

# **The Crayfish Worms (Annelida: Clitellata: Branchiobdellida) of Wisconsin**



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**Miscellaneous Publication PUB-SS-1045 2009**

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**Cover Photo:** A typical branchiobdellidan, *Cambarincola heterognathus* Hoffman, 1963, whole mount preparation photographed with DIC illumination by Dr. Stuart R. Gelder, University of Maine at Presque Isle.

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# The Crayfish Worms (Annelida: Clitellata: Branchiobdellida) of Wisconsin

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**Abstract:** An updated checklist of Wisconsin crayfish worms is presented based on records found in the scientific literature and museum databases. The four species remain poorly known in the state. References for their identification are listed and museum and literature records are provided to aid future researchers.

## Introduction

Branchiobdellidans, also called crayfish worms, are small (0.8-15 mm total length), 17-segmented annelids that form an obligate, ectosymbiotic association with freshwater crustaceans, primarily crayfishes (Brinkhurst and Gelder 2001; S.R. Gelder, pers. comm.). These worms occur throughout North America from southern Canada to Costa Rica. A few species are widespread, but many have more restricted ranges. Few records exist of species collected in Wisconsin, and when the state Department of Natural Resources (DNR) undertook work on the state's *Wildlife Action Plan*, biologists could not assess adequately the conservation status of branchiobdellidans in the state (Wisconsin DNR 2005, p. 2-70). The conservation planners note a combination of factors, including a lack of readily available reference materials (i.e. literature and specimens), as a primary cause of this situation. A lack of taxonomic specialists working with branchiobdellidans (and other annelids!) also complicates the conservation work of resource professionals. To help address our information needs and follow up on *Wildlife Action Plan* recommendations that "efforts should be made to compile and make available catalogs of existing taxonomic and related references for Wisconsin invertebrate groups" (Wisconsin DNR 2005, p. 4-1), I here summarize branchiobdellidan records from the state.

## Methods

I identified the principal literature pertaining to this group using various electronic databases (*Biological Abstracts*, 1969-2008; *MEDLINE*, 1950-2008; *Web of Science*, 1965-2008; *Zoological Record*, 1864-2008). I then reviewed all pertinent references. In addition, I examined much of the literature cited in these primary sources. In total, I combed through more than 175 relevant research papers and scholarly notes published between 1894 and 2008 for Wisconsin records. I supplemented the literature review with a search of available museum catalogs.

## Classification

To date, biologists have named and described 21 genera and about 150 species of branchiobdellidans world-wide (Gelder 1996a, Gelder and Ohtaka 2000). Although leech-like in appearance, most taxonomists believe that crayfish worms are more closely related to the earthworms and their freshwater allies (oligochaetes) than to the leeches (hirudineans) (see Gelder and Brinkhurst 1990, Brinkhurst 1999, and Siddall et al. 2001, but also Erseus and Kallersjo 2004 and Erseus 2005). Table 1 presents the current taxonomic arrangement of the group's higher classifications within the phylum Annelida. Madill et al. (1992) has established the common name for the order, but accepted no common names for species. The common collective name for the order is branchiobdellidan, making available a comparable collective name for each subfamily: bdellodrilid, branchiobdellid, cambarincolid, and xironodrilid.

**Table 1. Classification of the crayfish worms (branchiobdellidans) modified after Brinkhurst and Gelder (2001).**

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Phylum Annelida
Subphylum Clitellata
Order Branchiobdellida
Family Branchiobdellidae
Subfamily Branchiobdellinae
Subfamily Cambarincolinae
Subfamily Bdellodrilinae
Subfamily Xironodrilinae

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The order includes endemic genera that are restricted naturally to either North America (e.g., *Cambarincola*) or Eurasia, but introductions of crayfish hosts into Europe and eastern Asia have resulted in some North American species being reported as exotic species on those continents (e.g., Yamaguchi 1933, Gelder et al. 1994, Gelder et al. 1999, Ohtaka et al. 2005, Martens et al. 2006). The greatest diversity of genera and species is found in North America, with 103 species currently known from the continent (Gelder et al. 2002).

## Identification

Because of their minute size, identification of branchiobdellidans requires microscopic examination of live animals or carefully prepared slides, the latter being a time consuming and tedious process requiring some expertise and practice. Brinkhurst and Gelder (2001) provide details for both kinds of recommended methods of preparation.

Brinkhurst and Gelder (2001) and Smith (2001) provide useful keys to the genus level. Unfortunately, no single key to all North American species exists, but Gelder's (1996a) checklist does include citations to all papers containing type descriptions. Also, Holt and Opell (1993) provide a well illustrated key to the species of the subfamily Cambarincolinae, which includes the vast majority of species found in North America. The terms in the legend for their Figure 1 illustrations showing the "protrusible" and "eversible" penis (Holt and Opell 1993, p. 252), unfortunately, were reversed accidentally during production. This error, however, was not replicated in the actual key (p. 285). In addition, Gelder and Hall (1990) provide descriptions, diagnostic illustrations, and a key to the six species in the genus *Xironogiton* and Gelder (1996b) provides an illustrated key to the nine species in the genus *Pterodrilus*. The earlier synopsis of families (now considered subfamilies) and genera by Holt (1986) also remains helpful.

### **Wisconsin Species – Literature Records**

Ellis (1919) was the first to report branchiobdellidans from Wisconsin. He reported the occurrence of *Cambarincola philadelphicus* on *Cambarus diogenes* Girard 1852 and *Cambarincola vitreus* on *Orconectes virilis* (Hagen 1870) in the Rhinelander area (Oneida Co.). He also reported these worms from other hosts in other states.

Hoffman (1963) later confirmed the presence of *C. philadelphicus* in Wisconsin in his description of this species' range, but provided no new records from the state. Hoffman (1963) also confirmed Ellis' (1919) *C. vitreus* record from the Rhinelander area and provided three additional Wisconsin records for this species: Lake Mendota (Dane Co.), Blake Fork River (Grant Co.), and an unspecified location in Juneau County. Finally, Hoffman (1963) presented records of *Cambarincola mesochoreus* from unspecified hosts in Lake Mendota and Juneau County. He noted (p. 310) that it was collected on numerous species of crayfish in the genera *Procambarus* and *Orconectes* and suggested *C. mesochoreus* was the most abundant member of its genus in the Upper Mississippi Valley.

Holt (1978) recorded *Sathodrilus elevatus* from collection sites in nine Wisconsin counties: Barron, Chippewa, Columbia, Dane, Grant, Jefferson, Lafayette, Monroe, and Oconto. He noted specimens being collected from *Orconectes propinquus* (Girard 1852), *O. virilis*, and *C. diogenes*.

The few more recent Wisconsin literature records I encountered appear to be based on these earlier reports. In the most recent tabulation of North American branchiobdellidans, Gelder et al. (2002) list only these four species from Wisconsin (Table 2). All four are widespread in North America and belong to the subfamily Cambarincolinae.

**Table 2. Branchiobdellidan species reported from Wisconsin (based on Gelder et al. [2002] and available museum records).**

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*Cambarincola mesochoreus* Hoffman, 1963  
*Cambarincola philadelphicus* (Leidy, 1851)  
*Cambarincola vitreus* Ellis, 1919  
*Sathodrilus elevatus* (Goodnight, 1940)

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### Wisconsin Species - Museum Records

The National Museum of Natural History's online invertebrate zoology database (see <http://nhb-acsmith2.si.edu/emuwebizweb/pages/nmnh/iz/Query.php>; accessed August 2008) includes 68 records of Wisconsin branchiobdellidans. Forty-three of these have been identified to the species level (Table 3). All of these were collected prior to 1961. Twenty-one other specimens are identified only to family and one only to the genus. The remaining three specimens identified as being from Wisconsin (catalog nos. 100641, 100642, and 100645) are actually from Michigan collection localities (Delta Co.). Several of the cataloged records appear to be for the voucher specimens from Ellis' (1919) and Hoffman's (1963) early work (i.e. nos. 17669, 99579, 99581, 99857, 99858, and 100016 in Table 3).

While available resources prevent me from visiting the NMNH to examine these specimens, I believe the species identifications likely are accurate as most were determined by either P.C. Holt or R.L. Hoffman, both expert branchiobdellidan taxonomists. The taxonomic nomenclature used in the NMNH database, however, is somewhat dated. For clarity, I treat specimens identified as "*Cambarincola cf. elevata* Goodnight" in the NMNH database as *Sathodrilus elevatus* in Table 3. These clearly represent the vouchers for Holt's (1978) work and he listed (p. 481) all as *S. elevatus*. Similarly, those identified as "*Cambarincola cf. philadelphica* Leidy" and "*Cambarincola cf. vitrea* Ellis" are listed in Table 3 as *Cambarincola philadelphicus* and *Cambarincola vitreus*, respectively. It should be noted, however, that although *C. philadelphicus* is reported in the literature as an unusually variable species, many references to it undoubtedly apply to other related forms (Holt and Opell 1993). Thus, the specimens indicated as "*cf. philadelphica*" may actually represent other species. Examination of the specimens could shed light on this question.

I include the NMNH catalog numbers for all entries in Table 3 to aid future researchers in accessing these records and the specimens on which they are based. It is important to recognize that the NMNH's online database includes data on less than 33% of the museum's collections so additional records may exist at this institution but not yet be available online. NMNH staff members are constantly adding new data and correcting records, so future investigators may want to peruse an updated version of the online database or consult museum staff rather than simply relying on Table 3 as a definitive data source.

**Table 3. Wisconsin branchiobdellidan records from the National Museum of Natural History's online database (August 2008).**

<b>Species</b>			
<b>Catalog No.</b>	<b>Collection Locality (County: Waterbody)</b>		<b>Date</b>
<i>Cambarincola mesochoreus</i>			
100619	Chippewa Co.: Bob's Creek, 4.5 mi. west of Cornell		July, 1960
100618	Chippewa Co.: Mccann Creek, 11.3 mi. west of Cornell		July, 1960
99581	Dane Co.: Lake Mendota		Aug., 1949
99858	Juneau Co.: Mouston, 32.4 mi. southeast of county Line		July, 1958
99868	La Crosse Co.: 18 mi. east of La Crosse		July, 1958
100633	Langlade Co.: West Branch Eau Claire River, 5.9 mi. west of Antigo		July, 1960
100627	Lincoln Co.: 11.8 mi. west of Merrill		July, 1960
100630	Lincoln Co.: Pine River, 8.4 mi. west of county line		July, 1960
100638	Oconto Co.: Oconto River at confluence of Waupee River		July, 1960
100623	Taylor Co.: Black River, 12 mi. west of Medford		July, 1960
<i>Cambarincola philadelphicus</i>			
99861	Columbia Co.: Crawfish Creek, below Duck Pond		July, 1958
99580	Dane Co.: Lake Mendota		Aug., 1949
100603	Douglas Co.: Amnicon River, 3.3 mi. north of Middle River		July, 1960
100015	Grant Co.: Blake Fork, near Bloomington		May, 1956
100014	Lafayette Co.: 2.5 mi. south of Darlington		May, 1956
100625	Taylor Co.: Gilman, tributary to Yellow River		July, 1960
100606	Washburn Co.: Totagatic River		July, 1960
<i>Cambarincola vitreus</i>			
100612	Barron Co.: Bear Creek, 2.6 mi. north of Rice Lake		July, 1960
100608	Barron Co.: Meadow Creek, 3.4 mi. south of Rice Lake		July, 1960
100613	Chippewa Co.: Duncan Creek, 4.1 mi. north of Bloomer		July, 1960
100617	Chippewa Co.: Mccann Creek, 11.3 mi. west of Cornell		July, 1960
99579	Dane Co.: Lake Mendota		Aug., 1949
100602	Douglas Co.: Amnicon River, 3.3 mi. north of Middle River		July, 1960
100016	Grant Co.: Blake Fork River, near Bloomington		May, 1956
99857	Juneau Co.: Mouston, 32.4 mi. southeast of county Line		July, 1958
100632	Langlade Co.: West Branch Eau Claire River, 5.9 mi. west of Antigo		July, 1960
100626	Lincoln Co.: 11.8 mi. west of Merrill		July, 1960
100631	Lincoln Co.: Pine River, 8.4 mi. west of county line		July, 1960
100639	Oconto Co.: Oconto River at confluence of Waupee River		July, 1960
100640	Oconto Co.: Oconto River at confluence of Waupee River		July, 1960
17669	Oneida Co.: Rhinelander		Oct., 1915
100622	Taylor Co.: Black River, 12 mi. west of Medford		July, 1960
100624	Taylor Co.: Gilman, tributary to Yellow River		July, 1960
100607	Washburn Co.: Totagatic River		July, 1960

**Table 3, (cont.). Wisconsin branchiobdellidan records from the NMNH online database.**

Species	Catalog No.	Collection Locality (County: Waterbody)	Date
<i>Sathodrilus elevatus</i>			
	100611	Barron Co.: Bear Creek, 2.6 mi. north of Rice Lake	July, 1960
	100614	Chippewa Co.: Duncan Creek, 4.1 mi. north of Bloomer	July, 1960
	99862	Columbia Co.: Crawfish Creek, below Duck Pond	July, 1958
	101962	Dane Co.: Lake Mendota	Aug., 1949
	100017	Grant Co.: Blake Fork River, near Bloomington	May, 1956
	99870	Jefferson Co.: Rock River at Watertown	July, 1958
	100013	Lafayette Co.: 2.5 mi. south of Darlington	May, 1956
	99856	Monroe Co.: Sparta, 11.4 mi. east of county line	July, 1958
	100637	Oconto Co.: Oconto River at confluence of Waupee River	July, 1960

### Potential Wisconsin Species

Surprisingly few crayfish worms have been documented in the states surrounding Wisconsin (Table 4). Certainly, not enough is known about the ecological requirements of individual branchiobdellidan species to predict their distributions with certainty. Yet, a look at which species have been found where can suggest hypotheses regarding their zoogeographic relationships. For example, some species appear to be southern/southeastern, only reaching the edge of their ranges in the Upper Midwest, while others appear to be more widespread, occurring across the entire continent.

Several additional branchiobdellidan species may occur in Wisconsin as they occur in nearby states and have crayfish hosts that are found here. For example, *Cambarincola chirocephalus* Ellis 1919 occurs on *Orconectes virilis* (Hoffman 1963) and has been recorded in surrounding states (Gelder et al. 2002, Wetzel 2002). Similarly, *Cambarincola macrodontus* Ellis 1912 occurs on *Cambarus diogenes* (Ellis 1919, Hoffman 1963) and has a range that could encompass Wisconsin (Gelder et al. 2002). The more easterly distributed *Pterodrilus distichus* Moore 1895, which according to Ellis (1919) occurs on *Orconectes rusticus* (Girard 1852), could also turn up here. Finally, *Xironodrilus formosus* Ellis 1919, a symbiont of *O. propinquus* and *O. rusticus*, has been collected in Lake Michigan (Ellis 1919) and probably occurs in Wisconsin waters of at least that lake. Further survey work will be needed to determine if these species occur here.

The introduction of nonnative crayfish (and their parasites and ectosymbionts) into water bodies through angling, the pet trade, and aquaculture is a nation-wide concern. Preparation of accurate species and distribution lists will be necessary to assess the current situation and for effective management and regulation.

**Table 4. Branchiobdellidans recorded from Upper Midwest states (based on Ellis 1918, Hoffman 1963, Holt and Opell 1993, Gelder et al. 2002, Wetzel 1992 and 2002).**

Species	MN	IA	WI	IL	IN	MI
Subfamily Bdellodrilinae						
<i>Bdellodrilus illiminatus</i> (Moore, 1894)				X		
Subfamily Cambarincolinae						
<i>Cambarincola chirocephalus</i> Ellis, 1919		X		X	X	X
<i>Cambarincola dubius</i> Holt, 1973					X	
<i>Cambarincola illinoisensis</i> Holt, 1982				X		
<i>Cambarincola macrodontus</i> Ellis, 1912				X		X
<i>Cambarincola mesochoreus</i> Hoffman, 1963		X	X		X	X
<i>Cambarincola philadelphicus</i> (Leidy, 1851)	X	X	X	X	X	X
<i>Cambarincola vitreus</i> Ellis, 1919	X		X	X	X	X
<i>Ellisodrilus durbini</i> (Ellis, 1919)					X	X
<i>Oedopodrilus macbaini</i> (Holt, 1955)				X	X	
<i>Pterodrilus distichus</i> Moore, 1895				X	X	X
<i>Sathodrilus elevatus</i> (Goodnight, 1940)	X	X	X	X	X	X
Subfamily Xironodrilinae						
<i>Xironodrilus dentatus</i> Goodnight, 1940						X
<i>Xironodrilus formosus</i> Ellis, 1919				X	X	X

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## Acknowledgments

I initiated work on this report in preparation for the "Wisconsin's Species Diversity: the State of Scientific Knowledge" symposium sponsored by the Aldo Leopold Chapter of the Society for Conservation Biology in 1997. I am indebted to the chapter for providing the push needed to synthesize information pertaining to invertebrate diversity in the state and publish the report now to support continuing work on Wisconsin's *Wildlife Action Plan*. Mark J. Wetzel, Illinois Natural History Survey, and Stuart R. Gelder, University of Maine at Presque Isle, provided constructive comments on earlier versions of the manuscript. I appreciate their time and efforts.



