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# Notes on the Salamanders of Arkansas

Charles C. Smith
*Lyon College*

# NOTES ON THE SALAMANDERS OF ARKANSAS
## #1 Life History of a Neotenic Stream-Dwelling Form

Charles C. Smith
Arkansas College

## INTRODUCTION

While working with collections of salamanders from small streams, springs, and caves in the vicinity of Batesville (Independence County), Arkansas, one larval form was found which could not be identified with any known species. Because of the number of costal groves (15-16), and the number of intercostal folds between toes of appressed limbs (4-5-6), the specimens will not fit Bishop's(1) description of larval Typhlotriton nereus or of T. spelaeus. (Fig. 1.)

In this paper I am presenting evidence that this salamander is at least partially neotenic, that it varies from the larvae of Typhlotriton spelaeus in certain measurements and that for a portion of its life bears many light organs distributed in a regular pattern. Also presented are some interesting aspects of its life history.

These larval salamanders were very abundant in one spring (Fair Spring) and present in lesser numbers in several other places. Several hundred specimens have been collected during the past year, ranging from unhatched larvae to sexually mature but unmetamorphosed individuals.

Collections have been made monthly from several locations and have provided ample material for studying the reproductive cycle. Efforts were made to collect this salamander over a wide area to determine its range and habitat. During June and July, 1958, collecting activities were extended about 100 miles west and north of the original locations. Specimens from Hurricane Cave and a large spring west of Marshall (both in Searcy County) represent the westernmost collections and Howell County, Missouri, the northernmost. None has been

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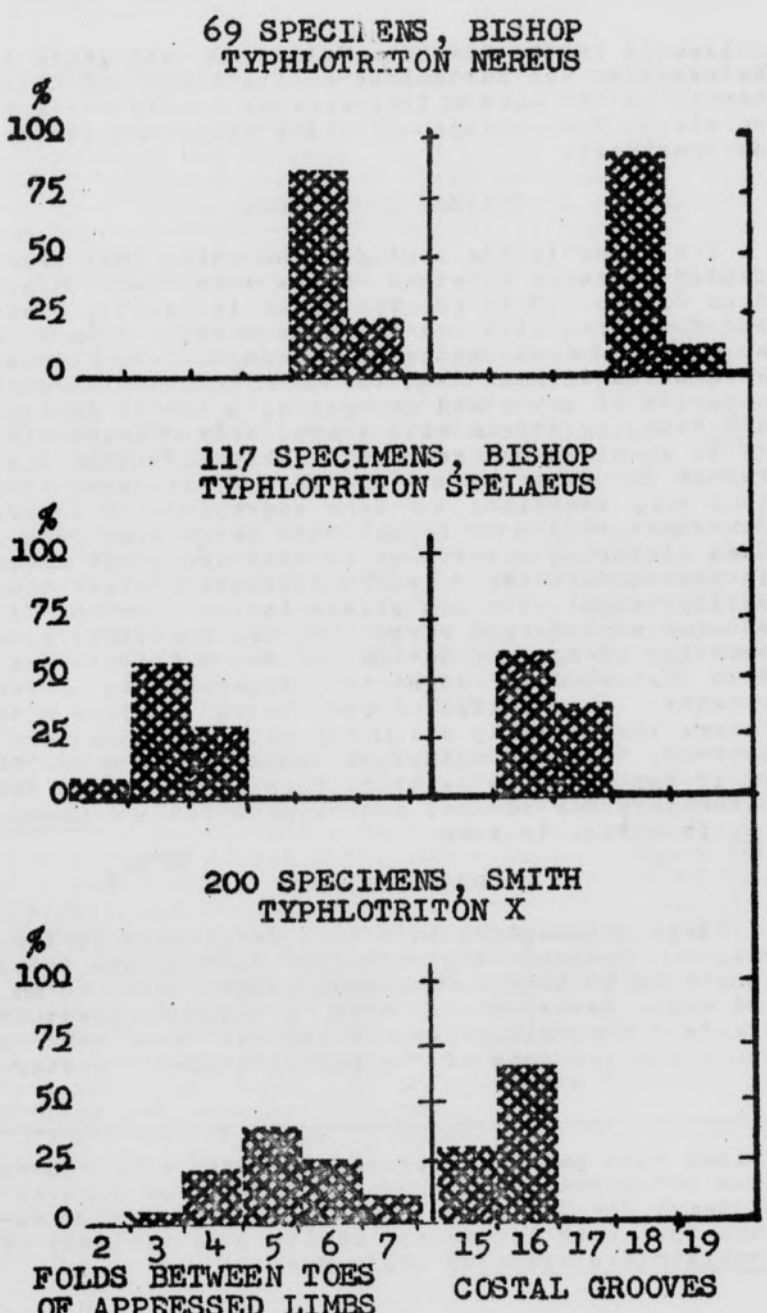
69 SPECIMENS, BISHOP
TYPHLOTRITON NEREUS
%
100
75
50
25
0
117 SPECIMENS, BISHOP
TYPHLOTRITON SPELAEUS
%
100
75
50
25
0
200 SPECIMENS, SMITH
TYPHLOTRITON X
%
100
75
50
25
0
2 3 4 5 6 7
FOLDS BETWEEN TOES
OF APPRESSED LIMBS
15 16 17 18 19
COSTAL GROOVES

FIGURE 1

collected in the Ouachita Uplift to the south of Batesville. The bottomland on the Black and White Rivers on the east of Independence County serve as barriers. The springs on Crowley Ridge have yielded no specimens.

## HABITAT CONDITIONS

The water in the springs from which this salamander has been obtained varies from 57-60° F. and from 6.1 to 6.7 in pH. The water is usually clear and free from silt and trickles or boils from sand or gravel in the bottom to form a free flowing stream. In Cushman Cave, the water descends through a series of tubes and emerges as a swift flowing and tumbling stream with gravel beds at intervals.

No specimens are seen until they have been disturbed by stirring of the gravel, at which time they may sometimes be seen scurrying for cover. Sometimes they are found under large flat rocks. When disturbed in swift water they are swept along in the current for a short distance and are thus easily caught in a net placed in the current. In streams coming from caves they are sometimes seen crawling along the bottom in the twilight zone. When disturbed by light they disappear in a few seconds. When collected and placed in jars with water, they quickly die if the water becomes warm. However, they can withstand temperatures up to 70° F. if the water is aerated. Specimens kept in the laboratory for several months have fed on Gammarus from time to time.

## DESCRIPTION

These salamanders have been found only as larvae, or neotenic individuals,[1] with mature total length of 90 to 120 mm., body length 50 to 60 mm. and wide heads, often with prominent parotoid glands. A prominent groove extends from between the posterior ends of the parotoid glands poster-

[1]Since this paper was prepared, three adults have been collected which appear to be the same species. At least one has normal eyes. It seems best to assume that both larvae and adults are variants of Typhlotriton spelaeus Stejneger.

iorly to near the origin of the caudal fin. The legs are slender. There are four toes on the front feet and five on the rear. There are fifteen or sixteen costal grooves and usually four to six intercostal folds between the toes of the appressed limbs. The tail makes up 45-65 per cent of total length. The tail is much compressed posteriorly and bears a rather wide fin dorsally, somewhat narrower ventrally and with the end pointed.

The dorsal and lateral ground color is light brown. Usually there is an irregular yellowish brown band mid-dorsally and dorso-lateral bands formed by a series of 20-30 yellow spots. Sometimes a row of ventro-lateral spots is also present.

Some or all of these spots have a light organ in the center which glows brightly while the animal is alive and healthy. In preservative those light organs appear as white dots in the center of the larger yellow spots.

Chromatophores form a netlike pattern over the base color and when fully expanded the dorsal side (except for the edge of the fin which remains yellow-brown) appears dark. When the chromatophores are contracted, the dorsum is light colored. Old individuals seem to lose the pigment from the chromatophores and also the yellowish background so that they appear flesh-colored, with the yellow spots unchanged.

Light organs occur in a circle around the eyes and extend forward in a band from each eye to the upper lip in the region of the naso-labial groove where the band extends back along the upper lip to just above the ends of the gular fold. A short row of 8 or 10 organs starts at the dorsal end of the operculum and extends forward to the posterior edge of the lateral lobe of the parotoid gland. Full-grown individuals have prominent parotoid glands.

The venter is flesh-colored with the heart showing through the body wall as a deep red or maroon spot just posterior to the center of the gular fold. There are three epibranchials on each side; these have numerous, fairly short rami, are biconvex in outline and densely ciliated.

The eyes vary greatly in development. In shaded springs or where access to a subterranean stream is available, the older individuals may be almost sightless, the eye covered by growth of the surrounding tissue.

One is at once struck by the heavy-set appear-

ance of the older individuals. Those above 50 mm in body length (90-100 total) are all more than 10 mm in diameter midway between the pectoral and pelvic girdles.

The males over 60 mm and the females over 80 mm in total length appear to be sexually mature.

Neoteny was early suspected since only the large "larvae" were found with the newly-hatched young around the outlets of springs. Proof of neoteny was not obtained until later when the large females became swollen with eggs.

## LIFE HISTORY

In one particular spring we have followed the activities of this salamander closely. This is Fair Spring, located about 3½ miles southeast of Cushman in Independence County, Arkansas. Water flows from several outlets in the wet season and the balance of the time water flows up through a gravel bed, creating a boiling effect. The water temperature stays between 57 and 60°. The flowing water creates a stream about 3 feet wide, 3 inches deep and approximately 100 feet long, at which point it tumbles down a short, rocky slope and runs into Polk Bayou. The first collection was made the first of January, 1958, at which time very small larva, and full-grown gilled individuals were very abundant in the first 100 feet of the small stream as well as in the spring pool. Until disturbed, all sizes and ages stay well down in the gravel or under stones and their presence would not be suspected. They were easily captured with a nylon aquatic net and a potato rake. Associated with these salamanders is the salamander Eurycea longicauda melanopleura. Small arthropods including Oniscus and Gammarus furnish most of the food for the salamanders.

When the salamanders are disturbed, the larger ones eagerly devour the smaller ones. When the specimens are dropped into formalin after capture, frequently various recently-swallowed food items are regurgitated, including smaller salamanders.

The fully-developed individuals remain well distributed the length of the spring-runs from early January until August or September. After the first collection from Fair Spring, collecting was restricted to sampling the gravel at intervals to ascertain the presence and abundance of these sal-

amanders. A few were retained each time and the rest released.

In May and June the largest females appeared to be swollen with eggs. Dissection revealed oviducts well filled and the ovaries still enlarged and producing eggs. It was hoped at the time that I would be able to follow the reproductive cycle although I was somewhat puzzled by the development of eggs in the early summer.

However, from July through December, 1958, the large females had disappeared from the stream, while fairly large males remained. Since the spring at that time was producing a comparatively small amount of water, the spring pool was small, about 4 feet across and 3 or 4 inches deep, with water boiling up through fine gravel. In August, I decided that the large females and probably part of the males must be migrating into the underground stream. Since there was no open outlet, it seemed likely that some individuals might be deep in the gravel through which the water flows. Gravel and water were dipped out with a bucket and emptied on dry ground. Several full-grown specimens were taken from each bucket of gravel for as far down as we could go, which was about 2 feet. Coarse rocks and gravel were beneath the fine gravel. Later on we counted the males and females we had collected over a ten-month period and found we had 74 percent males and 26 percent females. This seemed to indicate that as sexual maturity approaches, the females first, then the males follow the stream of water back into the ground, where egg laying takes place. The young come out into the open shortly after hatching, about December 15 to January 1. The adults reappear at the head of the head of the streams in January and move down-stream during the next few weeks.

During the period of time covered by the above notes, that is, January 1, 1958 until March 15, 1959, I have also followed the life history of this salamander in two other locations, following the same schedule. Cushman Cave is about 3 miles west of the town of Cushman. This very large cave has a swift stream meandering throughout its length, often under masses of fallen rock. Inside the entrance and to one side, the water drops almost vertically through a natural tube in the limestone and reappears as a spring about 100 feet below the cave. The distribution and size of individuals was identical with those of Fair Spring. On December

31, 1957, a group of boy scouts and I followed the stream of water throughout its length, much of the time on hands and knees. We stirred the gravel and caught the outwash. Many tiny larval salamanders were captured, some just hatched; the rest still in the gelatinous egg membranes. Various white blind arthropods were also captured. No adult salamanders were obtained at this time.[2] Adults of Eurycea lucifuga and E. longicauda melanopleura are fairly common in the cave.

We were working in the cave trying to find Typhlotriton spelaeus, which we assumed should be there, and supposed that we had the eggs and young of that species, or if not, then of E. lucifuga or E. longicauda melanopleura. The same large "larvae" we later collected from Fair Spring were collected in number from the stream below the spring in the valley below Cushman Cave. These, too, we supposed to be Typhlotriton spelaeus. When the tiny larvae were examined, they were found to be the same species as the larger larvae. For the next few months we carefully examined every cave we could find and get into in an ever-widening circle around Batesville, finally working in southern Missouri where one adult of T. spelaeus was found, but few larvae and these somewhat different from the many hundred larvae we had accumulated.

We finally had collections of this salamander from 14 locations, all larvae. This year the cycle of reproduction was identical to that of last year. On December 29, we went through Cushman Cave again in the same manner as a year earlier. We got the same-sized larvae and eggs, no large specimens. The main difference was that this time I found the eggs attached singly to the edges of rocks in the swift current. The large amount of yolk in the unhatched eggs makes them easy to see as they are moved back and forth by the current.

The spent females return to the open stream after depositing their eggs and in both years were common just below the springs we studied, later being found some distance from the spring. Then in July or August they reverse their direction and re-enter underground streams, leaving the males to

[2] One adult has since been captured in this cave. It has normal appearing eyes and is smoky colored.

follow. Their body cavities are filled with fat at this time and it is possible that little feeding is done underground before egg laying.

Although neoteny in this salamander was suspected shortly after the first few collections, it was not until the second season that I felt that it had been demonstrated.

We kept specimens that were collected in July in the laboratory until March. Experiments using potassium iodide and beef thyroid to induce metamorphosis were unsuccessful. This work is continuing. Positive identification as to species, or even to genus cannot be made with the larvae, although there is little doubt in my mind that it is a form of Typhlotriton.

## SUMMARY AND CONCLUSION

The life history of an unidentified neotenic salamander was studied carefully over a large area for the past 15 months. These conclusions were reached, based on accumulated data:

(1) The larvae show significant variation from published descriptions of Typhlotriton spelaeus and Typhlotriton nereus, although they occur in a type of habitat usually occupied by these species.

(2) The presence of a definite pattern of light organs appears to be unique.

(3) The sexually-mature individuals enter underground water in the late summer to lay their eggs; the exact date is not known. In all cases where complete records have been obtained, the very young larva appear in the spring pools and hatching eggs have been found on about January 1 of each year.

(4) The spent adults reappear in the open streams before the young larvae appear and slowly spread downstream until midsummer, at which time they return to enter the springs for breeding.

(5) No name is suggested in this paper because of uncertainty as to the affinities with other salamanders. Studies now in progress may provide sufficient information to classify the organism properly in the near future.[3]

[3]Since the above was written, adults have been obtained. They agree in most respects with the descriptions of Typhlotriton spelaeus Stejneger.

## LITERATURE CITED

(1) Bishop, Sherman C. A New Plethodont Salamander with Notes on Related Species. Copeia: 1944, No. 1, pp. 1-5.

(2) Dunn, E. R. 1926. The Salamanders of the Family Plethodontidae. Smith College Anniversary Series.