The aquatic annelid fauna of the San Marcos River headsprings, Hays County, Texas

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Abstract
The San Marcos River in Central Texas has been well studied and has been demonstrated to be remarkably specious. Prior to the present study, research on free-living invertebrates in the San Marcos River only dealt with hard bodied taxa with the exception of the report of one gastrotrich, and one subterranean platyhelminth that only incidentally occurs in the head spring outflows. The remainder of the soft-bodied metazoan fauna that inhabit the San Marcos River had never been studied. Our study surveyed the annelid fauna and some other soft-bodied invertebrates of the San Marcos River headsprings. At least four species of Hirudinida, two species of Aphanoneura, one species of Branchiobdellida, and 11 (possibly 13) species of oligochaetous clitellates were collected. Other vermiform taxa collected included at least three species of Turbellaria and one species of Nemertea. We provide the results of the first survey of the aquatic annelid fauna of the San Marcos Springs, along with a dichotomous key to these annelids that includes photos of some representative specimens, and line drawings to elucidate potentially confusing diagnostic structures.

Keywords
Annelida, Clitellata, Hirudinida, Aphanoneura, Branchiobdellida, oligochaetous clitellates, freshwater Nemertea, spring fauna
Introduction

The San Marcos River in Hays County, Texas (29°53.505’N; 97°55.973’W) is a spring fed river supplied with physicochemically stable water from the Edwards Aquifer (Crow 2012; Musgrove and Crow 2012). The spring outflows were impounded by a low head dam in 1849 to form a small reservoir known of as Spring Lake. Spring Lake and the upper 2 or 3 km of the spring run supports a rich biotic community (Edwards and Arnold 1961, Bowles et al. 2007, Gibson et al. 2008). At present there are four species that are federally protected, threatened, or endangered, with some other endemics probably worthy of such designation; three of which are vertebrates. The Comal Springs riffle beetle (*Heterelmis comalensis* Bosse, Tuff, and Brown) is the only protected invertebrate species that occurs in the San Marcos River (SMR). Circumstances associated with the biogeographic history of the headsprings no doubt contributed to the evolution of unique and endemic species. Indeed, many of the endemic invertebrates of Spring Lake and the San Marcos Springs are generally considered marine relicts (Holsinger and Longley 1980, Hershler and Longley 1986, Gibson et al. 2008). Therefore, endemism is high for some of the invertebrate taxa; especially taxa that are poor dispersers and have long inhabited the SMR.

The first studies of invertebrates from the SMR and nearby springs issuing from the Edwards Aquifer led to the description of several new stygobionts (Benedict 1896, Ulrich 1902, Holsinger 1966, Bowman and Longley 1976, Holsinger and Longley 1980, Hershler and Longley 1986) with no attention paid to epigean invertebrate species. The first study on epigean invertebrates only reported on trichopterans. Not surprisingly, this study led to the description of a new species, *Protoptila arca* (Edwards and Arnold 1961), which was determined to be a San Marcos endemic (Edwards and Arnold 1961). Thirty additional species of trichopterans were later reported from the San Marcos (Bowles et al. 2007). More recent surveys reported additional records of species from the SMR and associated springs (Gibson et al. 2008, Diaz and Alexander 2010, Hutchins et al. 2013).

A study of the diet of the fountain darter, *Etheostoma fonticola* Jordan and Gilbert from the SMR was the first study to report on epigean invertebrates other than trichopterans, but this diet study only reported on hard-bodied invertebrates (e.g. molusks and arthropods); additionally, recovered specimens were only identified to order (Schenck and Whiteside 1977). Despite its low taxonomic resolution, findings from this study suggested a remarkable amount of diversity, with twelve separate orders reported from the gut contents of this one species of fish. This diversity was verified by a subsequent diet study of the San Marcos salamander, *Eurycea nana* Bishop whereby numerous taxa (also largely hard-bodied forms), were reported from the SMR for the first time (Diaz 2010).

At the time of this writing, the only reports of free-living soft-bodied invertebrates from the SMR were the mention of a stygobirotic platyhelminth and a stygobirotic hirudinean (Hershler and Longley 1986, Bowles and Arsuffi 1993) and the documentation of the first gastrotrich of the genus *Redudasys* (Gastrotricha: Mac-
rodasyida) in the Northern Hemisphere (Kånneby and Wicksten 2014). Presented herein is the first report of identified annelids from the San Marcos River, with notes on other free-living vermiform fauna; including a new distribution record for a nemertean. This report adds several species to the ever-growing list of invertebrate taxa reported from the San Marcos Springs (SMS) and SMR. Several of these appear to be undescribed taxa that likely have a restricted distribution to the physicochemically stable spring run.

**Materials and methods**

Invertebrates were collected from January 2013 to August 2014. Several sampling methods were utilized, including a Ponar grab sampler, installation of nets over spring outflows, baited traps, dip netting of vegetation and substrate, and SCUBA diving with suction devices. All collected organisms were transported live to the Freeman Aquatic Biology Station at Texas State University-San Marcos. Specimens were examined under a dissecting and/or compound light microscope and were identified to lowest possible taxon using the most recent literature (Brinkhurst 1964, Brinkhurst and Jamieson 1971, Harman 1973, Spencer 1978, Hiltunen and Klemm 1980, Kathman and Brinkhurst 1998, Pinder 2010, Wetzel et al. 2015).

**Results**

At least 4 species of epigean Hirudinida, 2 species of Aphanoneura, 1 species of Branchiobdellida, and 11 (possibly 13) species of oligochaetous clitellates are present in the SMR and identified herein. At least 3 species of free-living Platyhelminthes and 1 species of Nemertea were also collected. The species of Nemertea is the first record of the phylum from the SMR, though this phylum has been documented elsewhere in the Guadalupe drainage basin (Ourso and Hornig 2000). See Table 1 for list of vermiform taxa identified in this study.

**Dichotomous key to Annelida of San Marcos Springs**

1a Parasitic or commensal ................................................................. 2
1b Free-living ............................................................................... 5
2a (1a) Chaetae absent ................................................................. 3
2b Chaetae present; commensal on gastropods (in mantle cavity); body usually quite small, <4 mm ....................... *Chaetogaster cf. limnaei*
3a (2a) Parasitic on exterior of vertebrates ................................. 4
3b Parasitic on exterior of crayfish of Family Cambaridae (Figure 1) ............ Order Branchiobdellida (Family *Cambarincolidae*)
**Table 1.** List of annelid and other vermiform taxa collected from San Marcos River headsprings.

| Phylum      | Class     | Subclass      | Order     | Family     | Genus/species            | Descriptor   |
|-------------|-----------|---------------|-----------|------------|--------------------------|--------------|
| Annelida    | Clitellata| Hirudinida    | Arhynchobdellida | Erpobdellida[†] |                          |              |
| Annelida    | Clitellata| Hirudinida    | Rhynchobdellida | Piscicolida  |                          |              |
| Annelida    | Clitellata| Hirudinida    | Rhynchobdellida | Glossiphoniida | *Placobdella parasitica* | Say, 1924    |
| Annelida    | Clitellata| Hirudinida    | Rhynchobdellida | Glossiphoniida | *Helobdella cf. papillata* | Moore, 1952  |
| Annelida    | Clitellata| Oligochaeta   | Lumbriculida  | Lumbriculida | Lumbriculida sp,         |              |
| Annelida    | Clitellata| Oligochaeta   | Lumbriculida  | Lumbriculida | Lumbriculida sp,         |              |
| Annelida    | Clitellata| Oligochaeta   | Haplotaxida   | Naidida     | *Stylaria lacustris*     | Linnaeus, 1767|
| Annelida    | Clitellata| Oligochaeta   | Haplotaxida   | Naidida     | *Chaetogaster cf. limnaei* | K. von Baer, 1827|
| Annelida    | Clitellata| Oligochaeta   | Haplotaxida   | Naidida     | *C. cf. diaphanus*       | Gruithuisen, 1828|
| Annelida    | Clitellata| Oligochaeta   | Haplotaxida   | Naidida     | *C. cf. crystallinus*    | Vejdovský, 1883|
| Annelida    | Clitellata| Oligochaeta   | Haplotaxida   | Naidida     | *Pristina leidyi*        | F. Smith, 1896|
| Annelida    | Clitellata| Oligochaeta   | Haplotaxida   | Naidida     | *Nais pseudobtusa*       | Piguet, 1906 |
| Annelida    | Clitellata| Oligochaeta   | Haplotaxida   | Naidida     | *Dero (Dero) cf. obtusa* | d’Udekem, 1855|
| Annelida    | Clitellata| Oligochaeta   | Haplotaxida   | Naidida     | *D. (Aulophorus) cf. furcatus* | Müller, 1773|
| Annelida    | Clitellata| Oligochaeta   | Haplotaxida   | Haplotaxida | *Haplotaxis cf. gordinoides* | Hartmann, 1821 |
| Annelida    | Aphanoneura|              |              | Aeolosomatida | *Aeolosoma cf. variegatum* | Vejdovský, 1884|
| Annelida    | Aphanoneura|              |              | Aeolosomatida | *A. cf. quartemarianum*  | Ehrenberg     |
| Platyhelminthes | Turbellaria  |              | Tricladida   | Dugesiida   | *Schmidtea sp.*          |              |
| Platyhelminthes | Turbellaria  |              | Tricladida   | Dugesiida   | *Dugesia sp.*            |              |
| Platyhelminthes | Turbellaria  |              | Macrostromida|            |                          |              |
| Platyhelminthes | Rhabditophora|            | Kenkiidae    |            | *Sphalloplana mohri[‡]  | Hyman, 1939  |
| Nemertea    | Enopla     |              | Hoplonemertea| Tetramembranida | *Prostoma cf. graccense* | Böhmg, 1892 |

[†] Both a stygobiotic and epigean species were collected.
[‡] This species was not collected by the authors but was included for completeness.
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Figure 1. Branchiobdellida from crayfish host (Cambaridae) (scale 1 mm).

4a (3a) Parasitic on fishes; anterior sucker about half the diameter of caudal sucker; body small (<2.5 cm)........................................... Family Piscicolidae

4b Usually parasitic on turtles; body large, (>2.5 cm) ...Placobdella parasitica

5a (1b) Chaetae absent.................................................................6

5b Chaetae present ........................................................................7

6a (5a) Multiple pairs of eyes (may be discrete and not visible)................

..............................................................................................................Family Erpobdellidae

6b Single pair of closely spaced conspicuous eyes .....................Helobdella sp.

7a (5b) Dorsal chaetae absent (at least on 10 or more anterior segments)........8

7b Dorsal chaetae present (Figure 2)..................................................10

8a (7a) Ventral chaetae bifid, and at least three and up to nine per bundle (Figure 3).................................................................9

Figure 2. Drawing of generalized aquatic oligochaete showing anterior end and example positions of dorsal and ventral chaetae.

Figure 3. Chaetogaster: A photograph of typical bifid ventral chaetal bundle B drawing showing shape of one chaeta.
8b Ventral chaetae 1 per bundle with simple point and tip curved towards posterior of worm (Figure 4); worm elongate, up to 10 cm or more in length, but usually 4-5 cm................................. *Haplotaxis cf. gordioides*

**Figure 4. Haplotaxis cf. gordioides:** A lateral view of anterior end showing prostomium and ventral mouth (scale 750 µm) B ventral view of one segment showing the two single ventral chaetae C drawing of one ventral chaeta.

9a (8a) Prostomium more conspicuous than other *Chaetogaster* spp.; only ventral chaetae present; worm usually small, total length <4 mm (Figure 5).............

.......................................................................................................................................... *Chaetogaster cf. diaphanus*

**Figure 5. Chaetogaster cf. diaphanus:** A drawing of entire body (scale 250 µm) B photo of anterior end showing prostomium protruding forward from mouth.

9b Prostomium inconspicuous with cleft (Figure 6); numerous chaetae per posterior ventral bundles; worm usually relatively large, with total length ≥ 4 mm.............................. *Chaetogaster cf. crystallinus*

**Figure 6. Chaetogaster cf. crystallinus:** A outline drawing of entire body showing positions of chaetae that are limited to only ventral bundles of segments (scale 1 mm) B photo of anterior end showing cleft in prostomium.
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10a (7b) Dorsal chaetae usually more than 1 per bundle and found on anterior portions of worm ................................................................. 11

10b Dorsal chaetae short, only 1 per bundle, only found on posterior of worm; ventral chaetae 1 per bundle with simple point curved posteriad; worm elongate, up to 10 cm long, usually 4–5 cm......Haplotaxis cf. gordioides

11a (10a) Ventral chaetae two per bundle and with simple point (Figure 7); worm usually quite large, total length >3 cm .................................................. 12

Figure 7. Paired chaetae typical of both dorsal and ventral bundles found on several lumbriculid taxa.

11b Ventral chaetae bifid, more than two per bundle with usually 3-9 per bundle in most species (Figure 8)................................................................. 13

Figure 8. Multiple bifid ventral chaetae.
12a (11a) Prostomium modified into elongated proboscis (Figure 9)..............................
.................................................................\textbf{Lumbriculidae sp}_1 \text{(may be two species)}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure9}
\caption{\textbf{Lumbriculidae sp}_1: lateral photo of anterior end showing prostomium with conspicuous proboscis (scale 500 µm).}
\end{figure}

12b Prostomium inconspicuous and without proboscis (Figure 10)..............................
.................................................................\textbf{Lumbriculidae sp}_2 \text{(may be two species)}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure10}
\caption{\textbf{Lumbriculidae sp}_2: photo showing inconspicuous prostomium.}
\end{figure}

13a (11b) Gills present on posterior end (digitiform projections; in some cases inconspicuous)..............................................................................................14
13b Posterior end without gills .................................................................................15
14a (13a) Gill fossa with two long parallel accessory palps (Figure 11)..............
................................................................................\textbf{Dero (Aulophorus) furcatus}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure11}
\caption{\textbf{Dero (Aulophorus) furcatus}: A photo of posterior end showing digitiform gills and elongate palps (scale 250 µm) B drawing of A C drawing of typical chaetae bundle D drawing of typical ventral chaeta.}
\end{figure}
14b Gill fossa not prolonged, often continuous with gills (Figure 12)..................

Dero (Dero) obtusa

Figure 12. Dero (Dero) obtusa; anterior end and typical chaetae: A photo of posterior end showing gill fossa (scale 250 µm) B outline drawing of A C drawing of typical dorsal chaetae bundle D drawing of typical ventral chaeta.

15a (13b) Eyes present.................................................................16
15b Eyes absent.................................................................17
16a (15a) Prostomium with elongate proboscis (Figure 13)........ Stylaria lacustris

Figure 13. Stylaria lacustris, showing elongate prostomial proboscis, eyes, and typical chaetae: A photo of anterior end (scale 500 µm) B drawing of dorsal “hair” C drawing of dorsal “needle” D drawing of ventral chaeta.

16b Prostomium protruding conspicuously over mouth, but without proboscis (Figure 14) .................................................Nais pseudobtusa

Figure 14. Nais pseudobtusa: A lateral photo of anterior end showing arrangement of chaetae, eyes, and overhanging prostomium (scale 500 µm) B dorsal photo of anterior end (scale 250 µm) C drawing of typical posterior-ventral chaeta D drawing of typical anterior-ventral chaeta D drawing of typical bundle of dorsal chaetae.
17a (15b)  Prostomium without proboscis ................................................................. 18
17b  Prostomium with elongate proboscis (Figure 15) .................. *Pristina leidyi*

![Figure 15. Pristina cf. leidy: A lateral photo of anterior end showing elongate proboscis (scale 200 µm) B drawing of typical bundle of dorsal chaetae C drawing of typical ventral chaeta.](image)

18a (17a)  Green epidermal glands ......................................................... *Aeolosoma cf. variegatum*
18b  Red epidermal glands (Figure 16) .................. *Aeolosoma cf. quarternarium*

![Figure 16. Aeolosoma cf. quarternarium: A photo of entire body showing red epidermal glands and disc-like anterior (scale 200 µm) B typical variable bundle of chaetae.](image)

**Discussion**

The annelids of the SMR headwaters, not surprisingly, proved to be quite diverse. The majority of this diversity was contained within the family Naididae. The naidid annelids that were identified belong to globally common and widely distributed genera and species (Brinkhurst and Jamieson 1971, Martin et al. 2008, Christoffersen 2010, Pinder 2010, Park and Yeon 2013). Though some showed slight morphological differences from published descriptions, these differences did not seem great enough to conclude that they might be new species.

*Haplotaxis cf. gordioides* (Family Haplotaxidae) was only collected from spring outflows, and the genus is known globally to be exclusively a groundwater taxon with
cryptic microdiversity (Wetzel and Taylor 2001). This collection documents a new stygobiont from the region.

The Family Lumbriculidae may be even more specious in the SMR than indicated herein, as there were four distinguishable forms of lumbriculids collected during this study. However, it could not be determined whether or not the smaller two forms were juvenile forms of the larger two forms. Only the larger two forms are reported herein. Neither of these lumbriculid species could be confidently assigned to any known genus, and it is possible that they represent undescribed endemic species. Along with the collection of two species of Aphanoneura, the occurrence of the lumbriculids is highly suggestive that the SMR headwaters is an ancient habitat, as the members of both of these taxa are typically collected from ancient lakes (Martin 1996). One of the lumbriculids (referred to here as Lumbriculidae sp1) was also found to contain larvae of a trichosomoid nematode, as determined by the presence of a stichosome. Therefore, this lumbriculid species is thought to be serving as the intermediate host in the life cycle of a potentially undescribed trichosomoid.

Species of *Helobdella* leeches are typically found free living on the benthic sediments hunting for small arthropods, mollusks, and oligochaetes (Kutschera et al. 2013). Interestingly, a few specimens from this group were found attached to largemouth bass (*Micropterus salmoides* Lacépède). The method of attachment was quite bizarre. Individual leeches were connected to the ventral anterior surface of the bass with a single point of attachment, and the rest of the worm was enclosed in a mesh-like sack that dangled from the point of attachment. This finding represents an interesting note of life history for this group, as it seems they can also be facultative parasites; however, this is not the first report of *Helobdella* leeches parasitizing vertebrates (Platt et al. 1993, Tiberti and Gentilli 2010, Zimić 2015) but is the first report of this genus parasitizing fish that we are aware of.

Two additional oligochaete taxa were collected but have not been included herein because only one specimen of each taxon was collected and specimens were not in suitable condition for identification. A species of leech, which was only rarely collected from turtles, was also not identified. Neither of these oligochaetes or the leech were included in our results. Throughout specimen collections, numerous different forms of soil- and vegetation-dwelling nematodes were also collected. We did not attempt to identify any of these specimens. However, the variety of forms collected suggests that free-living nematodes may be the most specious group of soft-bodied metazoans in the SMR headwaters. The study of the SMR nematode fauna would represent a great contribution to what is known of the invertebrate fauna in this habitat.

Kånneby and Wicksten (2014) noted the collection of a new gastrotrich of the enigmatic genus *Redudasys* (Gastrotricha: Macrodasyida) from the SMR headwaters. Theirs is the first report of this genus from the Northern Hemisphere. We also collected gastrotrichs from the SMR, but they were identified to the genus *Chaetonotus* (Gastrotricha: Chaetonotida).

The identifications presented herein represent the first work on identifying annelids of the SMR and all of Central Texas. Therefore, we cannot speculate about how
the diversity of the annelid fauna in the SMR compares to that of other Texas rivers. Greater taxonomic resolution could be achieved through genotyping specimens and we suspect that this would likely reveal appreciable cryptic diversity. Because this is the first annelid study in Central Texas we are hopeful that this will stimulate further research and lead to genotyping and further morphological studies by other authors in the SMR and other bodies of water. Even from the perspective of our incomplete survey, there seems to be compelling evidence that there is much more diversity in the SMR headwaters yet to be described, particularly for the invertebrate fauna.

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References

Polaszek A, Alonso-Zarazaga M, Bouchet P, Brothers DJ, Evenhuis NL, Krell FT, Lyal CHC, Minelli A, Pyle RL, Robinson N, Thompson FC, van Tol J (2005) ZooBank: the open-access register for zoological taxonomy: Technical Discussion Paper. Bulletin of Zoological Nomenclature 62: 210–220.

Benedict J E (1896) Preliminary descriptions of a new genus and three new species of crustaceans from an artesian well at San Marcos, Texas. Proceedings of the United States National Museum 18: 615–617. doi: 10.5479/si.00963801.18-1087.615

Bishop SC (1941) Notes on salamanders with descriptions of several new forms. Occasional Papers of the Museum of Zoology, University of Michigan 451: 1–21.

Bowles DE, Arsuffi TL (1993) Karst aquatic ecosystems of the Edwards Plateau region of central Texas, USA: a consideration of their importance, threats to their existence, and efforts for their conservation. Aquatic Conservation: Marine and Freshwater Ecosystems 3: 317–329. doi: 10.1002/aqc.3270030406

Bowles DE, Tiemann SG, Easley GW, Bueno-Soria J, Barba-Álvarez R, Armitage B (2007) Cadisfly (Insecta: Trichoptera) assemblages of large springs and spring-runs in central Texas, USA. Proceedings of the twelfth international symposium on Trichoptera 2007: 15–29.
Bowman TE, Longley G (1976) Redescription and assignment to the new genus *Lirceolus* of the Texas troglobitic water slater, *Asellus smithii* (Ulrich) (Crustacea: Isopoda: Asellidae). Proceedings of the Biological Society of Washington 88: 489–496.

Brinkhurst RO (1964) Studies on the North American aquatic Oligochaeta I: Naididae and Opistocystidae. Proceedings of the Academy of Natural Sciences of Philadelphia 116: 195–230.

Brinkhurst RO, Jamieson BM (1971) Aquatic Oligochaeta of the world. University of Toronto Press.

Christoffersen ML (2010) Continental biodiversity of South American oligochaetes: the importance of inventories. Acta Zoológica Mexicana (Nueva Serie) 26: 35–46.

Crow CL (2012) Geochemical and hydrologic data for San Marcos Springs recharge characterization near San Marcos, Texas, November 2008 – December 2010. US Geological Survey Data Series 672: 1–19.

Diaz PH (2010) Diet and mesohabitat associations of the threatened San Marcos salamander (*Eurycea nana*).

Diaz PH, Alexander ML (2010) Aquatic macroinvertebrates of a spring-fed ecosystem in Hays County, Texas, USA. Entomological News 121: 478–486. doi: 10.3157/021.121.0511

Edwards SW, Arnold CR (1961) The caddis flies of the San Marcos River. Texas Journal of Science 13: 398–415.

Gibson JR, Harden SJ, Fries JN (2008) Survey and distribution of invertebrates from selected springs of the Edwards Aquifer in Comal and Hays Counties, Texas. The Southwestern Naturalist 49: 435–441. doi: 10.1894/0038-4909(2008)53[74:sadoif]2.0.co;2

Harman WJ (1973) New species of Oligochaeta (Naididae) with additional distributional records from Oklahoma and Texas. The Southwestern Naturalist 18: 151–164. doi: 10.2307/3670416

Hershler R, Longley G (1986) Phreatic hydrobiids (Gastropoda: Prosobranchia) from the Edwards (Balcones Fault Zone) Aquifer region, south-central Texas. Malacologia 27: 127–172.

Hiltunen JK, Klemm DJ (1980) A guide to the Naididae (Annelida, Clitellata, Oligochaeta) of North America. EPA-600/4-80-03.

Holsinger JR (1966) Subterranean amphipods of the genus Stygonectes (Gammaridae) from Texas. American Midland Naturalist 76: 100–124. doi: 10.2307/2423237

Holsinger JR, Longley G (1980) The subterranean amphipod crustacean fauna of an artesian well in Texas. Smithsonian Institution Press, Washington DC.

Hutchins BT, Tovar RU, Schwartz BF (2013) New records for stygobionts from the Edwards Aquifer of Central Texas. Speleobiology Notes 5: 14–18.

Jordan DS, Gilbert CH (1886) List of fishes collected in Arkansas, Indian Territory, and Texas, in September, 1884, with notes and descriptions. Proceedings of the United States National Museum 9: 1–25. doi: 10.5479/si.00963801.549

Kånneby T, Wicksten MK (2014) First record of the enigmatic genus *Redudasys* Kisielewski, 1987 (Gastrotricha: Macrodasyida) from the Northern Hemisphere. Zoosystema 36: 723–733. doi: 10.5252/z2014n4a2

Kathman RD, Brinkhurst RO (1998) Guide to the freshwater oligochaetes of North America. Aquatic Resources Center, College Grove, 264 pp.

Martin P (1996) Oligochaeta and Aphanoneura in ancient lakes: a review. Hydrobiologia 334: 63–72. doi: 10.1007/BF00017354
Martin P, Martinez-Anseml E, Pinder A, Timm T, Wetzel MJ (2008) Global diversity of oligochaetous clitellates (“Oligochaeta”; Clitellata) in freshwater. Hydrobiologia 595: 117–127. doi: 10.1007/s10750-007-9009-1

Musgrove M, Crow CL (2012) Origin and characteristics of discharge at San Marcos Springs based on hydrologic and geochemical data (2008–10), Bexar, Comal, and Hays Counties, Texas. Scientific Investigations Report 2012–5126: 1–105.

Ourso RT, Hornig CE (2000) Stream and Aquifer Biology of South-Central Texas-A Literature Review, 1973–97. Open File Report, U.S. Geological Survey, 99–243.

Park HJ, Yeon JB (2013) Aquatic oligochaete (Annelida: Clitellata) fauna from the Jungnang Stream in Seoul, Korea, with eight new Korean records. KJEE 46: 507–512. doi: 10.11614/KSL.2013.46.4.507

Pinder A (2010) Tools for identifying selected Australian aquatic oligochaetes (Clitellata: Annelida). Museum Victoria Science Reports 13: 1–26.

Platt TR, Sever DM, Gonzalez VL (1993) First Report of the Predaceous Leech Helobdella stagnalis (Rhynchobdellida: Glossiphoniidae) as a Parasite of an Amphibian, Ambystoma tigrinum (Amphibia: Caudata). The American Midland Naturalist 129: 208–210. doi: 10.2307/2426450

Schenck JR, Whiteside B (1977) Food habits and feeding behavior of the fountain darter, Etheostoma fonticola (Osteichthyes: Percidae). The Southwestern Naturalist 21: 487–492.

Spencer DR (1978) Pristina acuminata Liang, a naidid oligochaete new to North America. Transactions of the American Microscopical Society 97: 236–239. doi: 10.2307/3225598

Tiberti R, Gentilli A (2010) First report of freshwater leech Helobdella stagnalis (Rhyncobdellida: Glossiphoniidae) as a parasite of an anuran amphibian. Acta Herpetologica 5: 255–258.

Ulrich CJ (1902) A contribution to the subterranean fauna of Texas. Transactions of the American Microscopical Society 23: 83–101. doi: 10.2307/3220939

Wetzel MJ, Taylor SJ (2001) First records of freshwater oligochaetes (Annelida, Clitellata) from caves in Illinois and Missouri, USA. Journal of Cave and Karst Studies 63: 99–104.

Wetzel MJ, Kathman RD, Fend SV, Coates KA (2015) Classification and checklist of the freshwater oligochaetes occurring in North America north of Mexico. 3 February. World Wide Web URL: http://www.inhs.uiuc.edu/~mjwetzel/FWOligoNACHklst.html [accessed: 18 May 2015]

Zimić A (2015) Commensalism, Predation or Parasitism: First report of the leech Helobdella stagnalis Linnaeus, 1758 on yellow-bellied toad, Bombina variegata (Linnaeus, 1758). Ecologica Montenegrina 2: 62–63.