

# HELMINTHS OF THREE SYMPATRIC SPECIES OF CAVE-DWELLING SALAMANDERS IN SOUTHERN ILLINOIS

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**ABSTRACT.**—Samples of three sympatric species of salamanders comprising 322 zigzag salamanders, *Plethodon dorsalis*, 41 slimy salamanders, *P. glutinosus*, and 17 cave salamanders, *Eurycea lucifuga*, were collected in a cave in southern Illinois and examined for helminths. The parasites recovered included *Brachycoelium* sp., *Cosmoceroides dukae*, *Oxysomatium* sp. and *Physaloptera* sp. The occurrence of *Brachycoelium* sp. and *C. dukae* in *P. dorsalis* constitutes new host records. Checklists of these helminths from salamanders in the contiguous United States are included.

While the literature on helminth parasites of amphibians in the contiguous United States is extensive, the majority of reports are confined primarily to the parasites of anurans. With the exception of comprehensive surveys conducted by Harwood (1932), Mann (1932), Rankin (1937, 1945) and Fischthal (1955a), little is known of salamander helminths. The majority of papers are restricted either to descriptions of new species or lists of helminths in a few salamanders made in connection with more extensive studies on other amphibians and reptiles.

Although the biology and habitats of several species of salamanders in southern Illinois have been investigated, little information on their helminth fauna is available. A previous survey of parasites in salamanders of this region was undertaken by Landewe (1963). However, his information has not been published. An account of the intestinal helminths of three sympatric species, *Plethodon dorsalis*, *P. glutinosus* and *Eurycea lucifuga*, is presented in this paper.

All salamanders were collected in Equality Cave, five miles southwest of Equality, Saline County, Illinois between November, 1963 and September, 1967. Although collections were made systematically, by month, for studies of salamander reproductive cycles, the number of specimens of *P. glutinosus* and *E. lucifuga* was regrettably low in comparison to *P. dorsalis*, resulting in insufficient data for analysis of seasonal abundance of helminths. These salamanders are not limited to caves, but *E. lucifuga* is basically an inhabitant of cave entrance ways, and the other two species, though inhabitants of forest floors, commonly use caves as brooding sites, and as retreats from drying woodlands.

None of the mature parasites examined are considered as new, but we report new host records and extend the known geographical range of several species.

## MATERIALS AND METHODS

As the primary purpose for collecting these salamanders involved studies of reproductive cycles, the 380 salamanders including 322 *P. dorsalis*, 41 *P. glutinosus* and 17 *E. lucifuga* were fixed in 10% formalin and transferred to 70% ethanol. Since the entire digestive tract was placed in alcohol, few protozoans were found in a condition that would warrant accurate identification. Trematodes were stained with Schneider's acetocarmine or Delafield's hematoxylin, cleared in beechwood creosote and mounted in Permount. Nematodes

TABLE 1.—Intestinal helminths of 380 salamanders collected in Equality Cave, Saline Co., Illinois.

Species of parasite	Species of salamander	Number examined	Number infected	Per cent infected
<i>Brachycoelium</i> sp.	<i>Plethodon dorsalis</i>	322	34	10.6
	<i>Eurycea lucifuga</i>	17	1	5.9
	<i>Plethodon glutinosus</i>	41	10	24.4
<i>Cosmocercoides dukae</i>	<i>Plethodon dorsalis</i>	322	13	4.0
	<i>Eurycea lucifuga</i>	17	3	0.9
<i>Oxysomatium</i> sp.	<i>Eurycea lucifuga</i>	17	1	5.9
<i>Physaloptera</i> sp.	<i>Plethodon dorsalis</i>	322	1	0.3

were cleared in glycerine and studied in temporary mounts. The anterior ends of some specimens were removed and mounted in glycerine-jelly for *en face* studies.

#### RESULTS AND DISCUSSION

Two species of nematodes and one trematode were recovered from 46 of 322 specimens of *P. dorsalis* and 4 of 17 of *E. lucifuga*. One species of trematode was found in 10 of 41 specimens of *P. glutinosus* (Table 1). The absence of tapeworms and acanthocephalans in *Plethodon*, which has a completely terrestrial life cycle, is not surprising. The occurrence of cestodes in salamanders appears to be essentially correlated with an aquatic environment. According to Rankin (1937) many larval salamanders become accidentally infested by ingesting infected copepods but the cestodes mature in few salamander species. Their absence in *E. lucifuga*, which does have an aquatic larval stage, may be an artifact of small sample size.

#### TREMATODA

##### *Brachycoelium* sp.

Species of *Brachycoelium* are the most common flukes encountered in salamanders and in the present study *Brachycoelium* sp. was the only fluke collected. It was recovered from the

small intestine of 45 (11.8%) of 380 salamanders examined. All three species of salamanders were found infected with this parasite. It occurred as a single infection in 41 salamanders and as a double infection with *Cosmocercoides dukae* in 3 *P. dorsalis* and 1 *E. lucifuga*. In *E. lucifuga*, only 5.9% of the hosts examined were infected and the average number of flukes per host was 4.3, while the terrestrial species, *P. dorsalis* and *P. glutinosus* were 10.6 and 24.4% infected, respectively. In *Plethodon*, the number of flukes per host ranged from 2 to 30. Crowding appeared to have a direct effect on the size of the flukes substantiating the conclusions of Rankin (1938) that heavy infections of *B. salamandrae* tend to produce many small flukes, whereas light infections are usually made up of larger specimens.

Landewe (1963) found *B. salamandrae* in *Ambystoma maculatum*, *A. opacum*, *A. talpoideum*, *Eurycea longicauda*, *E. lucifuga* and *Plethodon glutinosus* in Illinois. To our knowledge *P. dorsalis* constitutes a new host record for *Brachycoelium* sp.

Considerable differences of opinion exist in regard to the number of species in the genus *Brachycoelium*. Those reported exhibit wide variability in regard to size, shape and position of specific characters. Stafford

(1900) described *Distomum hospitale* from *Notophthalmus viridescens* in Canada, the first species of *Brachycoelium* reported from North America, and in 1903 assigned it to the proper genus. Since Stafford's report several species have been added as follows: *B. obesum* Nicoll, 1914; *B. trituri* Holl, 1928a; *B. storeriae* Harwood, 1932; *B. meridionalis* Harwood, 1932; *B. daviesi* Harwood, 1932 and *B. lynchi* Ingles, 1936. Byrd (1937) described five new species: *B. mesorchium*, *B. georgianum*, *B. ovale*, *B. dorsale*, and *B. louisianae*.

Rankin (1937) reduced *B. obesum*, *B. daviesi*, *B. meridionalis*, *B. storeriae* and *B. trituri* to synonymy with *B. hospitale*. In 1938, the same author presented a classic study on the variability of morphological characters in *Brachycoelium* in an attempt to evaluate their reliability for separation of species. He pointed out the error of many previous workers in describing new species on the basis of data obtained by examination of a few specimens from an individual host and demonstrated that while certain features may seem to be divergent enough to justify describing a new species they can only be fully evaluated when observed on many individuals from various hosts. Rankin concluded that the genus *Brachycoelium* is represented in North America by a single species, *B. salamandrae*. Manter (1938) also indicated the taxonomic difficulties existent in this genus and the doubtful validity of many characters considered to be diagnostic of species.

Parker (1941) and Cheng (1958), however, opposed any attempt to synonymize the various North American species of *Brachycoelium* and recognized 7 and 10 distinct species of *Brachycoelium*, respectively.

Cheng and Chase (1961) and Couch (1966), respectively, added

*B. stablefordi* and *B. ambystomae* to the genus.

Rankin (1938), Parker (1941) and Cheng (1958) unanimously agreed that the problem of species evaluation would have to be resolved, eventually, by life history studies.

To our knowledge, only two life history studies have been reported, those of *B. obesum* and *B. mesorchium* by Cheng (1960) and Jordan (1962), respectively. Both species utilize terrestrial snails as intermediate hosts. The study on *B. obesum* seems questionable since Cheng failed to explain how he determined the intermediate hosts were parasite-free prior to challenge. Jordan concluded that more than one species of *Brachycoelium* must be recognized for the following reasons: (1) *Brachycoelium* eggs from different definitive hosts would not develop in the same intermediate host, (2) similar snail hosts failed to become infected when exposed to eggs from similar definitive hosts from a different region, and (3) *B. mesorchium* failed to develop in some of the proven definitive hosts of *Brachycoelium*.

We have experienced difficulty in assigning specimens to described species because of variation in so-called specifically valid characters and for this reason, all specimens of *Brachycoelium* reported in this investigation are referred to as *Brachycoelium* sp.

The following list represents the geographical distribution of *Brachycoelium* reported from various salamander hosts in the contiguous United States. In view of the taxonomic problem of species recognition, scientific names of these flukes are given as originally reported with the exception *B. salamandrae* (= *B. hospitale*).

*Ambystoma jeffersonianum* — *B. salamandrae*, Massachusetts (Rankin, 1945).

- Ambystoma macrodactylum* — *B. salamandrae*, Idaho (Waitz, 1961).
- Ambystoma maculatum* — *B. salamandrae*, N. Carolina (Rankin, 1937, 1938), Massachusetts (Rankin, 1945), Illinois (Landewe, 1963).
- Ambystoma opacum* — *B. ambystomae*, Florida (Couch, 1966); *B. dorsale*, Louisiana (Byrd, 1937); *B. louisianae*, Louisiana (Byrd, 1937); *B. salamandrae*, N. Carolina (Mann, 1932; Rankin, 1937, 1938); Illinois (Landewe, 1963); *B. storeriae*, Tennessee (Parker, 1941).
- Ambystoma talpoideum* — *B. salamandrae*, Illinois (Landewe, 1963).
- Ambystoma texanum* — *B. daviesi*, Texas (Harwood, 1932); *B. salamandrae*, Texas (Harwood, 1932).
- Amphiuma tridactylum* — *B. salamandrae*, Louisiana (Bennett and Humes, 1938).
- Desmognathus fuscus* — *B. meridionalis*, Georgia (Parker, 1941); *B. mesorchium*, Georgia (Byrd, 1937; Parker, 1941; Denton, 1962), Virginia (Cheng, 1958); *B. obesum*, Georgia (Byrd, 1937; Parker, 1941); *B. ovale*, Georgia (Parker, 1941); *B. salamandrae*, N. Carolina (Mann, 1932; Rankin, 1937), Massachusetts (Rankin, 1945), Ohio (Odlaug, 1954), New York (Fischthal, 1955a), Pennsylvania (Fischthal, 1955b), Tennessee (Rankin, 1938); *B. trituri*, Georgia (Byrd, 1937).
- Desmognathus ochrophaeus carolinensis* — *B. salamandrae*, N. Carolina (Rankin, 1937).
- Desmognathus monticola* — *B. elongatum*, Virginia (Cheng, 1958); *B. salamandrae*, N. Carolina (Rankin, 1937).
- Desmognathus quadramaculatus* — *B. elongatum*, Virginia (Cheng, 1958); *B. salamandrae*, N. Carolina (Rankin, 1937).
- Eurycea b. bislineata* — *B. salamandrae*, Massachusetts (Rankin, 1945), New York (Fischthal, 1955a), Pennsylvania (Fischthal, 1955b).
- Eurycea b. cirrigera* — *B. obesum*, Georgia (Parker, 1941); *B. salamandrae*, N. Carolina (Mann, 1932; Rankin, 1937).
- Eurycea b. wilderae* — *B. salamandrae*, N. Carolina (Rankin, 1937).
- Eurycea longicauda* — *B. salamandrae*, Illinois (Landewe, 1963).
- Eurycea longicauda guttolineata* — *B. salamandrae*, N. Carolina (Rankin, 1937).
- Eurycea lucifuga* — *B. salamandrae*, Illinois (Landewe, 1963).
- Gyrinophilus p. porphyriticus* — *B. salamandrae*, New York (Fischthal, 1955a).
- Hemidactylium scutatum* — *B. salamandrae*, Michigan (Rankin, 1938).
- Notophthalmus meridionalis* — *B. daviesi*, Texas (Harwood, 1932); *B. meridionalis*, Texas (Harwood, 1932).
- Notophthalmus viridescens* — *B. salamandrae*, Michigan (Cort, 1915, 1919), N. Carolina (Mann, 1932; Rankin, 1937, 1938; Russell, 1951), New York (Rankin, 1938; Fischthal, 1955a), Virginia (Russell, 1951), Massachusetts (Rankin, 1938, 1945), Pennsylvania (Kelley, 1934); *B. trituri*, N. Carolina (Holl, 1928a, 1932), Massachusetts (Kelley, 1934), Ohio (Kelley, 1934), Virginia (Cheng, 1958).
- Phacognathus hubrichti* — *B. salamandrae*, Alabama (Brandon, 1965).
- Plethodon cinereus* — *B. louisianae*, Virginia (Cheng, 1958); *B. obesum*, Virginia (Cheng, 1958, 1960), Pennsylvania (Cheng, 1960); *B. salamandrae*, N. Carolina (Rankin, 1937, 1938), Massachusetts (Rankin, 1945), New York (Fischthal, 1955a), Pennsylvania (Fischthal, 1955b), Virginia (Cheng, 1958); *B. storeriae*, Virginia (Cheng, 1958), Pennsylvania (Cheng and Chase, 1961).
- Plethodon glutinosus* — *B. elongatum*, Virginia (Cheng, 1958); *B. meridionalis*, Georgia (Parker, 1941); *B. obesum*, S. Carolina (Byrd, 1937), Georgia (Parker, 1941), Pennsylvania (Cheng, 1960), Virginia (Cheng 1958, 1960); *B. ovale*, Georgia (Parker, 1941); *B. salamandrae*, N. Carolina (Mann, 1932; Rankin, 1937, 1938), Louisiana (Byrd, 1937), Tennessee (Rankin, 1938), New York (Fischthal, 1955a), Virginia (Cheng, 1958), Illinois (Landewe, 1963); *B. storeriae*, Pennsylvania (Cheng and Chase, 1961).
- Plethodon j. jordani* — *B. salamandrae*, N. Carolina (Rankin, 1938).
- Plethodon j. metcalfi* — *B. salamandrae*, N. Carolina (Rankin, 1937, 1938).
- Plethodon yonahlossee* — *B. salamandrae*, N. Carolina (Rankin, 1937).
- Pseudotriton ruber* — *B. salamandrae*, N. Carolina (Rankin, 1937, 1938); *B. storeriae*, Georgia (Parker, 1941).
- Taricha granulosa* — *B. salamandrae*, Oregon (Lehmann, 1954).

## NEMATODA

*Cosmocercoides dukae* (Holl, 1928) Wilkie, 1930

This species was the most common nematode encountered. It was found in the large intestine of 16 (4.2%) of 380 salamanders examined. Infections varied from 1 to 15 specimens per host with an average of 2.4. It

occurred as a single infection in 12 salamanders and as a double infection with *Brachycoelium* sp. in 3 *Plethodon dorsalis* and 1 *Eurycea lucifuga*. This parasite has been recorded from many terrestrial and aquatic amphibians and reptiles in the United States and Canada. This is the first report of this species from *P. dorsalis* and the second from *E. lucifuga*. Landewe (1963) found this nematode in several salamanders in southern Illinois, including *Ambystoma maculatum*, *A. opacum*, *A. talpoideum*, *A. texanum*, *Eurycea lucifuga*, *Plethodon cinereus* (because of the collection locality, these must be *P. dorsalis*) and *P. glutinosus*.

Several authors have reported life history studies of this parasite. Anderson (1960) described the development and transmission of nematodes of terrestrial molluscs which he tentatively identified as *Cosmocercoides dukae*. Anderson (1960) and Ogren (1953) demonstrated that third-stage larvae enter the respiratory pore of snails and develop in the mantle cavity. In addition, Anderson (1960) described transovarial infection in snails. McGraw (1968) showed that snails can also become infected by ingesting contaminated amphibian feces. Anderson (1960) also showed that worms of all stages from molluscs fed to amphibians were passed at intervals in the feces and he found no evidence that this species could establish itself in amphibians. He concluded that the ability of all stages to survive indefinitely in the external environment and to pass unharmed through the gut of amphibians must be important factors in the dissemination of *C. dukae*.

The following list shows the geographical distribution of *C. dukae* reported from salamanders in the contiguous United States.

*Ambystoma maculatum* — Illinois (Landewe, 1963).

*Ambystoma opacum* — N. Carolina (Mann, 1932; Rankin, 1937), U.S.A. (Walton, 1933), Ohio (McGraw, 1968), Illinois (Landewe, 1963).

*Ambystoma talpoideum* — Texas (Harwood, 1932; Ingles, 1936), Florida (Walton, 1938), Illinois (Landewe, 1963).

*Ambystoma texanum* — Texas (Harwood, 1932), U.S.A. (Walton, 1933), Illinois (Landewe, 1963).

*Desmognathus fuscus* — N. Carolina (Rankin, 1937), Ohio (Odlaug, 1954; McGraw, 1968), Pennsylvania (Fischthal, 1955a).

*Eurycea bislineata* — Ohio (McGraw, 1968).

*Eurycea lucifuga* — Illinois (Landewe, 1963).

*Notophthalmus meridionalis* — Texas (Harwood, 1930; Walton, 1933).

*Notophthalmus viridescens* — N. Carolina (Holl, 1928b, 1932; Harwood, 1932; Rankin, 1937), Massachusetts (Rankin, 1945), New York (Fischthal, 1955a), Pennsylvania (Fischthal, 1955b), U.S.A. (Walton, 1933).

*Plethodon cinereus* — N. Carolina (Rankin, 1937), Massachusetts (Rankin, 1945), Illinois (Landewe, 1963) (actually *P. dorsalis*).

*Plethodon glutinosus* — N. Carolina (Rankin, 1937), Illinois (Landewe, 1963), Ohio (McGraw, 1968).

*Plethodon longicrus* — N. Carolina (McGraw, 1968).

*Taricha granulosa* — Oregon (Lehmann, 1954).

*Taricha torosa* — California (Harwood, 1932; Ingles, 1936; Lehmann, 1954), Florida (Walton, 1938).

*Oxysomatium* sp.

A single male specimen was collected from the large intestine of a *Eurycea lucifuga*. Unfortunately, the worm was in poor condition, thus precluding specific identification. The characters of the described species of *Oxysomatium* and *Aplectana* are so intermingled that it is difficult to determine with certainty the genus in which a species should be placed. We agree with the conclusions of Fotedar (1960) that *Aplectana* should fall as a synonym of *Oxysomatium*. *Oxysomatium* sp. has also been found in *Plethodon cinereus* (actually *P. dorsalis*) in Illinois (Landewe, 1963). Mann (1932) reported *Oxy-*

*somatium* sp. from *Ambystoma opacum*, *Plethodon glutinosus* and *Notophthalmus viridescens* in North Carolina. Fischthal (1955a) recovered *O. americana* from *Eurycea b. bislineata* and *Desmognathus fuscus* and *O. longicaudata* from *P. glutinosus* and *Gyrinophilus p. porphyriticus* in south-central New York. *Pseudotriton r. ruber* was listed by Walton (1933) as a host of *O. brevicaudata* but the locality was not given.

#### *Physaloptera* sp.

Three unidentified larvae of the genus *Physaloptera* were recovered from the stomach of a single *Plethodon dorsalis*. To our knowledge no specimens of *Physaloptera* found in salamanders in the United States have been identified to species. *Physaloptera* larvae have been reported from salamander hosts as follows: *Ambystoma opacum* — N. Carolina (Mann, 1932); *Desmognathus fuscus* — N. Carolina (Mann, 1932; Rankin, 1937), Georgia (Reiber et al., 1940); *Notophthalmus viridescens* — Massachusetts (Rankin, 1945); *Plethodon glutinosus* — N. Carolina (Mann, 1932; Walton, 1935), Georgia (Reiber et al., 1940); and *Pseudotriton montanus montanus* — N. Carolina (Rankin, 1937).

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