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., Cosmocercoides dukae, Oxystrongyulus 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 helminth parasites of amphibians. 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 Landseer (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, Slinde 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 aceticarmine or Delafield's hematoxylin, cleared in beechwood creosote and mounted in Permount. Nematodes
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 infected 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. opocum*, *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. lynchii* 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. salamandracae*. Mauzler (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 opacum — B. amblystoma, Florida (Couch, 1966); B. dorsale, Louisiana (Byrd, 1937); B. louisianae, Louisiana (Byrd, 1937); B. salamandra, N. Carolina (Mann, 1932; Rankin, 1937, 1938); Illinois (Landewe, 1963); B. storeriae, Tennessee (Parker, 1941). Ambystoma talpoideum — B. salamandra, Illinois (Landewe, 1963).

Ambystoma texanum — B. daviesi, Texas (Harwood, 1932); B. salamandra, Texas (Harwood, 1932).

Ambystoma tridactylum — B. salamandra, Louisiana (Bennett and Humes, 1938).

Desmognathus fuscus — B. meridionalis, Georgia (Parker, 1941); B. mesorhachium, Georgia (Byrd, 1937; Parker, 1941; Denton, 1962), Virginia (Cheng, 1958); B. oseum, Georgia (Byrd, 1937; Parker, 1941); B. opacum, Georgia (Parker, 1941); B. salamandra, N. Carolina (Mann, 1932; Rankin, 1937), Massachusetts (Rankin, 1945), Ohio (Odlang, 1954), New York (Fischthai, 1955a), Pennsylvania (Fischthai, 1955b), Tennessee (Rankin, 1938); B. triterti, Georgia (Byrd, 1937).

Desmognathus ochrophaeus carolinensis — B. salamandra, N. Carolina (Rankin, 1937).

Desmognathus monticola — B. elongatum, Virginia (Cheng, 1958); B. salamandra, N. Carolina (Rankin, 1937).

Desmognathus quadramaculatus — B. elongatum, Virginia (Cheng, 1958); B. salamandra, N. Carolina (Rankin, 1937).

Eurycea b. bidens (B. salamandra, Massachusetts (Rankin, 1945), New York (Fischthai, 1955a), Pennsylvania (Fischthai, 1954b).

Eurycea b. cirrigera — B. oseum, Georgia (Parker, 1941); B. salamandra, N. Carolina (Mann, 1932; Rankin, 1937).

Eurycea b. wilderae — B. salamandra, N. Carolina (Rankin, 1937).


Eurycea longicauda guttata — B. salamandra, N. Carolina (Rankin, 1937).


Hemidactyllum scutatum — B. salamandra, Michigan (Rankin, 1938).

Notophthalmus meridionalis — B. daviesi, Texas (Harwood, 1932); B. meridionalis, Texas (Harwood, 1932).

Notophthalmus viridescens — B. salamandra, Michigan (Cort, 1915, 1919), N. Carolina (Mann, 1932; Rankin, 1937, 1938; Russell, 1951), New York (Rankin, 1938; Fischthai, 1955a), Virginia (Russell, 1951), Massachusetts (Rankin, 1938, 1945), Pennsylvania (Kelley, 1934); B. triterti, N. Carolina (Holm, 1952a, 1952b), Massachusetts (Kelley, 1934), Ohio (Kelley, 1934, 1945), Virginia (Cheng, 1958).

Phaeognathus hubrichti — B. salamandra, Alabama (Brandon, 1965).


Plethodon glutinosus — B. elongatum, Virginia (Cheng, 1958); B. meridionalis, Georgia (Parker, 1941); B. oseum, S. Carolina (Byrd, 1937), Georgia (Parker, 1941), Pennsylvania (Cheng, 1960), Virginia (Cheng, 1958, 1960); B. ovale, Georgia (Parker, 1941); B. salamandra, N. Carolina (Mann, 1932; Rankin, 1937, 1938), Louisiana (Byrd, 1937), Tennessee (Rankin, 1938), New York (Fischthai, 1955a), Virginia (Cheng, 1958), Illinois (Landewe, 1963); B. storeriae, Pennsylvania (Cheng and Chase, 1961).

Plethodon j. jordani — B. salamandra, N. Carolina (Rankin, 1938).


Plethodon yonahlossee — B. salamandra, N. Carolina (Rankin, 1937).

Pseudotriton ruber — B. salamandra, N. Carolina (Rankin, 1937, 1938); B. storeriae, Georgia (Parker, 1941).


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.


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


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


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-
somatum 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 Gymnophis p. porphyriticus in southcentral New York. Pseudeotriton r. ruber was listed by Walton (1933) as a host of O. longicaudata 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).

LITERATURE CITED


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