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# AQUATIC MACROINVERTEBRATES OF THREE ACID BOGS ON CROWLEY'S RIDGE IN NORTHEAST ARKANSAS

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## ABSTRACT

Qualities and quantities of parameters composing the bog systems in Northeast Arkansas are not entirely reflective of those defining bogs of the northern United States. While pH is restricting to the organisms of each bog studied (4.8-6.9), the major limiting factor is the amount of available water. Three acidophilic bogs with shallow water depths (2-30 cm) yielded a total of 75 aquatic macroinvertebrate taxa. The bog with greatest surface area supported 67 taxa and a mean numerical standing crop of 14 organisms/2 hr sampling period. The bog with the smallest surface area had 13 taxa and a mean standing crop of 2 organisms/2 hr sampling period. No clear seasonal fluctuations were observed in these bogs because the standing crops were never great, and because the amount of water available exerted the greater influence. Water levels did not always fluctuate in consort among the bogs.

## INTRODUCTION

Herein, a bog is defined as a peat-covered area or peat-filled depression with a high water table and a surface mat of mosses, chiefly *Sphagnum*. The presence of an extreme limiting factor in bogs (low pH) results in a relatively simple ecosystem (McLachlan and McLachlan, 1975; Saber and Dunson, 1978). Within the spectrum of existing bog ecosystems, bogs previously studied have been relatively large and complex (Welch, 1952; Heinselman, 1963; McLachlan and Dickinson, 1977; Ramcharan and Paterson, 1978), rather than small forested bogs, such as those reported in this study. Furthermore, greater emphasis in other bog studies was placed upon the plant communities rather than on describing the aquatic macroinvertebrate communities. An absence of effective faunal sampling devices for this ecosystem type has perhaps compounded the problem.

Apparently no previous study has dealt with description of bogs in Arkansas. In fact, knowledge of their existence in this state is limited. Bogs occur sporadically along the length of Crowley's Ridge in Northeast Arkansas. Although all share certain defining characteristics (e.g., pH, vegetation), they differ in size, basin shape, water depth, pH, and soil types. These differences can be expected to influence the kinds and relative abundance of aquatic macroinvertebrates supported by each bog. The purposes of this study were to describe the existing aquatic macroinvertebrate communities within three bogs on Crowley's Ridge and to discern physicochemical relationships which may explain their present distribution and relative abundance.

## STUDY SITES

The three bogs selected for study are located within Greene County, Arkansas, among the forests of Crowley's Ridge. This Ridge is generally comprised of loessial hills, with the major soil type being of the Lorine Granada Association. A secondary soil type in the study area is the Brandon Lexington Association. Both soils are deep, well to poorly drained and moderately permeable, with gentle to steep slopes developed from this loess over gravelly and sandy tertiary material. The forest of Crowley's Ridge in the vicinity of the bogs can be generally regarded as white oak-red oak-hickory with certain edaphic factors ac-

counting for beech (*Fagus grandifolia* var. *caroliniana* Loud.) and its community associates at one extreme with shortleaf pine (*Pinus echinata* Mill.) at the other (Arkansas Department of Planning, 1974). All three of the bogs studied lie at the base of steep slopes and are adjacent to sand pits where extensive removal of material has destroyed a portion of the aquifer head which formerly furnished a constant water supply. The current water source is restricted to spring seeps located on the adjacent slopes and to limited run-off directly dependent upon rainfall. Mean annual rainfall in this region during the 1930-1980 period was 125 cm. During 1979-1980 it was 35.1 cm (U.S. Dept. Commerce, 1931-1980).

Bogs have only recently been grouped under the single term "wetlands". According to Cowardin et al. (1979), all three bogs in this study are Palustrine Systems and are contained in the Forested Wetlands class; the subclass is Broad-Leaved Deciduous. Their water regime is Saturated, water chemistry is Fresh-Acid, and soil is Organic. The bogs of this study are now in a dying state or climax condition specifically referred to as sedge-meadow.

Glory Hole Bog lies in the Brandon Lexington Association soils on the western edge of Crowley's Ridge, approximately 5 km northeast of the junction of State Highways 25 and 168 in the NW $\frac{1}{4}$  S23, T17N, R4E. This bog is essentially a forested mire draining into what now resembles the early stages of a swamp. Water enters the basin by rainfall runoff largely from the south and west, and leaves by an outflow channel in the north shore. The bog, with an area of 42,968 m<sup>2</sup>, is surrounded by mat formations and peat deposits which are thoroughly protected by closely-surrounding woods and hills such that wind action would never produce major turbulence. This dense understory, combined with numerous ferns, heavily shades the water from spring through fall.

Ramer's Chapel Bog lies in the Lorine Granada Association soils at the eastern edge of Crowley's Ridge. The bog is bordered to the east by Ramer's Chapel Road, and lies 1.5 km northeast of the junction of State Highways 135 and 34 at Lefe, in S12, T18N, R5E. A climatic forest type with widely fluctuating water level, pH, and temperature is characteristic of this bog. Water flow is from direct runoff which flows in a westerly direction through the bog and terminates in a lentic environment surrounded by cultivated fields and pastures. Covering an area of 31,604 m<sup>2</sup>, the bog has a basin composed of clay and silt with deeply stained detritus.





The ecology of *Caecidotea* spp. in North America is not well known. However, in most of Europe this genus is characteristically present within given sections of organically-polluted rivers (Williams, 1976). Its tolerance to a wide range of water depths and substrata is exhibited in this study where it was collected in all three bogs throughout most of the sampling period.

The diversity and relative abundance of the aquatic macroinvertebrates were greatest in Glory Hole Bog, intermediate in Ramer's Chapel Bog, and least in Bluff Springs Bog. This sequence follows that of bog size, but the strongest influence is exerted by the amount of water available, which entails water depth as well as surface area. Bluff Springs Bog, with 0.7% of the area of Glory Hole Bog, had 19% as many taxa (13 vs. 67). All these taxa were able to function in the wetted organic debris and mud in the absence of standing water.

Among those taxa found only in Glory Hole Bog were the following. *Pisidium* is often the only molluscan representative found in bog lakes (Welch, 1952). *Procambarus* is found in sluggish to moderately flowing streams and lentic habitats (Hobbs, 1976). However, in this study, *Procambarus* was present only in the sandy troughs of Glory Hole Bog. *Nepa* and *Ranatra*, two sluggish-swimming predators, are definitely restricted to dense pondweed masses and heavy, submerged leaf litter. These hemipterans were also noted by Lindeman (1941) as bog forms. *Sialis* larvae are common predators in many streams and ponds and are adapted for survival during periods of low prey density in that they can live up to two months without food and then develop rapidly when food becomes abundant (Azam and Anderson, 1969). Further, they have a wide tolerance range for pH (2.8-8.3) (Tarter and Woodrum, 1972).

Those species found only within Ramer's Chapel Bog (*Limnoporus*, *Gelastocoris*, *Notonecta irrorata*, *Helochares*, *Enochrus*, and *Celina*) are all invading forms that may, or may not, be consistently present in the bog during drying conditions. One obvious difference in the macroinvertebrate communities of Ramer's Chapel Bog is the absence of amphipods. As a group, amphipods are cold stenotherms, strongly thigmotactic, and react negatively to light (Pennak, 1978). Consequently, daytime is spent beneath vegetation or hidden between debris and stones. In addition, amphipods are most often found in unpolluted clear waters, a condition never present in Ramer's Chapel Bog. Their presence and relative abundance in Glory Hole and Bluff Springs Bogs were sporadic, depending mainly upon the amount of water present during sampling.

Taxa found only in Bluff Springs Bog fail to reflect any distinctive physicochemical characteristics. Rather, the absence of taxa and the presence of such forms as *Tachopteryx* seem to reflect the dried nature of this bog. These bog odonates are known to burrow in substrate adjacent to shores (Needham and Westfall, 1955), and can withstand periods of drought and other adverse environmental conditions. This was the only odonate taken at Bluff Springs bog. The amphipod *Synurella* was found in this bog. Pennak (1978) stated that although amphipods are not generally adapted for withstanding drought, *Crangonyx gracilis* and *Synurella bifurca* are inhabitants of temporary as well as permanent ponds and streams. It has been suggested that these species tide over unfavorable conditions by burrowing into the substrate. This was verified in both Glory Hole and Bluff Springs Bogs during drying conditions when only mud was present.

Within Glory Hole Bog the sapling sites differed as to substratum, water, depth, current, and macroinvertebrates collected. Site One was composed of extremely heavy detritus upon fine, darkly stained silt. Water depth never rose above 6 cm and a current was virtually absent. Among the 32 taxa at this site, common lentic water forms such as *Caecidotea* dominated numerically, followed by amphipods, *Sialis*, and *Bitacomorpha*. These species quickly drop in number at Site Two which is composed of sandy troughs with a slow current present during much of the sampling period. *Cordulegaster* is the numerically dominant taxon here. This effective predator is adapted for burrowing in the sandy substrate by the presence of short, stout legs and tarsal claws. The relative sterility of sand substrates is reflected in the fact that the lowest number of taxa and the lowest standing crops within Glory Hole Bog were at this site. At Site Three, a beaver dam along the north shore

is causing a transition of the bog toward a swamp condition. Water depths range from 15-30 cm. Greater water depth and surface area at this site is utilized by a more diverse macroinvertebrate community, particularly by the highly predatory Hemiptera and Coleoptera. The diversity of microhabitats available within Site Three is clearly reflected in that 53 of the 67 taxa found in Glory Hole Bog were here (Table).

A recommendation to preserve one or more of Arkansas' bogs is strongly indicated by this study. First, bogs in this state are characteristically small, and therefore more subject to damage or alteration due to sand and gravel mining, timbering, or other land uses. Second, they constitute relatively simple ecosystems, thus facilitating the study of the interrelationships of organisms which populate them. Finally, these bogs support a number of species found infrequently and in small numbers within Arkansas. In many instances, they are found only in bogs.

Previous to this study, only three specimens of *Nepa apiculata* had been collected in Arkansas, one each from three different sites. Ten specimens were collected from Glory Hole Bog. One adult specimen of *Gomphaeschna fuscillata* had been previously collected from Arkansas. Virtually nothing is known of its biology. Three naiads were collected from this bog. One adult *Tachopteryx* had been previously collected from northwest Arkansas. Its collection from Glory Hole and Bluff Springs Bogs represent the first naiads taken in this state, as well as the second and third sites for this species. *Erythrodiplax umbrata* has been collected once previously in Arkansas, *Libellula semifasciata* from three scattered Arkansas sites, *L. flavida* from seven sites, *Cordulegaster maculata* and *obliqua* from four and seven sites, respectively (Harp and Rickett, 1977). All these species were collected in Glory Hole Bog.

The presence of so many species in Glory Hole Bog that are rare in the state makes it a prime candidate for preservation. Its relatively large size and its location enhance the probability that preservation efforts would be successful.

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