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Selection of Breeding Ponds by the Ringed Salamander, Ambystoma annulatum

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GENERAL NOTES

SELECTION OF BREEDING PONDS BY THE RINGED SALAMANDER, *AMBYSTOMA ANNULATUM*

The ringed salamander, *Ambystoma annulatum,* is a fossorial woodland species restricted to isolated populations in the Ozark Plateaus and Ouachita Mountains. They migrate to ponds to breed and oviposit during heavy fall rains. Their success depends upon suitable woodland habitat and breeding ponds.

Several investigators have studied the range and natural history of *Ambystoma annulatum* (Stejneger, 1894; Brimley and Brimley, 1951; Blair, 1952; Trapp, 1956, 1959; Spotila and Beumer, 1970; Bonati, 1980). Trapp (1959) noted that the four breeding ponds she studied contained some form of vegetation of varying amounts, were shallow and muddy and contained no fish. She also noted that a short expanse of woodland area was adjacent to all ponds. Spotila and Beumer (1970) added that *A. annulatum* probably migrates to specific breeding ponds each year; similar to *A. maculatum.* The purpose of this investigation was to better define the characteristics of *A. annulatum* breeding ponds.

Two areas in northwest Arkansas which have populations of *A. annulatum* were chosen to study. The first area was located approximately 7.5 miles NE of Fayetteville, Washington County, Arkansas. The second was located over a broader area 2-5 miles west of Decatur, Benton County, Arkansas. Six pairs of ponds were investigated. Each pair consisted of a breeding pond and a pond of similar morphometry within 400 yards that was not used as a breeding site. The ponds were numbered 1-12 such that even numbered ponds were used by salamanders.

Measurements of dissolved oxygen (D.O.), temperature of the water and air, pH, conductivity, total organic carbon and turbidity were taken at each pond. Relative humidity and rainfall were also noted during migration periods. These data were collected just before dawn to insure measurement of D. O. at the low point in the diel cycle. Several measurements of D. O. taken in different parts of each pond were averaged. Breeding activities near Decatur began before the Fayetteville site. From 4 to 25 visits were made to each of the ponds at night and during the day to observe movements of the salamanders and note the occurrance of egg masses.

Adult salamanders were observed in and around the ponds at both study sites for a period of approximately two weeks. Migration to the ponds occurred in the largest numbers during or shortly after precipitation, although some individuals were seen migrating to ponds on partly cloudy nights with intermittent strong moonlight. Mass courtship, liebenspiel (Noble, 1931), was not observed, but it may have occurred and not have been seen due to the turbid water conditions. Eggs occurred attached to vegetation and on the bottom.

Numerous egg masses and one adult were found on 29 September 1981 west of Decatur. Fifteen adults were recorded traveling toward a pond on the night of 7 October 1981. The temperature of the soil was 13.0° C, and water 15.0° C. The relative humidity was 90% and there was no preciptation. On 13 October 1981, 25-30 were observed to be headed toward a pond northeast of Fayetteville. A light rain was falling and the relative humidity was 99%. The temperature of the soil was 17.0° C, air 20.0° C, and water 17.0° C.

The physical-chemical data are summarized in the Table. Breeding ponds generally had slightly higher dissolved oxygen concentrations, although not significantly different. Temperatures were virtually identical between pond pairs (see Table). There was a significant difference ($t = 3.46$, $p < 0.05$) in pH with the ponds used for breeding being slightly more acid. The pH of some ponds would decrease after a rain and gradually increase to pH 6-7 within two weeks. Neither conductivity nor total organic carbon showed any obvious relationship to the presence of breeding salamanders in the ponds. Ponds used for breeding were considerably more turbid ($t = 3.00$, $p < 0.05$) than the ponds not used. All breeding ponds were located in open pasture near woodlands and were heavily used by livestock (five by cattle; one by horses). Use by livestock resulted in greater turbidity and fewer aquatic macrophytes. According to land owners, none of the 12 ponds dry up in years with normal rainfall. Salamanders at both study areas were observed passing within 20 meters of some ponds while headed for a more distant pond for mating.

Results of this study indicate that *A. annulatum* migrates to specific breeding ponds in open areas near woodlands which normally retain water all year. These ponds without exception are heavily used by livestock, have a high turbidity, and contain fewer macrophytes than adjacent ponds. These ponds are also slightly more acid than ponds not used by *A. annulatum.* Spotila and Beumer (1970) stated that while humidity and temperature are the most important factors in the spring migration of *A. maculatum,* heavy rain (greater than 1.27 cm) is the most important factor to *A. annulatum.* Early fall in the Ozarks is a very dry time and a rainfall greater than 1.27 cm would certainly be required to wet the soil sufficiently to maintain a high enough humidity to allow migration to breeding ponds. After the initial migration was triggered by heavy rain, salamander movements were observed on nights when the humidity was high. The rain is necessary, but like *A. maculatum, A. annulatum* migration is heavily dependent upon humidity level.

When the first settlers arrived in Arkansas, the native mammal fauna included buffalo (Sealander, 1979). These animals wallow in mud to free themselves from insect pests (Palmer and Fowler, 1975). The ponds frequented by buffalo deepened with time because of dredging effects. The ringed salamander apparently adapted to using these buffalo-wallow ponds. Their increased turbidity offered some protection for the larvae from predators using visual cues. Also, these ponds probably insured sufficient water for breeding activity. Continued success of this salamander species appears to be related to the present methods of livestock production in the Ozarks.

Pond Number	Dissolved Oxygen (MG/L)	Temperature (° C)	pH	Conductivity (mhos/CM)	Turbidity (NTU)	TOC (mg/L)
1	5.4	18	5.0	75	37	18.7
2	3.7	19	4.8	140	228	36.7
3	0.87	18	5.5	130	190	31.0
4	2.9	18	4.5	50	426	20.7
5	1.4	18	5.5	140	30	25.4
6	8.8	18	4.8	65	65	32.2
7	1.5	16	5.5	130	102	24.5
8	4.7	18	5.0	91	390	31.7
9	6.2	9	6.7	71	90	20.0
10	8.0	9	6.0	69	163.5	25.8
11	6.1	9.5	6.0	71	10.9	18.0
12	7.3	9.5	6.0	69	26.0	14.0

Table. Physical and chemical characteristics of ponds utilized by *Ambystoma Annulatum* (even numbered ponds) for breeding and oviposition, with adjacent unused ponds for comparison. Ponds 1-8 were located near Decatur, Arkansas, in Benton County and were studied 16 October 1981. Ponds 9-12 were located northwest of Fayetteville and data were collected 28 October 1981.

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WATER CHEMISTRY OF FARM PONDS IN ARKANSAS

There are more than 100,000 farm ponds in Arkansas. Most were constructed in the last 30 years for multiple use purposes and are used for fish production, swimming, livestock drinking water, domestic household water, and irrigation.

Water quality concerns led us to begin an educational program in the fall of 1978 aimed at farm pond management. More than 1,000 water samples were tested at farm pond clinics during the following three-year period using the University of Arkansas Mobile Lab (Figure). Objectives were to: 1) Characterize water chemistry of farm ponds, 2) make recommendations to farm pond owners based on water chemistry, and 3) collect and summarize water chemistry data for future reference.

Water samples from farm ponds were taken by the owners on the day the samples were analyzed. Measurements of total alkalinity, total hardness, specific conductance, turbidity, iron, nitrate, pH and other analyses were made using a Hach Water Analysis Kit (Model DR-EL/4). This Kit is similar to the one used by Horn and Garner in their pre-impoundment studies of Beaver Reservor (1965). The Hach Kit utilizes wet chemical methods described in standard methods published by APHA/AWWAW/WPCF (1975). Results from the use of the kit compare favorably with those obtained by standerd chemical methods (Boyd, 1977, 1979). Total alkalinity was titrated to the Brom Cresol Green-Methyl Red endpoint with 0.02 N sulfuric acid. Total hardness was titrated with TitraVer Hardness Titrant (ethylene diamine tetracetic acid disodium salt). The specific conductance was determined by an electrical conductivity meter with a range of 0-20,000 micromhos per centimeter (μmhos/cm). Iron was determined by the 1, 10-Phenanthroline method at 510 nm. Nitrate was determined by the cadmium reduction method at 500 nm. Total hardness, alkalinity, nitrate, and iron, were reported as milligrams per liter (mg/1). Turbidity was determined by the absorptometric method at 450 nm expressed in Formazin Turbidity Units (FTU), which are equivalent to Jackson units. A portable digital pH meter, capable of measuring pH over the full 0-14 range, was used to determine the pH.

In general, water samples from ponds in the 39 counties reflected differences in soils and geology (Tables 1 and 2). Fish ponds in Chicot County were an exception to this. These ponds are filled from wells containing relatively high concentrations of salts. Essentially, all of the other ponds are filled from surface rainwater.

The farm pond analyses were summarized in Table 3 according to major soil areas as described by the Soil Conservation Service (1967). Pond waters from the Ozark Highlands reflect the limestone geology. These waters contain relatively high mineral contents. In contrast, the sandstone and shale geology of the Boston Mountains, Arkansas Valley Uplands, Ouachita Mountains, and Coastal Plains is reflected by the relatively low mineral content of the waters. The four samples collected from farm ponds in the Blackland Prairie area reflect the chalky, limestone geology.

One major environmental concern is that of nitrates in drinking water. In no case did pond water nitrates exceed the U. S. Public Health Service standard (1962) of 45 mg/1. Average nitrate values exceeded 2 mg/1 in only two counties.

Most of the farm pond water samples from the Bottomlands and Terraces area were from Chicot County. They reflect well waters high in total salts (average specific conductance of 1787 μmhos/cm; average turbidity of 15 FTU). Major soil areas were not identified for more than half of the pond samples.

Water samples were collected in 8 different months from April through December during the three-year sampling period. Analyses of the samples did not seem to reflect definite trends in water chemistry by month of sampling.