Macroinvertebrates Collected From Seven Oklahoma Springs

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We collected macroinvertebrates, measured physicochemical conditions, and visually observed the microhabitats of seven springs located across Oklahoma. Fifty-four species were collected from the seven springs. No single taxon was found in all seven sites and only four species were observed in over half of the sites. This indicates that many of the macroinvertebrates occurring in these springs are not truly spring invertebrates, but are local species able to exist in these environments. The number of taxa collected was directly related to the various microhabitats present and the concentration of dissolved oxygen. Based on the macroinvertebrate community, Sorensen's similarity coefficient revealed that Boiling Springs and Big Spring were most similar, with both containing abundant microhabitats. Desperado Spring and Cattlewash Spring were least similar, having a large difference in dissolved oxygen concentrations. Four of the seven springs were sampled previously. Only 17% of macroinvertebrate species had been previously recorded from a particular site, indicating that a large turnover of species occurs in these spring habitats.

INTRODUCTION

The study of springs in Oklahoma has been limited to unpublished reports for the Oklahoma Water Resources Institute (*1*) and the Nature Conservancy (*2*), and macroinvertebrate community data from several unpublished collections by D. Bass. Natural freshwater springs are used as sources of irrigation and as public water supply in many Oklahoma communities, therefore, directly affecting people, livestock, and crops. More baseline studies and observations should be done so that any changes in springs could be detected. A survey of macroinvertebrates existing in springs as well as physicochemical testing of their waters would be an uncomplicated, yet efficient method of evaluating springs to determine differences among springs located in certain areas and differences that may occur in a spring over a period of time.

The objectives of this research included identification of the macroinvertebrates collected from each spring; comparison, based on the macroinvertebrate fauna, of the springs to each other; observation of the information collected to determine the existence of any patterns occurring among the springs; and comparison of the macroinvertebrates found in these collections with those of previous collections.

METHODS

Seven springs located in a northwest to southeast transect across Oklahoma were selected to provide a representation of those in the state (Fig. 1). Composition of their aquatic macroinvertebrate communities was studied from July to September of 1999. Physicochemical conditions at each site were determined before any collecting occurred. The temperature was recorded by using a submersible thermometer, dissolved oxygen concentration was determined by using the Winkler method (*3*), and pH was measured by using a pH meter. Most of the spring sites were subdivided into an emergence pool (where water exited the ground) and a run

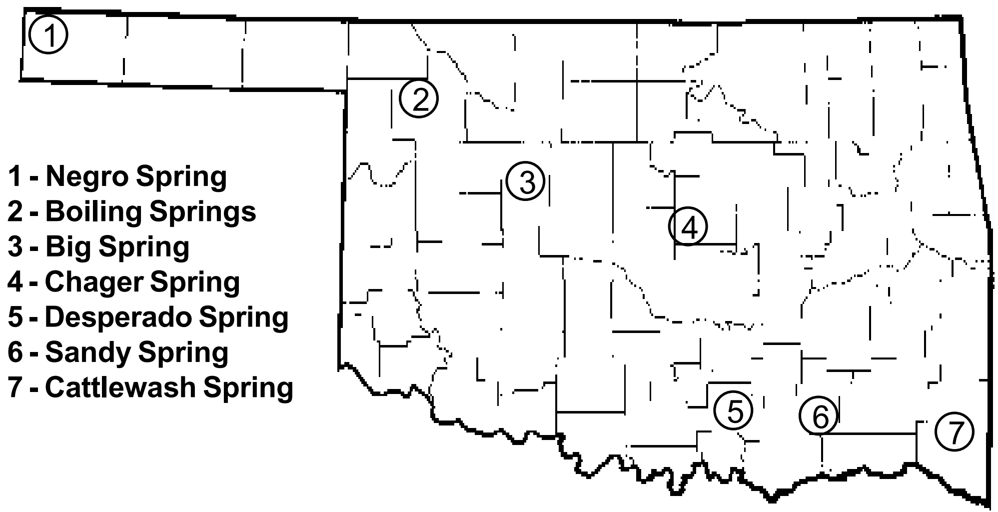

Figure 1. Location of sampling sites

(where water flowed from the pool). Qualitative sampling of the macroinvertebrate community in both areas was conducted by using several different collecting techniques: all microhabitats were visually examined, and forceps were used to pick organisms from moss, rocks, leaf debris, wood debris, and any other substrates. Dipnets were used to collect organisms in the water column or clinging to submerged vegetation. These collecting techniques were continued at each spring until no additional taxa were found. Collection times varied from 60-120 min, depending on the size and complexity of the spring being sampled. Collections of wood debris, plant debris, and other substrates from each spring were also placed in labeled jars and transported to the laboratory with other collections, where they were examined for any additional macroinvertebrates. All collections were preserved in alcohol or formalin at each site. In the laboratory, the specimens were identified to the lowest possible taxon. The relative occurrence and trophic position of each taxon collected was also determined (*4,5*). The number of taxa collected from each spring was totaled, and Sorensen's similarity coefficient (*6*) was used to compare faunal percent similarity among the seven springs.

RESULTS and DISCUSSION

Variation in water temperature, dissolved oxygen concentration, and pH existed among the seven springs (Table 1). Generally, the values of these measurements fell within ranges capable of supporting aquatic macroinvertebrates. Possible exceptions to this might be where low dissolved oxygen concentrations occurred near the point of emergence at two sites. Fifty-four species were collected from the springs (Table 2).

Negro Spring: Negro Spring, located in the northwest corner of the state near Black Mesa, is on private property in Cimarron County (36.9396°N, 102.9972°W). The landowner has built a collecting tank to make use of the spring water. Spring water flows to the tank through a pipe imbedded 33 m into the mesa. The overflow from the tank forms a nearby shallow pond with a surface area of approximately 60 m^2 and a depth of less than 0.5 m. This pond has a muddy substrate with an abundance of algae growing on the surface. This site contained the most taxa of the seven springs, having 18 different taxa from seven families. Representatives of both immature and adult stages for most of the organisms were collected, suggesting that reproduction of these organisms does occur at the site. Predators and collectors seem to be the trophic categories most represented within this spring (Table 2). Organisms from Negro Spring have been previously collected by Matthews and coworkers (*1*), and we found six of the taxa reported by them. Sorenson's similarity index indicated the faunal composition of Negro Spring was most similar to that of Boiling Springs, 0.375, and least similar to that of Desperado Spring, 0.065 (Table 3).

Boiling Springs: Boiling Springs is located within Boiling Springs State Park in Woodward County (36.4541°N, 99.2876°W). This spring emerges from a sandy bottom, covered by numerous rocks and an abundance of aquatic vegetation as well as leaf debris and wood debris. The emergence pool is approximately 2 m in diameter and less than 0.5 m deep. The run was approximately 15 m long, 0.5 m wide, and 0.1 m deep. Boiling Springs provided 14 different taxa from nine families. Many of these taxa collected were immature, suggesting that reproduction does occur within the spring. A few hemipterans and coleopterans were collected in the adult stage only, suggesting that they may not be reproducing or that reproduction occurs at a different time. Predators, scavengers, and collectors were typical at this site (Table 2). When comparing the collection to those made by D. Bass (unpublished data) on several occasions, only three taxa were observed in both his earlier collections and this collection. Boiling Springs was most similar to Big Spring, 0.476 and least similar to Desperado Spring, 0.222 (Table 3).

Big Spring: Big Spring is located in Roman Nose State Park in Blaine County (35.9365°N, 98.4469°W). Its name is appropriate because its flow was visually observed to be the greatest of the seven springs. The pool is approximately 10 m long, 2 m wide, and less than 1 m deep with water gushing from an opening in the rock. The run is about 15 m long, 2 m wide, and less than 0.5 m deep. Substrates include sand; gravel; rock; wood debris; leaf debris; and root debris. Considering the diversity of microhabitats present, Big Spring was less productive than expected, supporting only seven taxa from six families. Of the seven taxa, only one was not collected in the immature stage, suggesting most organisms are reproducing. Many of the organisms collected at this spring were either collectors or predators (Table 2). Big Spring is most similar to Boiling Springs, 0.476, and least similar to Negro Spring, 0.080 (Table 3). No previous collections of macroinvertebrates are known from this spring.

Chager Spring: Chager Spring is located in Lincoln County (35.485°N, 97.048°W). This spring consists of a seepage along a sandstone wall supporting an abundance of moss. A pool less than 0.2 m deep forms about 10 m from the seepage. Its bottom substrate consists of sand and silt with few rocks. The spring yielded 14 taxa from six families. The majority of the organisms collected were immature, suggesting reproduction of these organisms occurs within the spring. The coleopterans were found only as adults; therefore, they may or may not be reproducing. This spring seems to be dominated by predators (Table 2). It has been previously collected (*1*), and we found five taxa in common with the previous study. Chager Spring was most similar to Desperado Spring, 0.296, and least similar to Negro Spring, 0.065 (Table 3).

TABLE 1. Physicochemical conditions of each spring at time of sampling.

Spring	Temperature (°C)	Dissolved Oxygen (mg/L)	pH
Negro Spring	29	15.6	9.0
Boiling Springs	17	4.2	7.3
Big Spring	16	9.2	7.4
Chager Spring	21	9.0	NA[a]
Desperado Spring	18	6.0	6.9
Sandy Spring	20	1.4	5.4
Cattlewash Spring	20	0.7	NA[a]

[a] Not Available

TABLE 2. Taxa collected from seven Oklahoma springs, July - September 1999.

Taxon	Neg Spr	Boi Spr	Big Spr	Cha Spr	Des Spr	San Spr	Cat Spr	Trophic Relationship
Turbellaria								
Dugesia sp.		PRIMa			RIc			predator
Hymanella retenuova					RMc			predator
Nematoda								
Unidentified Nematoda					RMc			
Oligochaeta								
Limnodrilus sp.	PIMc	RIMa		RIMc	RIMc	RIMc		detritivore
Gastropoda								
Fontigens sp.					RIMa			scraper-herbivore
Physa sp.	PIMa	PRIMa					RMc	scavenger-omnivore
Pseudosuccinia columnella				RMc				scraper-herbivore
Isopoda								
Caecidotea sp.					RIMa			scavenger-omnivore
Lirceus hoppinae						PRIMa		scavenger-omnivore
Amphipoda								
Allocrangonyx sp.					PRIMc			scavenger-omnivore
Gammarus sp.						RIMc		scavenger-omnivore
Hyalella azteca		PRIMa	PRIMa			PRIMa		collector-gatherer
Decapoda								
Cambaridae			PRIc		PRIc			scavenger-omnivore
Orconectes sp.							RMc	scavenger-omnivore
Ephemeroptera								
Baetis sp.	PIa	PRIa	RIc					collector-gatherer
Odonata								
Anax junius				PIc				predator-engulfer
Archilestes sp.				PIc				predator-engulfer
Argia sp.		PRIa	RIa	RIc	RIa			predator-engulfer
Somatochlora sp.							PRIc	predator-engulfer
Sympetrum sp.	PIa							predator-engulfer
Tramea sp.	PIc							predator-engulfer
Hemiptera								
Aquarius sp.		RMc	PMc					predator-piercer
Limnoporus sp.		RIMc	RIc	PIMc			RMc	predator-piercer
Microvelia sp.	PIMc	PMc		PIMa		RIMa	PRIMa	predator-piercer
Notonecta sp.	PIMa					RMc	PRMa	predator-piercer
Trepobates sp.				PIc				predator-piercer
Megaloptera								
Sialis sp.							RIr	predator-engulfer
Coleoptera								
Berosus sp.	PMa							piercer-herbivore
Celina sp.				PMc				predator-piercer
Cymbiodyta sp.	PMr							collector-gatherer?
Dineutus sp.				PMc				predator-engulfer?
Hydroporus sp.				RMr				predator-piercer
Laccobius sp.				RMc	RMc			collector-gatherer
Laccodytes sp.							RMa	predator-piercer
Laccophilus sp.	PMa	RMc						predator-piercer
Paracymus sp.	PMr							collector-gatherer?
Tropisternus sp.	PIMa	RMc						collector-gatherer?

TABLE 2. (cont.) Taxa collected from seven Oklahoma springs, July - September 1999.

Taxon	Neg Spr	Boi Spr	Big Spr	Cha Spr	Des Spr	San Spr	Cat Spr	Trophic Relationship
Diptera								
Anopheles sp.				PIc				collector-filterer
Brachypremna sp.				RIa	RIc			shredder?
Chironomidae pupae	PIc							
Chironomus sp.	PIc					PRIc	PRIc	collector-gatherer
Cladotanytarsus sp.	PIc							collector-gatherer
Conchapelopia sp.					RIc			predator-engulfer
Dicrotendipes leucoscelis	PIa							collector-gatherer
Glyptotendipes barbipes	PIa							shredder-herbivore
Hybomitra sp.							RIr	predator-piercer
Larsia sp.							RIc	predatpr-engulfer
Leptotarsus sp.			RIa					shredder?
Myxosargus sp.					RIc			collector-gatherer?
Natarsia sp.		RIc						predator-engulfer
Notiphila sp.		PIr						collector-gatherer
Pedicia sp.							RIr	predator-engulfer
Simulium sp.		RIc						collector-filterer
Tabanidae	PIc							predator-piercer
Total Number of Taxa	18	14	7	14	13	7	12	

Collecting sites include: Neg Spr = Negro Spring, Boi Spr = Boiling Springs, Big Spr = Big Spring, Cha Spr = Chager Spring, Des Spr = Desperado Spring, San Spr = Sandy Spring, Cat Spr = Cattlewash Spring.
Habitat from where taxa was collected: P = pool, R = run
Stage of life cycle collected: I = immature, M = mature
Occurrence of taxa: c = common (>20% of collection), a = abundant (5-20% of collection), r = rare (<5% of collection).

TABLE 3. Coefficients of similarity for all pairs of springs.

Sites	Neg Spr	Boi Spr	Big Spr	Cha Spr	Des Spr	San Spr	Cat Spr
Neg Spr	*	0.375	0.080	0.125	0.065	0.320	0.267
Boi Spr	*	*	0.476	0.286	0.222	0.286	0.231
Big Spr	*	*	*	0.190	0.200	0.143	0.105
Cha Spr	*	*	*	*	0.296	0.190	0.154
Des Spr	*	*	*	*	*	0.100	0.000
San Spr	*	*	*	*	*	*	0.316
Cat Spr	*	*	*	*	*	*	*

Neg Spr = Negro Spring, Boi Spr = Boiling Spring, Big Spr = Big Spring, Cha Spr = Chager Spring, Des Spr = Desperado Spring, San Spr = Sandy Spring, Cat Spr = Cattlewash Spring.

Desperado Spring: Desperado Spring, located within Blue River State Recreation Area in Johnston County (34.3319°N, 96.5993°W), emerges from a rocky outcrop. The emergence pool consists of a rocky bottom substrate and measures approximately 1 m in diameter. The run, approximately 15 m long and less than 10 cm deep, consists of rock, gravel, sand, leaf debris, and an abundance of aquatic vegetation. Desperado Spring provided 13 taxa from 10 families and had been previously sampled by Matthews and coworkers (*1*). We found only one taxa in common with their study. Many of the trophic categories, such as predators, scavengers, collectors, and scrapers, were present in this collection. Most organisms were found in the immature stage, suggesting their reproduction is occurring at the site (Table 2). Desperado Spring was most similar to Chager Spring, 0.296, and least similar to Cattlewash Spring, 0.000 (Table 3).

Sandy Spring: Sandy Spring is located on private property near Farris in Atoka County (34.2346°N, 95.8537°W). It emerges through a sandy bottom substrate and is now encased within a cement cylinder having a diameter of less than 1 m and a depth of approximately 1.5 m, with algae growing along the interior walls. The small run is heavily vegetated. Sandy Spring provided few species, having only seven taxa from five families. Most of the organisms were found in the immature stage, indicating reproduction of these organisms is occurring. Scavengers and predators were the most abundant trophic categories represented (Table 2). Along with Big Spring, this site provided the least number of taxa. The Sandy Spring fauna was most similar to the fauna of Negro Spring, 0.320, and least similar to that of Desperado Spring, 0.100 (Table 3). No previous collections of macroinvertebrates from this spring are known.

Cattlewash Spring: Cattlewash Spring is located within Beavers Bend State Park in McCurtain County (34.1368°N, 94.6886°W). The emergence pool is less than 1 m in diameter, less than 0.5 m deep, and contains an abundance of leaf and little wood debris. The run is less than 5 cm deep and continues approximately 20 m away from the pool, consisting of leaf debris, rocks, wood debris, and moss. Collection of macroinvertebrates yielded 12 taxa from seven families, with the majority of organisms being predators. A few of the taxa were only collected as adults; therefore, they may or may not be reproducing at the site. Many others were immature (Table 2). The fauna of Cattlewash Spring was most similar to that of Sandy Spring, 0.316, and least similar to that of Desperado Spring, 0.000 (Table 3). No previous collections of macroinvertebrates from this spring are known.

Taxon Comparison: The number of organisms collected from each site was directly related to the amount of various microhabitats within the spring. The springs where more species were collected generally had more microhabitats present. Typically the runs of these springs were longer, with bends and curves where debris accumulates, consequently allowing the formation of multiple microhabitats. The various substrates present in the runs, such as sand, rock, gravel, leaf, and wood debris, also provide numerous microhabitats for organisms. Fewer organisms were collected from those springs with limited microhabitats. These springs typically consisted of shorter runs and mostly soft, uniform bottom substrates.

No species occurred at all seven sites sampled. Only four species were found in over half of the springs sampled. They included the oligochaete *Limnodrilus,* the damselfly *Argia,* and the waterstriders *Limnoporus* and *Microvelia.* It is also interesting to note that 38 of the 54 (70%) taxa collected were encountered at only one site (Table 2). These findings indicate that very little of the macroinvertebrate fauna living in Oklahoma springs are truly “spring invertebrates.” Inhabitants of these springs are probably species that occur in other nearby aquatic habitats and are also able to exist in spring environments. However, additional data are necessary to confirm this hypothesis.

The species lists compiled by Matthews and coworkers (*1*) for Negro, Chager, and Desperado Springs, and the species list determined by D. Bass for Boiling Springs (unpublished data) were compared to those of our study. Eighty-eight species are present in the springs when all collections are combined. However, we found only 15 species (17%) in common with those collected in the previous studies at the same four sites. This indicates a large turnover of species occurs at spring habitats over the course of several years, an observation also made by Matthews and coworkers (*1*).

Similarity Analysis: According to the similarity analysis, the two springs having the greatest macroinvertebrate community in common were Boiling Springs and Big Spring (Table 3). Although Big Spring only provided half as many taxa as Boiling Springs, five of the seven taxa found at Big Spring also were found at Boiling Springs. The trophic categories present at both springs consist of collectors, scavengers, and predators. Both springs are somewhat protected because they are located within state parks. In addition, they are closest to each other in the statewide transect. Both had long runs with sand, rock, gravel, wood debris, and plant debris composing the substrate, perhaps providing them with many similar microhabitats preferred by the taxa the two springs shared in common.

The two least similar springs were Desperado Spring and Cattlewash Spring (Table 3). Because many organisms were present at both springs, it was surprising that they shared no common taxa. Furthermore, Cattlewash Spring was dominated by predators, whereas Desperado Spring contained many scavengers as well as predators. Desperado and Cattlewash are smaller springs with similar substrates, leading us to the assumption that another physicochemical difference may be the major factor limiting the number of taxa common to both. The dissolved oxygen concentration differed by 5.3 mg/L. Based on the ability of different organisms to tolerate variations of oxygen concentration (*4*), this disparity could be a reason for the difference in macroinvertebrate similarity between the two springs .

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