface to attain oxygen.

Limonia sp. Ninety-five specimens of Limonia larvae were collected from Black Springs in fine organic detritus that had settled on the bottom of the spring. Although common at Black Springs, this genus was rare throughout the Ouachita Mountain province.

Family Chironomidae - Non-biting Midges

At least six genera were taken in the Ouachita Mountain springs indicating a broad usage of the spring habitat by chironomids.

Chironomus sp. All indiciduals keying out to Chironomus were lumped here, although surely several species are distinguished within the larvae collected. Abundant.

Tanypus sp. Only a single larval specimen of Tanypus was collected indicating that this madge is rare in springs in the Ouachita Mountains. Rare.

Dicrotendipes sp. This midge was quite widespread in spring ecosystems throughout the Ouachita Mountains. Abundant.

Polypedilum sp. This species was collected only once from an unnamed spring in Polk County near Bard Springs.

Stictochironomus sp. This tube-making burrower was collected from several unnamed springs in Garland County, but overall was rare throughout the Ouachita Mountains.

Diamesia sp.? A few larvae closely related to Diamesia are mentioned here although identification is tentative because of the difficulty in verifying chironomid larvae forms to species.

Family Psychodidae - Moth Flies

Pericoma sp. Black Springs, Montgomery County, proved to offer quite a diverse spring fauna as two larvae of Pericoma, typically lotic burrowers in organic material at the edges of spring outflow, were found. Rare in the Ouachita Mountain province springs.

Family Culicidae - Mosquitoes

Anopheles punctipennis (Say). Although mosquitoes are commonly encountered when sampling springs in the Ouachita Mountains, it is difficult to determine their precise aquatic origin unless larvae are collected in the spring itself. This species seemed to be relatively common in springs throughout the Ouachitas.

ORDER EPHEMEROPTERA - Mayflies

Family Heptageniidae

Stenacron interpunctatum Say. Naiads of this mayfly species were collected from West Springs which is a small spring located quite close to an adjacent small tributary. Because of the abundant flow and gravel substrate of this spring, *S. interpunctatum* was locally common; however, throughout the Ouachita Mountains mayflies in springs were rare.

Species A. An unidentifiable larval specimen was collected from Black Springs, Montgomery County.

Family Baetidae

Species A. Three naiads damaged in collection were also taken from West Spring; however, identification was impossible beyond the family level due to the damage sustained.

ORDER ODONATA - Dragonflies and Damselflies

Interestingly, Pflieger (1976) does not record a single odonate species from Missouri springs, although he does admit the aquatic insect fauna of springs in Missouri is poorly known. In this survey, odonates proved to be utilizing spring habitats in a wide area of the Ouachita Mountains.

Family Aeshnidae - Darners

Aeshna umbrosa (Walker). Five naiads of *A. umbrosa* were collected from Black Springs, Montgomery County. Generally, this species prefers lentic situations with vascular hydrophytes common. Thus it appears

that A. umbrosa is using the spring run habitat where detritus has collected in side pockets. Rare in springs.

Family Libellulidae

Pachydiplax longipennis Burmeister. Rarely collected.

Family Corduliidae

Neurocordulia xanthosoma? (Williamson). This odonate was quite rare in the Ouachita Mountain springs being found in only one unnamed spring in Polk County. Because the key to species of Neurocordulia is not reliable, the species determination is questionable (Dr. G. L. Harp, pers. comm.).

Somatochlora linearis? Hagen. Very small naiads of this Somatochlora species were collected from several unnamed springs in Garland County and thus determination of species is tentative.

Family Gomphidae

Hagenius brevistylus Selys. A single specimen of H. brevistylus was taken from vegetation in the outflow of an unnamed spring located in the bed of the Caddo River, Montgomery County.

Ophiogomphus rupinsulensis Walsh. One naiad was taken from the spring in the bed of the Caddo River, Montgomery County.

Libellula vibrans? Fabricius. Because the key to species is unreliable for Libellula (Dr. G. L. Harp, pers. comm.), the identification of a single naiad taken from the heavily vegetated spring in the Caddo River bed is tentative.

Family Cordulegasteridae

Cordulegaster maculata Selys. A widespread state form, this species was never abundant in springs, but rather inhabited the adjacent spring-fed tributaries of the Ouachita Mountains.

Family Calopterygidae (=Agrionidae)

Calopteryx (=Agrion) maculata (Beauvois). This damselfly was quite widespread in the Ouachita Mountains, although not abundant in springs. Typically C. maculata preferred streams which were fed by the springs investigated, rather than the springs themselves.

ORDER HEMIPTERA - True Bugs

Family Gerridae - Water striders

Gerris remigis Say. The most common hemipteran collected from Ouachita Mountain springs. Almost every spring had two to four specimens of this species skating across the boil region. Seventeen specimens of G. remigis were collected at the surface of the boil at Black Springs, Montgomery County.

Family Veliidae - Broad-shouldered water striders

Rhagovelia knighti Drake and Harris. Although not as common as G. remigis, R. knighti was collected from three springs in low numbers.

ORDER MEGALOPTERA - Alderflies, Dobsonflies, and Fishflies

Family Corydalidae - Dobsonflies

Subfamily Chauliodinae - Fishflies

Chauliodes rastricornis Rambur. The fishfly, C. rastricornis was

collected at Buttermilk Springs No. 1, Montgomery County only once. It was extremely rare in Ouachita Mountain springs.

ORDER TRICHOPTERA - Caddisflies

Family Rhyacophilidae

Rhyacophila lobifera Betten. This widespread genus of over 100 species was represented in spring sampling from West Spring, Montgomery County by R. lobifera. A single free ranging larval specimen was collected.

Family Brachycentridae

Micrasema sp. Seven specimens of Micrasema were collected with diagnostic cases from Buttermilk Springs No. 2. This was the only spring from which Micrasema was taken during the study.

Family Hydropsychidae

Cheumatopsyche sp. Collections from small rock substrate in West Spring yielded several larval specimens of this genus. Unfortunately, larvae of most species are not presently described (Wiggins, 1977).

Hydropsyche sp. Several larvae were collected from unnamed springs in Polk County and future planned light trapping of adults is needed for precise specific identifications of these larvae.

Family Glossosomatidae

Agapetus medicus Ross. Ross (1938) described A. medicus from McFadden Springs in Garland County; howver, this spring is believed to be inundated by Lake Ouachita presently. No specimens were taken in this survey.

Family Helicopsychidae

Helicopsyche limnella Ross. Ross (1941) reported holotypes and paratypes of H. limnella from McFadden Springs. No specimens were collected in this survey.

Family Philopotamidae

Chimarra feria Ross. McFadden Springs also yielded paratypes of C. feria. No specimens were taken in this survey.

PHYLUM CHORDATA

SUBPHYLUM VERTEBRATA

ORDER CYPRINIFORMES - Minnows

Family Cyprinidae - Minnows and Carps

Campostoma anomalum (Rafinesque). Stoneroller. Although most of the springs were too small to allow much in the way of a varied ichthyofauna to develop, Abernathy Springs and Bear Spring were large enough to have significant outflow regions for juvenile stonerollers to swim toward the boil.

Serratilus atromaculatus (Mitchill). Creek chub. A rather common inhabitant of larger springs in the Ouachita Mountains. Common.

ORDER CYPRINODONTIFORMES - Topwater Killifishes

Family Cyprinodontidae - Killifishes

Fundulus catenatus (Storer). Northern studfish. The only topminnow collected in springs during the study was the common Ouachita upland

killifish, Fundulus catenatus. F. catenatus prefers clear, spring-fed streams and particularly pool regions of such streams. Only in larger springs did F. catenatus venture upstream toward the source of the spring.

ORDER PERCIFORMES - Perches

Family Percidae - True Perches

Etheostoma pallididorsum Distler and Metcalf. Paleback darter. The paleback darter (E. pallididorsum) is the only "threatened" fish species collected from springs in the Ouachita Mountains in this study. Research underway presently indicates the paleback darter should be given threatened status as was done previously by Robison (1974). Specimens were collected from several unnamed springs in the Caddo River system.

Etheostoma radiosum (Hubbs and Black). Orangebelly darter. The orangebelly darter was the most common and widespread darter as well as the most common fish inhabitant of springs collected in the Ouachita Mountain province.

ORDER ANURA - Frogs and Toads

Family Ranidae - True Frogs

Rana sphenocephala Cope. Southern leopard frog. I follow Johnson (1977) in using the designation Rana sphenocephala for the populations of the Rana pipiens complex inhabiting Arkansas. Four specimens of R. sphenocephala from areas immediately adjacent to or actually within

the spring run were collected during the study making this species fairly rare in Ouachita springs.

Family Hylidae - Tree Frogs

Acris crepitans blanchardi Harper. Blanchard's cricket frog. Only six specimens of Blanchard's cricket frog were collected during the study. All specimens were sitting at the edges of the spring outfall and jumped into the water upon approach where they attempted to escape by swimming beneath filamentous algae or gravel.

ORDER CAUDATA - Salamanders

Family Plethodontidae - Lungless Salamanders

Desmognathus brimleyorum Stejneger. Ouachita dusky salamander. Previously, the Ouachita Mountain population of the often confusing genus Desmognathus has been considered as a full species, Desmognathus brimleyorum Stejneger (1895) and as a subspecies, D. fuscus brimleyorum by others (Conant, 1958). The former name will be used in this report as Means (1974) has provided convincing data to justify elevation of this form to full species level. Only three adults of D. brimleyorum were collected in springs during the study. Instead springs were used primarily as a nursery area for juveniles. Seventy-five juveniles of this species were collected from under small rocks and vegetation immediately downstream of the boil from Ouachita Mountain springs.

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