A Contribution to the Tardigrade Fauna of Oklahoma

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The Phylum Tardigrada consists of minute arthropod relatives, commonly known as water bears. Terrestrial species are renowned for their anhydrobiosis, which allows them to survive drying out. Over 960 species of marine, freshwater, and terrestrial water bear are known worldwide (Guidetti and Bertolani 2005). Of these, more than 200 freshwater and terrestrial species are known to occur in North America (Meyer and Hinton 2007). Four published papers have reported the presence of tardigrades in the state of Oklahoma. Beasley (1978) collected lichens and mosses in nineteen counties from across the state and found sixteen species. Lee and Woolever (1983) sampled mosses and lichens in Adair County. They found two species, and were able to identify one of them as *Milnesium tardigradum*, a cosmopolitan species also found by Beasley (1978). Beasley and Pilato (1987) described a new species, *Doryphoribius bertolani*, from material collected in Payne County. Most recently, Beasley (1988) noted that he had collected *Hypsibius macrocalcaratus* in Oklahoma, but did not specify where.

On September 2, 2008 I collected dry moss (three samples) and foliose lichen (one sample) from trees at the Cherokee Heritage Center in Tahlequah, Cherokee County, Oklahoma (35° 52′N, 94° 57′W). Samples were stored in sealed envelopes. Four species of tardigrade - *Echiniscus viridis*, *Paramacrobiotus areolatus*, *Macrobiotus echinogenitus*, and *Milnesium tardigradum* – have previously been identified from Cherokee County (Beasley 1968), and Lee and Woolever (1983) found an unidentified *Macrobiotus* there.

In the laboratory samples were soaked overnight in tap water to rehydrate the tardigrades. The material was passed through a 42 μm sieve and the residue sorted with a dissecting microscope. Specimens were mounted on slides in polyvinyl lactophenol and examined using phase contrast microscopy. Tardigrades were identified using keys and descriptions in Nelson and McInnes (2002) and Ramazzotti and Maucci (1983), and by reference to the primary literature. Taxonomic nomenclature in this paper accords with Guidetti and Bertolani (2005). Comments on the global biogeography of tardigrade species are based primarily on McInnes (1994).

The four samples contained 67 specimens and eight eggs, representing four genera and six species. All six species – *Echiniscus mauccii* (8 specimens), *Echiniscus wendti* (1 specimen), *Paramacrobiotus areolatus* (10 specimens), *Macrobiotus* cf. *hufelandi* (1 specimen), *Minibiotus furcatus* (1 specimen), and *Milnesium tardigradum* (1 specimen) – were present in the foliose lichen sample. The three moss samples contained *E. mauccii* (10 specimens), *Paramacrobiotus areolatus* (15 specimens and 2 eggs), *Macrobiotus* cf. *hufelandi* (15 specimens and 6 eggs), *Minibiotus furcatus* (1 specimen), and *Milnesium tardigradum* (4 specimens).

This study adds one species of tardigrade, *Echiniscus wendti*, to the tardigrade fauna of Oklahoma. Currently 20 species of tardigrade are known to occur in Oklahoma (Table 1).

Pilato and Binda (2001) categorized 6.8% of all non-marine tardigrade species as cosmopolitan in distribution (reported in five or more biogeographic regions). In Oklahoma twelve (60%) of the known species are cosmopolitan (Table 1). In the Nearctic realm as a whole 18% of tardigrade

Table 1. Tardigrade species reported from Oklahoma, and their global distribution. Biogeographic abbreviations: Na=Nearctic, Nt=Neotropical, P=Palearctic, Af=Afrotropical, I=Indomalayan, Au=Australian NZ=New Zealand, O=Oceania, An=Antarctic and subantarctic.

Species	Biogeographic Regions
Cornechiniscus lobatus (Ramazzotti, 1943)	Na, Nt, P
Echiniscus canadensis Murray, 1910	Na, Nt, P
Echiniscus mauccii Ramazzotti, 1956	Na
Echiniscus viridis Murray, 1910	Na, Nt, P, O
Echiniscus wendti Richters, 1903	Na, Nt, P, Af, I
Paramacrobiotus areolatus (Murray, 1907)	Na, Nt, P, Af, I, Au, NZ, O
Macrobiotus echinogenitus Richters, 1904	Na, Nt, P, Af, I, Au, NZ, An
Macrobiotus harmsworthi Murray, 1907	Na, Nt, P, Af, I, Au, NZ, O, An
Macrobiotus hibiscus de Barros, 1942	Na, Nt, P
Macrobiotus hufelandi C.A.S. Schultze, 1833	Na, Nt, P, Af, I, Au, NZ, O, An
Minibiotus furcatus (Ehrenberg, 1859)	Na, Nt, P, Af, I, An
Minibiotus intermedius (Plate, 1888)	Na, Nt, Pa, Af, I, Au, NZ, O, An
Haplomacrobiotus hermosillensis May, 1948	Na
Doryphoribius bertolanii Beasley and Pilato, 1987	Na
Hypsibius convergens (Urbanowicz, 1925)	Na, Nt, Pa, Af, I, NZ, An
Hypsibius macrocalcaratus Beasley, 1988	Na
Isohypsibius schaudinni Richters, 1909	Na, Nt, P, Af, I
Ramazzottius oberhaueseri (Doyère, 1840)	Na, Nt, Pa, Af, I, NZ, O, An
Thulinius augusti (Murray, 1907)	Na, Nt, Pa, Af, I, Au, O
Milnesium tardigradum Doyère, 1840	Na, Nt, Pa, Af, I, Au, NZ, O, An

species are cosmopolitan (Meyer and Hinton 2007). While the proportion of Oklahoma tardigrade fauna that is cosmopolitan is relatively high, the endemic proportion is correspondingly low. The distribution of only one species, *Doryphoribius bertolani*, is restricted to Oklahoma, whereas 30% of Nearctic species are known from only a single site (Meyer and Hinton 2007).

This study should be considered a preliminary survey of tardigrade diversity in Cherokee County, Oklahoma. Some substrates known to harbor tardigrades – e.g., leaf litter, soil, and aquatic vegetation and sediment – have not been sampled in Oklahoma. No doubt more species remain to be found in Oklahoma, including additional endemic species. Tardigrade distributions are extremely patchy at fine spatial scales (Meyer 2006) and only the rigorous sampling programs employed by All Taxa Biological Inventories (e.g. Bartels and Nelson 2007) can estimate their true diversity.

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