FIRST RECORDS OF FRESHWATER OLIGOCHAETES (ANNELIDA, CLITELLATA) FROM CAVES IN ILLINOIS AND MISSOURI, USA

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Aquatic oligochaetes were collected from the fine sediments of eight cave streams in Illinois and Missouri from June 1998 through January 2000. Five families, 9 genera, and 15 taxa are reported. Rhyacodrilus subterraneus (Tubificidae) represents a new state record for Illinois, and 10 species—Dero digitata, D. nivea, and Prista leidiyi (Naididae) and Limnodrilus cervix, L. hoffmeisteri, L. udekemianus, Rhacodrilus falciformis, R. sodalis, R. subterraneus, and Varichaetadrilus angustipenis (Tubificidae)—represent new state records for Missouri. Of the species collected, Haplotaxis cf. gordoioides (Haplotaxidae), P. leidiyi, and L. hoffmeisteri, R. falciformis, R. subterraneus, and Tubifex tubifex (Tubificidae) have previously been reported from caves in North America. These are the first published records of freshwater oligochaetes in caves of Illinois and Missouri.

The fauna of Illinois and Missouri caves has been the subject of several faunal surveys (Craig 1977; Gardner 1986; Lewis 1974; Lewis et al. 1999; Peck & Lewis 1978; Peck & Christiansen 1990; Webb et al. 1993). While several of these studies listed epigean oligochaetes (families Acanthodrilidae, Komarekionidae, Lumbricidae, and many Enchytraeidae), none reported the presence of aquatic Oligochaeta. Illinois’ epigean aquatic oligochaete fauna includes 86 species in 44 genera representing seven families (Wetzel 1992), some of which are from karst springs (Webb et al. 1995; Webb et al. 1996, 1998b). Aquatic oligochaetes are poorly known in Missouri, but a similar degree of diversity is expected to occur there.

Elsewhere in North America, records of aquatic oligochaetes from cave streams are sparse (e.g., Brinkhurst 1986; Cook 1971, 1975; Holsinger & Culver 1988; Kathman & Brinkhurst 1984; Reeves & Reynolds 1999; Reeves et al. 2000), but phreatic and hyporheic habitats are known to harbor a variety of aquatic oligochaetes (Gibert et al. 1994; Rodriguez 1996; Rodriguez & Coates 1996; Strayer 2001; Strayer et al. 1995), including a new family of freshwater annelids (Parvidrilidae: Parvidrilus strayeri Erséus, 1999) recently described from the hyporheic zone of a spring-fed stream (Erséus 1999). Culver et al. (2000) noted that the under-representation of groups such as the aquatic oligochaetes in published accounts might alter our understanding of the taxonomic pattern of cave biodiversity in the United States.

We examined aquatic oligochaetes collected from the fine sediments of streams in several of the longest caves in Illinois and Missouri (Middleton & Waltham 1986) in conjunction with studies of the fauna and water quality of caves in the karst areas of southwestern Illinois and southeastern Missouri (Taylor & Webb 2000; Taylor et al. 2000).

SITE DESCRIPTIONS

Aquatic oligochaetes were obtained from four caves in Illinois: Fogelpole Cave, Illinois Caverns, and Krueger-Dry Run Cave (all in Monroe County) and Stremler Cave (St. Clair County) (lengths: >24 km, 8.8 km, ~11 km, and 1800 m, respectively [Webb et al. 1998a]), and from four caves in Perry County, Missouri: Crevce Cave, Mertz Cave, Mystery Cave, and Rimstone River Cave (lengths: 45.5 km [Middleton & Waltham 1986; Walsh 1997], ~2.9 km [Vandike 1985], ~25.7 km [Walsh 1997], and 22.6 km [Middleton & Waltham 1986], respectively). All of these caves are situated in well-developed sinkhole plain karst terrain in the Salem Plateau (Fig. 1), where the dominant land use is row-crop agriculture (corn, soybeans, wheat). Other prominent land uses include hay fields, livestock pastures, woodlots, rural housing, and farmsteads. The urbanized area associated with Perryville, Missouri, is within the drainage basin of Crevce and Mertz caves (Vandike 1985) and extensive rural development associated with the growth of the St. Louis metropolitan area threatens karst groundwater quality of the Illinois sites (Panno et al. 1996, 1999; Taylor et al. 2000).

METHODS

The Illinois caves were sampled on a monthly basis from early February 1999 through early January 2000. Perry County, Missouri, caves were sampled on 5 July (Crevce Cave and Mertz Cave), 20 June (Mystery Cave), and 6 September (Rimstone River Cave) 1998. During each visit, three (six in Mystery Cave) samples were taken from the dark zone of each cave in near-shore, silty sediments in pools of the main stream passages by pushing a 4.7 cm diameter clear plastic tube into the substrate to a depth of 5 cm. Core samples were placed in Whirl-Pak™ bags, fixed in 10% buffered formalin for at least...
Oligochaetes representing 5 families, 10 genera, and 15 distinct taxa were identified from the samples (Table 1). Of the 1582 specimens examined, many were fragments of whole specimens, and the majority of specimens were sexually immature. Thus, much of the material could not be identified. A few undetermined specimens representing the oligochaete families Enchytraeidae, Lumbriculidae, and Naididae (genus Pristina) were collected, plus a single specimen of another clitellate annelid group, the Branchiobdellida. No edaphobitic oligochaetes were present in any of the sediment samples.

**RESULTS**

Of the 13 oligochaete species determined from this material, one represents a new record for Illinois and 10 represent new records for Missouri (Table 1). Although most of the caves have been previously sampled for aquatic fauna, all oligochaete species collected during this study represent first records for the caves in which they were found.

**SPECIES ACCOUNTS**

**HAPLOTAXIDAE**

_Haplotaxis cf. gordioides_ (Hartmann, 1821). This species is the only recognized haplotaxid occurring in North America north of Mexico (Kathman & Brinkhurst 1998). We refer to this taxon with “cf” because the species limits within the genus _Haplotaxis_ are not clear, there is a large size range between the largest and smallest specimens of _Haplotaxis cf. gordioides_, and the pattern of dorsal chaetae is variable. Although other _Haplotaxis_ species have been described from sexually mature individuals elsewhere in the world (Brinkhurst 1988), no fully mature specimen of _H. cf. gordioides_ has been reported from North America. The limited and seemingly disjunct distributional information for _H. cf. gordioides_ and other haplotaxids is likely an artifact of collecting effort, particularly since the majority of records are from groundwater habitats (cisterns, wells, springs, caves, hyporheic and phreatic waters) (Brinkhurst 1986; Kathman & Brinkhurst 1998; Strayer 2001). Cook (1975) reported _H. gordioides_ from a cave in West Virginia, and Kathman & Brinkhurst (1984) reported it from a cave in Tennessee.

**NAIDIDAE**

_Dero digitata_ (Müller, 1773), a cosmopolitan species, is common and widespread in surface waters throughout North America.

_Dero nivea_ Aiyer, 1930, a cosmopolitan species, is uncommon but widespread in surface waters throughout North America.

_Pristina jenkiniae_ (Stephenson, 1931), although widespread in surface waters throughout North America, is collected only occasionally.

_Pristina leidyi_ Smith, 1896, a cosmopolitan species, is uncommon but relatively widespread in surface waters throughout North America. This species was recently reported...
from caves in South Carolina (Reeves & Reynolds 1999; Reeves 2000).

**Tubificidae**

*Limnodrilus cervix* Brinkhurst, 1963 is widespread and commonly collected in surface waters throughout North America, and has been introduced into Europe and Asia. Although commonly collected from organically enriched habitats (Kathman & Brinkhurst 1998), *L. cervix* is not as tolerant of environmental extremes as is *Limnodrilus hoffmeisteri* Claparède.

*Limnodrilus hoffmeisteri* Claparède, 1862, a cosmopolitan species, is perhaps the most commonly collected freshwater oligochaete worldwide. It occurs in a wide variety of surface water habitats, reaching very high abundance in organically enriched areas - often with *Tubifex tubifex* (Brinkhurst 1975, 1996). The most commonly collected oligochaete during this study, the presence of *L. hoffmeisteri* may reflect organic enrichment associated with fecal contamination in the study area (Taylor et al. 2000). Kathman & Brinkhurst (1984) reported ed *L. hoffmeisteri* from caves in Tennessee.

*Limnodrilus udekemianus* Claparède, 1862, a cosmopolitan species, is found in organically polluted waters as well as oligotrophic habitats. It is widespread but rarely abundant in surface waters throughout North America (Klemm 1985).

*Rhyacodrilus falciformis* Breitscher, 1901, a rare Holarctic groundwater species, was first reported in North America from a creek on Vancouver Island, British Columbia (Brinkhurst 1978); this species has since been documented from Cascade Cave (Vancouver Island), the Hudson River in New York (Brinkhurst 1986), from Fraction Run, a small groundwater-influenced stream in Will County, Illinois (Wetzel 1992), and Montana (Kathman & Brinkhurst 1998). The collection of *R. falciformis* from Mystery Cave extends its range to the south and is the second report of this species from a cave in North America.

Table 1. Aquatic Oligochaeta (Annelida, Clitellata) collected from caves in southwestern Illinois and southeastern Missouri from 1998 to 2000.

| Order Lumbriculida | Family Limbriculidae | + | + | + | + | + | + | + | + | + | + |
| Order Haplotaxida | Family Haplotaxidae | + | + | + | + | + | + | + | + | + | + |
| Order Enchytraeida | Family Enchytraeidae | + | + | + | + | + | + | + | + | + | + |
| Order Tubificida | Family Naididae | + | + | + | + | + | + | + | + | + | + |
| | Family Tubificidae | + | + | + | + | + | + | + | + | + | + |

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(1975) reported *R. sodalis* from a cave in West Virginia.

*Rhyacodrilus subterraneus* Hrabe, 1963, a rare Holarctic groundwater species, was first reported in North America from a hyporheic habitat in New York by Strayer & Bannon-O’Donnell (1988). More recent records document its occurrence in Tennessee (Kathman & Brinkhurst 1998), and in hyporheic habitats in Alabama, Kentucky, New York, Ohio, Tennessee, and Virginia (Strayer 2001). During their studies, Strayer (2001) and Strayer & Bannon-O’Donnell (1988) noted that *R. subterraneus* was the most widespread and commonly collected hyporheic tubificid; despite its abundance, they collected no mature specimens. Although most specimens were collected from deeper sediments by Strayer (2001)—supporting its status as an interstitial specialist (Hrabe 1963)—Strayer (2001) occasionally collected it from surface stream sediments, as did Timm et al. (1996). Our specimens, all immature, extend the known range of *R. subterraneus* farther west in North America.

*Tubifex tubifex* (Müller, 1774), a cosmopolitan species that is not commonly encountered, is locally abundant in habitats of marginal water quality—pristine alpine and subalpine lakes (Klemm 1985), the bottoms of large, unproductive, oligotrophic lakes (e.g., Lake Superior), grossly polluted and organically enriched sites with low oxygen tensions, and aquatic habitats supporting few other species (Brinkhurst 1996). In areas with heavy organic pollution, *T. tubifex* is usually associated with *L. hoffmeisteri*, where the two species are often the dominant oligochaetes or even the dominant or exclusive benthic invertebrates (Brinkhurst 1996). Brinkhurst (1970) also suggested that *T. tubifex* may prefer situations in which other species find it difficult to survive—either because there is too little active decomposition, or too much. *Tubifex tubifex* is widespread in North America and has been reported from a cave in Virginia (Holsinger 1966).

*Varichaetadrilus angustipenis* (Brinkhurst & Cook, 1966), an uncommon but widespread Nearctic species east of the Mississippi River and east of Manitoba (Kathman & Brinkhurst 1998), has recently been reported from California (Kathman & Brinkhurst 1998) and Arizona (Wetzel et al. 1999). The senior author has identified *V. angustipenis* from numerous springs and springruns in Illinois (Webb et al. 1995; Webb et al. 1996, 1998b), from Montezuma Well in Arizona (Wetzel et al. 1999), and from resurgence springs of the Edwards Aquifer in Texas (unpublished records, INHS Annelida Collection). Extensive collecting in Illinois and other states and provinces in North America by the senior author has failed to produce *V. angustipenis* from habitats other than those associated with or influenced by groundwater. The collection of *V. angustipenis* from Crevice and Mertz caves in Missouri represents a new record for the state. An aberrant (developing?) specimen of the genus *Varichaetadrilus*, probably attributable to *V. angustipenis*, was collected from Mystery Cave.

The abundance of new records in this study emphasizes the paucity of available information on North American aquatic Oligochaeta in caves. In reviewing the faunal studies of caves in Illinois and Missouri, and several studies of North American cave faunas (Franz et al. 1994; Holsinger 1963, 1966; Holsinger & Culver 1988; Holsinger & Peck 1971; Kathman & Brinkhurst 1984; Lewis 1983; Peck 1988; Reeves et al. 2000), few species-level identifications of aquatic annelids were included among the extensive lists of reported taxa. Our data indicate the presence of a diverse and relatively abundant aquatic oligochaete fauna in Midwestern cave streams associated with loess-covered karst terranes developed in Ordovician and Mississippian age bedrock (Panno et al. 1999). Aquatic clitellate annelids should receive careful consideration in ecological studies of cave environments because they comprise a significant and prevalent component in aquatic cave communities.

**ACKNOWLEDGMENTS**


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