

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

MARK J. WETZEL AND STEVEN J. TAYLOR

*Illinois Natural History Survey, Center for Biodiversity, 172 N.R.B., 607 E. Peabody Drive, MC-652, Champaign, IL 61820-6917 USA MJW: mjwetzel@uiuc.edu; SJT: sjtaylor@inhs.uiuc.edu*

*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 Pristina leidy (Naididae) and Limnodrilus cervix, L. hoffmeisteri, L. udekemianus, Rhyacodrilus falciformis, R. sodalis, R. subterraneus, and Varichaetadrilus angustipenis (Tubificidae)—represent new state records for Missouri. Of the species collected, Haplotaxis cf. gordioides (Haplotaxidae), P. leidy, 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 edaphobitic oligochaetes (families Acanthodrilidae, Komarekionidae, Lumbricidae, and many Enchytraeidae), none reported the presence of aquatic Oligochaeta. Illinois' epigeal 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.

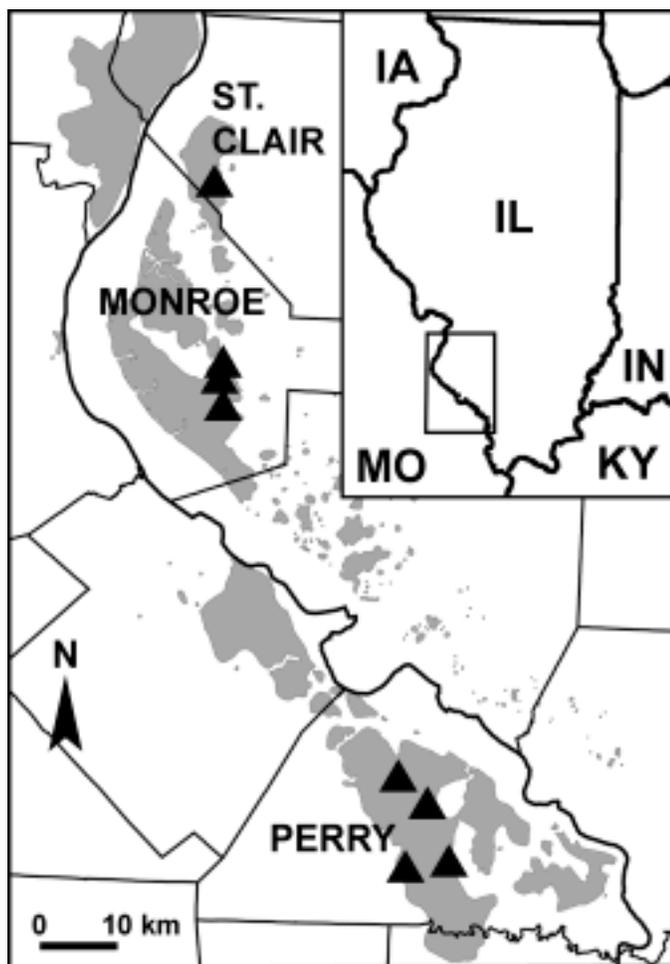
We examined aquatic oligochaetes collected from the fine sediments of streams in several of the longest caves in Illinois and Missouri (Middleton & Waltham 1986) in conjunction with studies of the fauna and water quality of caves in the karst areas of southwestern Illinois and southeastern Missouri (Taylor & 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 Stemler 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: Crevice 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 Crevice 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 (Crevice 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



**Figure 1.** Karst terrain of southwestern Illinois and southeastern Missouri. All caves sampled (triangles) lie in the shaded sinkhole areas (Panno *et al.* 1999) in the labeled counties.

48 hours, then rinsed with water before transferring to 70% ethanol for temporary storage. Oligochaetes were picked from samples and carefully cleaned of minute sand and detrital material, processed through an ethanol series, washed in punctilious ethanol, placed in an ethanol/xylene solution for 30 minutes, then mounted in Permount™ on standard microscope slides under cover slips. Compound microscopes equipped with Nomarski Differential Interference Contrast were used for identification. Identifications and distribution data follow the original descriptions of Sperber (1948), Brinkhurst (1978), Brinkhurst & Jamieson (1971), Brinkhurst & Wetzel (1984), Klemm (1985), Kathman & Brinkhurst (1998), and Collado & Schmelz (2000). All specimens are deposited in the Illinois Natural History Survey (INHS) Annelida Collection, Champaign.

#### RESULTS

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.

#### DISCUSSION

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

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

	Fogelpole Cave	Krueger-Dry Run Cave	Illinois Caverns	Stemler Cave	Crevice Cave	Mertz Cave	Mystery Cave	Rimstone River Cave	Illinois New Record	Missouri New Record
<b>Order Lumbriculida</b>										
<b>Family Lumbriculidae</b>										
unidentified specimens	+			+						
<b>Order Haplotaxida</b>										
<b>Family Haplotaxidae</b>										
Genus <i>Haplotaxis</i> Hoffmeister, 1843										
<i>Haplotaxis</i> cf. <i>gordioides</i> (Hartmann, 1821)		+		+						
<b>Order Enchytraeida</b>										
<b>Family Enchytraeidae</b>										
unidentified specimens		+					+			
<b>Order Tubificida</b>										
<b>Family Naididae</b>										
Genus <i>Dero</i> Oken, 1815										
<i>Dero digitata</i> (Müller, 1773)		+			+					+
<i>Dero nivea</i> Ayer, 1930							+			+
Genus <i>Pristina</i> Ehrenberg, 1828										
<i>Pristina jenkinae</i> (Stephenson, 1931)				+						
<i>Pristina leidy</i> Smith, 1896	+				+	+				+
<i>Pristina</i> sp.		+		+						
<b>Family Tubificidae</b>										
Genus <i>Limnodrilus</i> Claparède, 1862										
<i>Limnodrilus cervix</i> Brinkhurst, 1963		+			+					+
<i>Limnodrilus hoffmeisteri</i> Claparède, 1862	+	+	+	+	+	+	+			+
<i>Limnodrilus udekemianus</i> Claparède, 1862							+			+
Genus <i>Rhyacodrilus</i> Bretscher, 1901										
<i>Rhyacodrilus falciformis</i> Bretscher, 1901							+			+
<i>Rhyacodrilus</i> cf. <i>sodalis</i> (Eisen, 1879)						+				+
<i>Rhyacodrilus subterraneus</i> Hrabe, 1963		+		+			+	+	+	+
Genus <i>Tubifex</i> Lamarck, 1816										
<i>Tubifex tubifex</i> (Müller, 1774)	+									
Genus <i>Varichaetadrilus</i> Brinkhurst & Kathman, 1983										
<i>Varichaetadrilus angustipenis</i> (Brinkhurst & Cook, 1966)	+	+			+	+				+
<i>Varichaetadrilus</i> sp.							+			

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) report-

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* Bretscher, 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.

*Rhyacodrilus* cf. *sodalis* (Eisen, 1879), considered widespread but rare in North America, is of somewhat uncertain taxonomic status because of variability in morphology (Brinkhurst & Cook 1966; Kathman & Brinkhurst 1998; Klemm 1985). Cook

(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

Funding for this research was supported in part by the U.S. Department of the Interior-Fish & Wildlife Service, Illinois Department of Transportation, Illinois Department of Natural Resources, and the Illinois Natural History Survey. We thank G. Adams, J. Angel, L. Brennan, R. Haley, C. Hespian, J. Kath, C. Lee, D. Mahon, B. Molano-Flores, P. Moss, S.V. Panno, G. Resch, J. Roberts, G. & G. Schropp, H. Stuck, D. Tecic, M. Tiritilli, R. Toomey, K. Victory, S. Langowski, D.W. Webb, C.P. Weibel, P. Wightman, and R. Young for their assistance with field work in Illinois and Missouri caves. We also thank H. Stuck and W. Borchert for laboratory assistance, and D.W. Webb, C.P. Weibel, C.A. Phillips, G.A. Levin, D.L. Thomas, S.V. Fend, D.C. Ashley, and one anonymous reviewer for assistance with this manuscript.

#### REFERENCES

- Brinkhurst, R.O., 1970, Distribution and abundance of tubificid (Oligochaeta) species in Toronto Harbour, Lake Ontario: Journal of the Fisheries Research Board of Canada, v. 27, p. 1961-1969.
- Brinkhurst, R.O., 1975, Oligochaeta, in Parrish, F.K., ed., Keys to the water quality indicative organisms of the southeastern United States: Cincinnati, OH, U.S. Environmental Protection Agency, Office of Research and Development, Environmental Monitoring and Support Laboratory, p. 69-85.
- Brinkhurst, R.O., 1978, Freshwater Oligochaeta in Canada: Canadian Journal of Zoology, v. 56, no. 10, p. 2166-2175.
- Brinkhurst, R.O., 1988, A taxonomic analysis of the Haplotaxidae: Canadian Journal of Zoology, v. 66, no. 10, p. 2243-2252.
- Brinkhurst, R.O., 1996, On the role of tubificid oligochaetes in relation to fish disease with special reference to the Myxozoa: Annual Review of Fish Diseases, v. 6, p. 29-40.

- Brinkhurst, R.O. & Cook, D.G., 1966, Studies on the North American Aquatic Oligochaeta. III: Lumbriculidae and additional notes and records of other families: Proceedings of the Academy of Natural Sciences of Philadelphia, v. 118, no. 1, p. 1-33.
- Brinkhurst, R.O. & Jamieson, B.G.M., 1971, Aquatic Oligochaeta of the world: Buffalo, New York, University of Toronto Press.
- Brinkhurst, R.O. & Wetzel, M.J., 1984, Aquatic Oligochaeta of the world: Supplement: Canadian Technical Report of Hydrography and Ocean Sciences no. 44, p. v+101.
- Collado, R. & Schmelz, R.M., 2000, *Pristina silvicola* and *Pristina terrena* spp. nov., two new soil-dwelling species of Naididae (Oligochaeta, Annelida) from the tropical rain forest near Manaus, Brazil, with comments on the genus *Pristinella*: Journal of Zoology, London, v. 252, p. 509-516.
- Cook, D.G., 1971, *Trichodrilus allegheniensis* n. sp. (Oligochaeta, Lumbriculidae) from a cave in southern Tennessee: Transactions of the American Microscopical Society, v. 90, no. 3, p. 381-383.
- Cook, D.G., 1975, Cave-dwelling aquatic Oligochaeta (Annelida) from the eastern United States: Transactions of the American Microscopical Society, v. 94, no. 1, p. 24-37.
- Craig, J.L., 1977, Invertebrate faunas of caves to be inundated by the Meramec Park Lake in eastern Missouri: NSS Bulletin, v. 39, no. 3, p. 80-89.
- Culver, D.C., Master, L.L., Christman, M.C. & Hobbs, H.H., III., 2000, Obligate cave fauna of the 48 contiguous United States: Conservation Biology, v. 14, no. 2, p. 386-401.
- Erséus, C., 1999, *Parvidrilus strayeri*, a new genus and species, an enigmatic interstitial clitellate from underground waters in Alabama: Proceedings of the Biological Society of Washington, v. 112, no. 2, p. 327-337.
- Franz, R., Bauer, J. & Morris, T., 1994, Review of biologically significant caves and their faunas in Florida and south Florida: Brimleyana, v. 20, p. 1-109.
- Gardner, J.E., 1986, Invertebrate fauna from Missouri caves and springs: Natural History Series, Missouri Department of Conservation.
- Gibert, J., Danielopol, D.L. & Stanford, J.A., 1994, Groundwater ecology: San Diego, California, Academic Press.
- Holsinger, J.R., 1963, Annotated checklist of the macroscopic troglobites of Virginia with notes on their geographic distribution: National Speleological Society Bulletin, v. 25, no. 1, p. 23-36.
- Holsinger, J.R., 1966, A preliminary study of the effects of organic pollution of Banners Corner Cave, Virginia: International Journal of Speleology, v. 2, p. 75-89.
- Holsinger, J.R. & Culver, D.C., 1988, The invertebrate cave fauna of Virginia and a part of eastern Tennessee: zoogeography and ecology: Brimleyana, v. 14, p. 1-162.
- Holsinger, J.R. & Peck, S.B., 1971, The invertebrate cave fauna of Georgia: National Speleological Society Bulletin, v. 33, no. 1, p. 23-44.
- Hrabe, S., 1963, *Rhyacodrilus subterraneus* n. sp., eine neue Tubificiden-Art aus dem Brunnen in der Umgebund von Leipzig: Zoologische Anzeiger, v. 170, p. 249-252.
- Kathman, R.D. & Brinkhurst, R.O., 1984, Some benthic invertebrates from Tennessee and Kentucky caves: Journal of the Tennessee Academy of Science, v. 59, no. 1 & 2, p. 19-21.
- Kathman, R.D. & Brinkhurst, R.O., 1998, Guide to the freshwater oligochaetes of North America: College Grove, Tennessee, Aquatic Resources Center.
- Klemm, D.J., 1985, A guide to the freshwater Annelida (Polychaeta, naidid and tubificid Oligochaeta, and Hirudinea) of North America: Dubuque, Iowa, Kendall/Hunt Publishing Company.
- Lewis, J.J., 1974, The invertebrate fauna of Mystery Cave, Perry County, Missouri: Missouri Speleology, v. 14, no. 4, p. 1-19.
- Lewis, J.J., 1983, The obligatory subterranean invertebrates of glaciated southeastern Indiana: NSS Bulletin, v. 45, p. 34-40.
- Lewis, J.J., Moss, P.L. & Tecic, D.L., 1999, A conservation focused evaluation of the imperiled troglobitic fauna of the sinkhole plain karst of southwestern Illinois: The Nature Conservancy.
- Middleton, J. & Waltham, T., 1986, The underground atlas - a gazetteer of the world cave regions: Great Britain, Robert Hale Ltd.
- Panno, S.V., Krapac, I.G., Weibel, C.P. & Bade, J.D., 1996, Groundwater contamination in karst terrain of southwestern Illinois: Illinois State Geological Survey Environmental Geology Series Report, v. 151, p. 1-43.
- Panno, S.V., Weibel, C.P., Wicks, C.M. & Vandike, J.E., 1999, Geology, hydrology, and water quality of the karst regions of southwestern Illinois and southeastern Missouri: ISGS Guidebook 27, Champaign, Illinois State Geological Survey.
- Peck, S.B., 1988, A review of the cave fauna of Canada, and the composition and ecology of the invertebrate fauna of caves and mines in Ontario: Canadian Journal of Zoology, v. 66, p. 1197-1213.
- Peck, S.B., 1989, The cave fauna of Alabama: Part I. The terrestrial invertebrates (excluding insects): NSS Bulletin, v. 51, p. 11-33.
- Peck, S.B. & Christiansen, K., 1990, Evolution and zoogeography of the invertebrate cave faunas of the Driftless Area of the Upper Mississippi River Valley of Iowa, Minnesota, Wisconsin, and Illinois, U.S.A.: Canadian Journal of Zoology, v. 68, p. 73-88.
- Peck, S.B. & Lewis, J.L., 1978, Zoogeography and evolution of the subterranean invertebrate faunas of Illinois and southeastern Missouri: NSS Bulletin, v. 40, no. 2, p. 39-63.
- Reeves, W.K., 2000, *Caecidotea carolinensis* (Isopoda: Asellidae): First record of a stygobite from South Carolina: Journal of Cave and Karst Studies, v. 62, no. 1, p. 8-19.

- Reeves, W.K., Jensen, J.B. & Ozier, J.C., 2000, New faunal and fungal records from caves in Georgia, USA: *Journal of Cave and Karst Studies*, v. 62, no. 3, p. 169-179.
- Reeves, W.K. & Rrynolds, J.W., 1999, New records of cave-dwelling earthworms (Oligochaeta: Lumbricidae, Megascoclecidae and Naididae) and other annelids (Aeolosomatida, Branchiobdellida and Hirudinea) in the southeastern United States, with notes on their ecology: *Megadriologica*, v. 7, no. 10, p. 65-71.
- Rodriguez, P., 1996, *Stylodrilus californianus* n. sp., a new lumbriculid (Annelida: Oligochaeta) from North America: *Hydrobiologia*, v. 333, p. 161-164.
- Rodriguez, P. & Coates, K.A., 1996, A new American *Stylodrilus* species (Lumbriculidae, Oligochaeta): *Canadian Journal of Zoology*, v. 74, no. 1, p. 92-96.
- Sperber, C., 1948, A taxonomical study of the Naididae: *Zoologiska Bidrag fran Uppsala*, v. 28, p. 1-296.
- Strayer, D.L., May, S.E., Nielsen, P., Wollheim, W. & Hausam, S., 1995, An endemic groundwater fauna in unglaciated eastern North America: *Canadian Journal of Zoology*, v. 73, no. 3, p. 502-508.
- Strayer, D.L., 2001, Ecology and distribution of hyporheic microannelids (Oligochaeta, Aphanoneura, and Polychaeta) from the eastern United States: *Archiv für Hydrobiologie*, v. 131, no. 3, p. 493-510.
- Strayer, D.L. & Bannon-O'Donnell, E., 1988, Aquatic microannelids (Oligochaeta and Aphanoneura) of underground waters of southeastern New York: *American Midland Naturalist*, v. 119, p. 327-335.
- Taylor, S.J., Webb, D.W. & Panno, S.V., 2000, Spatial and temporal analyses of the bacterial fauna and water, sediment, and amphipod tissue chemistry within the range of *Gammarus acherondytes*: Illinois Natural History Survey Center for Biodiversity Technical Report, v. 2000, no. 18, p. 1-115.
- Taylor, S.J. & Webb, D.W., 2000, Subterranean Amphipoda (Crustacea) of Illinois' Salem Plateau: Spatial and temporal components of microdistribution: Illinois Natural History Survey Center for Biodiversity Technical Report, v. 2000, no. 27, p. 1-62.
- Timm, T., Erséus, C. & Lundberg, S., 1996, New and unusual records of freshwater Oligochaeta from the Scandinavian peninsula: *Nordic Journal of Freshwater Research*, v. 72, p. 15-29.
- Vandike, J.E., 1985, Movement of shallow groundwater in the Perryville karst area, southeastern Missouri, Water Resources Report: Rolla, Missouri, Missouri Department of Natural Resources, Division of geology and Land Survey.
- Walsh, J., 1997, Selected Ordovician, [sic] & Devonian age caves, caving the stratigraphic successions of Missouri - Part II, in Taylor, R.L., ed., *Exploring Missouri caves - A guidebook for the 1997 Convention of the National Speleological Society*, Sullivan, Missouri, June 23-27, 1997: Huntsville, Alabama, National Speleological Society, Inc., p. 145-184.
- Webb, D.W., Taylor, S.J. & Krejca, J.K., 1993, The biological resources of Illinois' caves and other subterranean environments: Illinois Natural History Survey Center for Biodiversity Technical Report, v. 1993, no. 8, p. 1-168.
- Webb, D.W., Wetzel, M.J., Reed, P.C., Phillippe, L.R. & Harris, M.A., 1995, Aquatic biodiversity in Illinois springs: *Journal of the Kansas Entomological Society*, v. 68, no. 2 suppl, p. 93-107.
- Webb, D.W., Wetzel, M.J., Reed, P.C., Phillippe, L.R. & Young, T.C., 1996, Biodiversity, hydrogeology, and water quality of 10 karst springs in the Salem Plateau Section of Illinois, in Davis, M., ed., *Research on agricultural chemicals in Illinois groundwater: Status and future directions VI. Proceedings of sixth annual conference*, Illinois Groundwater Consortium, Makanda, Illinois, March 27-28, 1996: Carbondale, Southern Illinois University, p. 146-185.
- Webb, D.W., Page, L.M., Taylor, S.J. & Krejca, J.K., 1998, The current status and habitats of the Illinois Cave Amphipod, *Gammarus acherondytes* Hubricht and Mackin (Crustacea: Amphipoda): *Journal of Cave and Karst Studies*, v. 60, no. 3, p. 172-178.
- Webb, D.W., Wetzel, M.J., Reed, P.C., Phillippe, L.R. & Young, T.C., 1998, The macroinvertebrate biodiversity, water quality, and hydrogeology of ten karst springs in the Salem Plateau Section of Illinois, USA, in Botosaneanu, L., ed., *Studies in crenobiology - The biology of springs and springbrooks*: Leiden, The Netherlands, Backhuys Publishers, p. 39-48.
- Wetzel, M.J., 1992, Aquatic Annelida of Illinois: Introduction and checklist of species: *Transactions of the Illinois State Academy of Science*, v. 85, no. 1 & 2, p. 87-101.
- Wetzel, M.J., Oberlin, G. & Blinn, D.W., 1999, The aquatic Oligochaeta (Annelida: Clitellata) of Montezuma Well, Arizona: A near thermally constant limnocrone: *Southwestern Naturalist*, v. 44, no. 4, p. 514-518.