6-2016

DISTRIBUTION OF SHORT-TAILED SHREWS (MAMMALIA: SORICIDAE: BLARINA) IN MISSOURI

Russell S. Pfau

Aaron P. Figueroa

DISTRIBUTION OF SHORT-TAILED SHREWS (MAMMALIA: SORICIDAE: *BLARINA*) IN MISSOURI—Three species of short-tailed shrews (genus *Blarina*) occur throughout the eastern one-half of the United States and southern Canada. *B. brevicauda* is the most widely distributed, ranging from the Atlantic ocean to the western Great Plains. *B. carolinensis* occurs throughout the southeastern U.S., and *B. hylophaga* is found in the southern plains states. The current understanding of the geographic distributions of these species is based primarily on morphology; size is the primary characteristic used for identification with *B. brevicauda* the largest and *B. carolinensis* the smallest.

The only states in which all three species have been reported are Oklahoma and Missouri. Until recently, it was thought that *B. brevicauda* in Missouri occurred only in the northern one-third of the state and that *B. hylophaga* occurred in the southern three-fourths of the state, with the two species being broadly sympatric (Moncrief et al. 1982). Thompson et al. (2011), using genetic analyses, demonstrated that the two species are not sympatric in northern Missouri, but rather are parapatric. Subsequently, Pfau et al. (2011) and Pfau and Braun (2013), also using genetic analyses, documented the occurrence of *B. brevicauda* in northwestern Arkansas and northeastern Oklahoma. Before these observations, it was thought that *B. hylophaga* was the species that occurred in northwestern Arkansas and northeastern Oklahoma.

Given that *B.brevicauda* in Arkansas and Oklahoma were misidentified as *B. hylophaga*, it seems probable that *Blarina* in southern Missouri also were incorrectly identified as *B. hylophaga*. As a result, the geographical distribution of *B. brevicauda* is likely is continuous from northern Missouri into Arkansas. However, it cannot be ruled out that the range of *B.brevicauda* is disjunct in the southernmost portion of its geographic range, where it is separated by the presence of *B. hylophaga* in southern Missouri. To clarify the distribution of *Blarina* in Missouri, we sequenced a portion of mitochondrial DNA from voucher specimens available in museum and university collections.

Tissue or snips from the skin or toes of voucher specimens were obtained from the following institutions: Pittsburg State University; Sternberg Museum of Natural History, Fort Hays State University; Natural Science Research Laboratory, Texas Tech University; and University of Missouri. Whole frozen specimens were provided by J. S. Scheibe at Southeast Missouri State University and cataloged into the collections at Texas Tech University. See Appendix A for details regarding specimens successfully identified by genetic analysis.

A 254 bp portion of the mitochondrial cytochrome *b* (*cyt b*) gene was amplified by polymerase chain reaction (PCR) using the primers LGL765 (5'-GAA AAA CCA YCG TTG TWA TTC AAC T-3'; Bickham et al. 1995, 2004) and *Blarina*_cytb_Int-2 (5'-TTT GCG TGT AGA TAG CGG-3'; Pfau et al. 2011). All PCR products were sequenced with primer LGL765 using a Beckman-Coulter CEQ8000 Genetic Analysis System (Beckman-Coulter, Inc., Fullerton, California).

Care was taken to minimize the chance of PCR contamination due to the small amounts of degraded DNA extracted from voucher specimens. We conducted DNA extractions, PCRs, and gel electrophoresis/sequencing reactions in separate rooms using separate instruments. In additional, we conducted PCRs in a fume hood where instruments were exposed to UV radiation. We used at least four negative control PCRs with each set of reactions. We repeated sets of reactions in which negative controls were positive for a PCR product following bleach or UV treatment of instruments and with new reagents.

To determine species identifications, a neighbor-joining tree was conducted in MEGA 6 (Tamura et al. 2013) using maximum composite likelihood distances. We included reference sequences in the phylogenetic analysis representing *B. hylophaga*, *B. brevicauda*, and *B. carolinensis* from Kansas, Iowa, and Arkansas, respectively (GenBank accession numbers JF912177, JF912169, and JF912173). The phylogenetic tree unambiguously grouped all specimens with reference specimens of *B. brevicauda* or *B. carolinensis* (results not shown due to size of tree). Thus, all specimens were identified as either *B. brevicauda* or *B. carolinensis* (Fig. 1; Appendix A). These results, together with those of Pfau et al. (2011), Thompson et al. (2011), and Pfau and Braun (2013), document the continuous distribution of *B. brevicauda* from Iowa, through Missouri, and into Arkansas and Oklahoma.

This revision of the geographic distribution likely corrects for historical mis-identifications of *Blarina* based on size (or other morphological characteristics). Although detailed morphological investigations of *Blarina* in Arkansas, Kansas, Missouri, and Oklahoma have not yet been conducted, it appears that in the southern-most portion of its distribution *B. brevicauda* are small and similar in size to that of *B. hylophaga*. Specimens need to be collected from northwestern Missouri and examined to determine whether *B. hylophaga* occurs in counties other than Atchison, Holt, and Nodaway in extreme northwestern Missouri. Additionally, these results call into question the distribution of *Blarina* in Kansas as currently understood (Webster 2011).

We thank the following individuals for access to specimens for genetic analysis: S. Ford (Pittsburg State University), M. Gompper (University of Missouri), V. Jackson (University of Central Missouri), J. Luscier (Truman State University), J. Scheibe (Southeast Missouri State University), and C. Schmidt (Fort Hays State University).—*Russell S. Pfau[1] and Aaron P. Figueroa. Department of Biological Sciences, Tarleton State University, Stephenville, Texas 76402, USA. [1]Corresponding author email address: pfau@tarleton.edu.*

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Submitted 5 August 2015. Accepted 23 April 2016. Associate Editor was Sue Fairbanks.

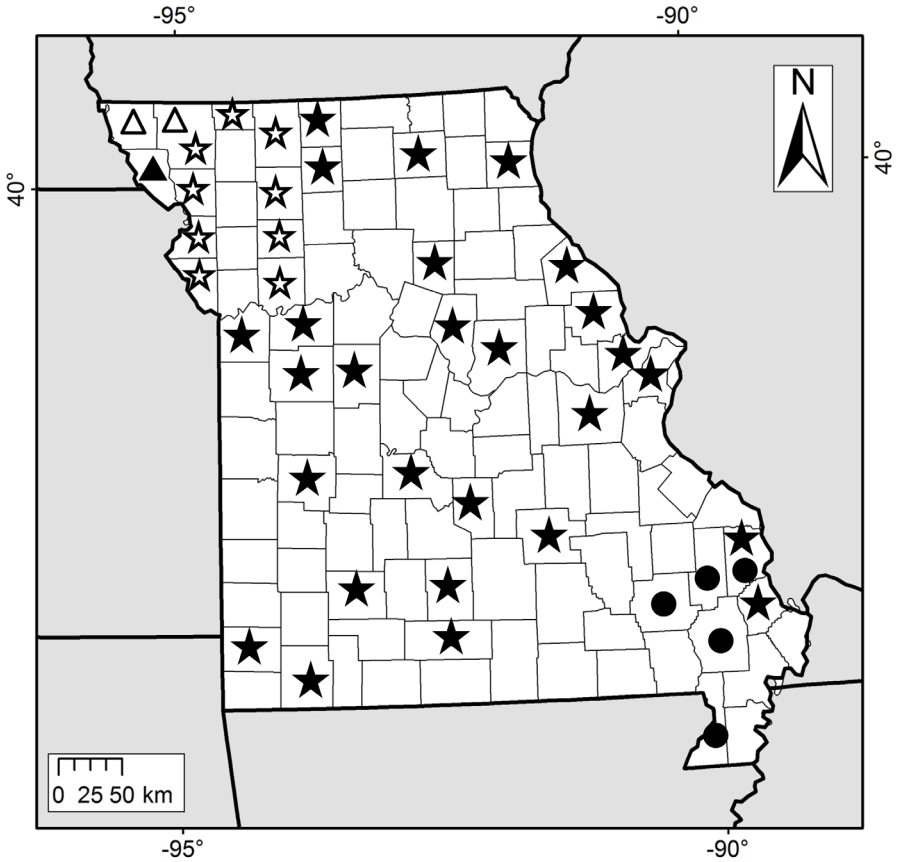

Figure 1. Distribution of *Blarina* in Missouri. Identifications were based on results of genetic analyses from the current study (filled symbols) and Thompson et al. (2011; hollow symbols). Stars represent *B. brevicauda*, triangles represent *B. hylophaga*, and dots represent *B. carolinensis*.

Appendix A.— List of specimens examined, including locality and catalog number. Catalog number acronyms refer to the following institutions: Pittsburg State University (KSCP), Fort Hays State University Sternberg Museum of Natural History (FHSM); Texas Tech University Natural Science Research Laboratory (TTU/TK), and University of Missouri (UMOC). Three specimens from Pittsburg State University did not have a KSCP catalog number. These specimens are indicated with an asterisk in front of the number that was on the skin tag.

Blarina brevicauda

Adair Co.: Kirksville City Limits (TSU 1433, TSU 1536, TSU 1705, TSU 1730, TSU 1751, TSU 1794, TSU 1799, TSU 1970, TSU 1973, TSU 2010); **Barry Co.:** no specific locality (UMOC 1659); **Boone Co.:** Columbia (UMOC 5142, UMOC 5144, UMOC 4244); **Callaway Co.:** no specific locality (UMOC 3443), Tebbetts (UMOC 2656); **Camden Co.:** Ha Ha Tonka State Park (CMSU 2133, UMMZ 60685); **Cape Girardeau Co.:** no specific locality (UMOC 2065, TTU 119133/TK 116997, TTU 119134/TK 116998, TTU 119135/TK 164245, TTU 119123/TK 164242); **Cooper Co.:** Boonville, 3.5 mi W & 3.5 mi S of Jct I-70 and Hwy 5 (*PJJ 11); **Dent Co.:** 7.4 km S, 21.8 km E of Licking (UMOC 3679); **Douglas Co.:** S1, T27N, R13W (UMOC 1895); **Franklin Co.:** Meramec St. Pk (UMOC 2807); **Greene Co.:** Springfield (UMOC 1732, UMOC 2730); **Grundy Co.:** 3 1/2 mi S Modena, by road (MHP 16018), 5 mi S Modena, by road (MHP 16019); **Jackson Co.:** Kansas City, 99th and Wornall (*0112), no specific locality (UMOC 2926), Brush Creek (UMOC 852), Kansas City (UMOC 3434, UMOC 3435), S22, T49N, R32W (UMOC 3284); **Johnson Co.:** no specific locality (CMSU 1786, CMSU 308, CMSU 810, CMSU 841), Montserrat (CMSU 704), Warrensburg (CMSU 1013, CMSU1391, CMSU 1393, CMSU 1446, CMSU 1448, CMSU 677, CMSU 724, CMSU 963, CMSU 967); **Lafayette Co.:** Concordia (CMSU 1339); **Lewis Co.:** 1/2 mi S, 2 1/2 mi E Deer Ridge (MHP 16032); **Lincoln Co.:** 1 1/2 mi N Winfield (MHP16035); **Mercer Co.:** 1 mi N Goshen, by road (MHP 16041); **Newton Co.:** 2 mi W OF Diamond George Washington Carver National Monument (GWCA) (MHP 37167); **Pettis Co.:** Sedalia (CMSU 961); **Pike Co.:** Bowling Green (UMOC 3887); **Platte Co.:** North Kansas City, near Line Creek Park (*0110); **Pulaski Co.:** FLWR LCTA 119 UTM:567370, 4164050 (MHP 27659), FLWR LCTA 45 UTM:569890, 4181260 (MHP27652), FLWR LCTA 69 UTM:571620, 4166250 (MHP27658); **Randolph Co.:** Moberly (UMOC 3011, UMOC 3015); **Scott Co.:** Commerce (UMOC 2680); **St Clair Co.:** no specific locality (UMOC 2388); **St. Charles Co.:** 0.7 mi SW Welden Springs (MHP 26854), Weldon Spring Training Area, ADM 3 (MHP 29857); **St. Louis Co.:** 1 1/2 mi NW Weldon Spring (MHP 28072), Arrowhead Airport (MHP 25947), Chesterfield (MHP 25683), Maryland Heights (MHP 25948, MHP 25949, MHP 25950, MHP 25952); **Wright Co.:** Mtn. Grove (UMOC 1199).

Blarina carolinensis

Bollinger Co.: Duck Creek Wildlife Area (UMOC 4677); **Cape Girardeau Co.:** (TTU 119124/TK 164243, TTU 119125/TK 164244); **Dunklin Co.:** Kennett (UMOC 1850); **Scoddard Co**. (UMOC 4240, UMOC 4246), Mingo Nat. Wl. Refuge (UMOC 1813); **Wayne Co**. (TTU 119136/TK 164246, TTU 119137/TK 164247, TTU 119138/TK 164248, TTU 119139/TK 164249, TTU 119140/TK 164250, TTU 119141/TK 195001, TTU 119142/TK 195002, TTU 119143/TK 195003).

Blarina hylophaga

Holt Co.: 1/2 mi W Fortescue (MHP 16028, MHP 16029, MHP 16030, MHP 16031).