

THE FIRST GRAY MYOTIS IN INDIANA WAS ACTUALLY A SOUTHEASTERN MYOTIS

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ABSTRACT. The gray myotis, *Myotis grisescens*, is a cavernicolous species which until recent years was infrequently found in Indiana. Walter L. Hahn collected a bat on 9 August 1907 from Twin (currently Bronson) Cave, Lawrence County, Indiana in what is now Spring Mill State Park. It was sent to Arthur H. Howell who in March of 1909 described the gray myotis and concluded Hahn's specimen was a gray myotis. This was the first and only gray myotis known from the state for five decades. However, when one considers in combination (1) information Hahn and subsequent researchers provided, (2) the taxonomic malaise of bats in the genus *Myotis* at the time, (3) Hahn's numerous captures of southeastern myotis (*M. austroriparius*) incorrectly identified, including four individuals capture at the same time and place as the individual he identified as a gray myotis, (4) unique coloration of some southeastern myotis, concurrent with Howell's notation that Hahn's bat differed "slightly in color" from specimens he used to describe the gray myotis, and (5) most notably, that the southeastern myotis would not be described as a species for an additional 19 years, it argues that the first recorded gray myotis in Indiana was actually a southeastern myotis.

Keywords: Bat, gray bat, gray myotis, southeastern bat, southeastern myotis, *Myotis grisescens*, *Myotis austroriparius*

INTRODUCTION

The gray myotis (*Myotis grisescens*), a species listed under the Endangered Species Act, roosts in caves year-round. Its range is typically defined as cave regions of Missouri to northern Arkansas, east through Tennessee and Kentucky, including most of Alabama to northern Florida (Decher & Choate 1995; Whitaker & Hamilton 1998). However, abundant cave resources in more northerly latitudes (Culver et al. 1999) are rarely used by gray myotis. In southern Indiana, the Mitchell Plateau and Crawford Upland physiographic regions (Malott 1922; Gray 2000) have extensive karst exposure and cave formations, and there are limited karst features east of the Mitchell Plateau. Harrison and Crawford counties border the Ohio River and Kentucky and have a high cave density, many of them extensive, such as, Wyandotte Cave (NSS 2007). Nevertheless, with rare exception caves in Indiana have not been used by the gray myotis (Mumford & Whitaker 1982), despite populations in adjacent counties of Kentucky across the Ohio River to the south.

The gray myotis was described as a species 114 years ago (Howell 1909) based on specimens from Nickajack Cave, Tennessee collected 31 August 1908; however, a postlactating female collected 9 August 1907 by Walter L. Hahn from Twin (currently Bronson) Cave, Lawrence County, Indiana in what is now Spring Mill State Park (SMSP), was noted in that description. This is confusing because Howell had previously identified the bat from Twin Cave, in a letter to Hahn (1909), as a large winged bat (*Myotis velifer*), and thus Hahn (1908) had reported it as a large winged bat. This specimen remained the only gray myotis identified in the state for the next 50 years until a male was captured 14 August 1958, in Donaldson Cave, also now in SMSP (Mumford & Cope 1964).

Recent and increasing numbers of gray myotis, previously uncommon in Indiana, both during summer (Brack et al. 1984a; Whitaker et al. 2001; Whitaker & Mumford 2009; Brack & Brack 2022) and winter (Brack et al. 2019, 2022), at the northern edge of its range, rekindled our curiosity about early occurrences, notably including the first occurrence. Intensive reexamination of primary (Hahn 1908; 1909) and secondary (Miller & Allen 1928; Lyon 1936; Mumford & Cope 1964;

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Mumford & Whitaker 1982; Whitaker & Mumford 2009) literature led to an alternate interpretation: the specimen collected by Hahn at Bronson Cave, Indiana in 1907 was a southeastern myotis (*Myotis austroriparius*).

METHODS

The first specimen of a gray myotis in Indiana, collected by Hahn (1908), has long been lost to science (Miller & Allen 1928; Lyon 1936; Mumford & Whitaker 1982). However, Hahn's (1908, 1909) research that produced the specimen and information later provided by other researchers (Lyon 1936; Mumford & Cope 1964; Mumford & Whitaker 1982; Whitaker & Mumford 2009) help place in context documentation of the first gray myotis in Indiana. Our analysis included not just the gray myotis, but all species Hahn encountered during his studies, including the southeastern myotis, the state of bat taxonomy in 1907, and the likelihood of an errant gray myotis so far north in the state.

When referencing past studies, vernacular and scientific names provided in those documents were used for context and were matched to those used in current nomenclature. Nevertheless, both scientific and common names remain confusing due to frequent past and ongoing name changes, and because some bats have more than one common name. For example, for species in the genus *Myotis*, current common nomenclature often (but not always) replaces "bat" with "myotis" (e.g., gray bat becomes gray myotis). It is confusing and awkward to refer to the same species in the past as "bat" and currently as "myotis" – sometimes in the same sentence, and it is cumbersome to frequently reiterate this difference. Thus, for bats belonging to the genus *Myotis*, use of "bat" and "myotis" in common names should be considered synonyms. Sometimes, use of scientific names is the easiest, clearest solution, and conveys best information in previous documents.

RESULTS AND DISCUSSION

Before Miller & Allen (1928), taxonomy of bats of the genus *Myotis* was hopelessly confused and it is possible that the gray myotis was present but undetected in Indiana before 1907. However, there is no evidence of this in collections. Mumford & Cope (1964) noted that of the many preserved specimens collected in Indiana dating back to 1896, none were since identified as gray

myotis, nor are we aware of recent documentation from fossils. If gray myotis were historically collected in Indiana, one might expect their capture in caves most proximal to Kentucky, especially those that attract and hold large numbers of bats in eastern Crawford and adjacent western Harrison counties (Brack et al. 1984b, 2003). Locations where bats were most frequently collected in the late 1800s and early 1900s include Wyandotte Cave (Crawford County), < 6 km from Kentucky, and caves now in SMSP (Lawrence County), 60 km from Kentucky. These caves support populations of other myotis species similar to gray myotis. Collections at Wyandotte Cave produced the type locality for the Indiana myotis, *M. sodalis* (Miller & Allen 1928). Most southeastern myotis collected in the state were from caves in SMSP. Notably, 40 of 50 southeastern myotis were collected in Bronson Cave on 7 February 1949 (Mumford & Whitaker 1982).

While studying bats in caves in present-day SMSP, Hahn (1908) identified "six species . . . [of bats] living more or less commonly" in Indiana caves between 20 September 1906 – 7 September 1907. In order of abundance, they were little brown bat (*M. lucifugus*), Georgian bat (*Pipistrellus subflavus*), Say bat (*M. subulatus*), large brown bat (*Eptesicus fuscus*), big eared bat (*Corynorhinus macrotis*), and large winged bat (Table 1). He stated *M. lucifugus* was "considerably more abundant" than *M. subulatus*, and we now know his designation of *M. lucifugus* included Indiana myotis. Current taxonomic and vernacular names (Table 1), in the same sequence, are little brown bat/myotis (*M. lucifugus*), tricolor bat/eastern pipistrelle (*Perimyotis subflavus*), northern long-eared bat/myotis (*M. septentrionalis*), big brown bat (*E. fuscus*), Rafinesque's big-eared bat (*C. rafinesquii*), and cave bat/myotis (*M. velifer*). However, identification of *M. velifer* was provided by Howell to Hahn in a letter (hence Hahn's 1908 listing), but Howell (1909) subsequently identified this specimen as a gray bat (*M. grisescens*) when he described that species, and Hahn (1909) 'corrected' *M. velifer* to be the first gray bat in the state.

Gray and southeastern myotis are morphologically similar (Sasse et al. 2019) and both are similar to the cave myotis (Fitch et al. 1981; Jones & Manning 1989; Decher & Choate 1995). Hahn's taxonomic struggles with myotis in general and specifically the southeastern myotis influenced his inclusion of *M. velifer* (then large winged bat, now cave bat/myotis) as one of six species inhabiting

Table 1.—Names, common and scientific, used by Hahn (1908) and currently, for bats encountered 20 September 1906 – 7 September 1907 at caves now in Spring Mill State Park, Lawrence County, Indiana.

Common and Scientific Names		Comments
Hahn	Current	
Little brown <i>M. lucifugus</i>	Same	Over time, individuals of many species of bats in North America belonging to the genus <i>Myotis</i> have been designated as <i>M. lucifugus</i> . Some individuals Hahn identified as little brown were Indiana myotis (<i>M. sodalis</i>), another species not described until 19 years later (Miller & Allen 1928).
Georgian <i>Pipistrellus subflavus</i>	Tricolored <i>Perimyotis subflavus</i>	In the interim, eastern pipistrelle was the most common vernacular name, but with the recent generic name change, tricolored is most frequently used.
Say <i>M. subulatus</i>	N. long-eared <i>M. septentrionalis</i>	In the interim, <i>M. subulatus</i> became two species: <i>M. leibii</i> , eastern small-footed, and <i>M. keenii</i> , Keen's myotis. The latter species was split and in eastern North America became <i>M. septentrionalis</i> and was first called northern and now northern long-eared myotis.
Large brown <i>Eptesicus fuscus</i>	Big brown	
Big eared <i>Corynorhinus macrotis</i>	Rafinesque's big-eared <i>C. Rafinesquii</i>	In the interim, the genus changed to <i>Plecotus</i> and back to <i>Corynorhinus</i>
Large winged <i>M. velifer</i>	Cave	This single bat was sent to Howell who informed Hahn via letter it was <i>M. velifer</i> , large winged bat, which Hahn reported (1908), but Howell (1909) reported it as a <i>Myotis grisescens</i> , gray bat, when he described that species, and Hahn (1909) reported the same. In turn, we conclude this bat was a southeastern myotis, <i>M. austroriparius</i> .

Indiana caves, despite only a single unconfirmed occurrence (Hahn 1908). Of 13 southeastern myotis he collected and placed in collections, he labeled 12 as northern-long-eared and one as a little brown myotis (Mumford & Whitaker 1982; Whitaker & Mumford 2009). In effect, he separated the southeastern myotis from the little brown myotis and placed it in the next logical spot. In so doing, he inflated numbers of northern long-eared myotis, allowing him to conclude it was common “to a considerable extent” and thus contributing materially to his studies of sensory adaptations. With over 40 years of intra-cave studies in Indiana (Brack et al. 1984b, 2003, 2019, 2022), our team has not found enough northern long-eared myotis to support Hahn's assertion. Rather, it is considered an intra-cave rarity, as similarly noted by McAtee (1907).

Between 2–9 August 1907 Hahn collected four southeastern myotis from caves that are now in SMSP that he prepared as specimens and labeled as the northern long-eared myotis, then *M. subulatus*, (Miller & Allen 1928; Lyon 1936;

Mumford & Whitaker 1982). He also collected a fifth specimen on 9 August that he sent to Howell. At that time, neither southeastern (Table 2) nor gray myotis were described; only the cave myotis. When Howell received Hahn's bat, he initially concluded in a letter to Hahn (1909) that it was a cave myotis, but Howell was in the process of describing the gray myotis and ultimately decided it was a gray myotis (Howell 1909), noting however that the pelage differed “slightly in color” from Tennessee specimens he used to describe the species, being “sepia above, with a russet tinge [and] below, hair-brown”. Howell (1909) could not compare the pelage, or other morphological characteristics, of the specimen from Hahn to other southeastern myotis as it was not described as a species for another 19 years (Miller & Allen 1928). Notably, the four southeastern myotis collected in 1907 from SMSP by Hahn (mis-identified as northern long-eared myotis) and collected concurrent with the specimen sent to Howell and identified as a gray bat, were used by Miller & Allen (1928) to describe *M.*

Table 2.—The timeline associated with the taxonomic status of the southeastern myotis (*M. austroriparius*) in relation to the bat captured by Hahn (1908), in Lawrence County, Indiana, and considered a gray myotis (*M. grisescens*) for the past 115 years.

Date	Event affecting nomenclature of the southeastern myotis
1831/32 & 1843	Thomas Drummond collected a specimen in North America, at a location that was believed to be in Canada (likely Saskatchewan). Gray (1843) identified this specimen as <i>Vesperillo carolii</i> , later considered a synonym for <i>M. lucifugus</i> .
1897	Rhoads (1897) considered bats he collected in Florida a subspecies (race) of the little brown bat, applying the name <i>M. lucifugus austroriparius</i> .
1928	Miller & Allen (1928) concluded that Gray's (1843) and Rhoads' bats belonged to the species they described as <i>M. austroriparius</i> , while noting the Drummond bat's capture location as "the interior of Canada". In addition, they included four bats from Mitchell, Indiana, collected by Hahn 2 – 9 August 1907 in SMSP – that Hahn misidentified as <i>M. subulatus</i> , now <i>M. septentrionalis</i> , or northern long-eared myotis. These four bats were collect at the same time and place as the specimen awarded <i>M. grisescens</i> (gray bat) status by Howell (1909). Miller & Allen (1928) initially used Hahn's four bats to describe the species, until reexamination of Rhoads specimens (spurred by 12 additional skins from Florida), predating Hahn's specimens, rightfully usurped that honor. This change was made as their manuscript was going to press.
1943 - 1989	Numerous authorities discounted the Drummond specimen because the location was extralimital (see Jenkins & Sealy 2022).
2022	Jenkins & Sealy (2022) confirmed the specimen collected by Drummond was <i>M. austroriparius</i> and that the collection site was not Canada but rather Indiana / Kentucky (centered around Louisville; May 1831), Illinois / Missouri (centered around St. Louis; July 1831), or Louisiana (centered around New Orleans and Covington; December 1831 – September 1832).

austroriparius until additional materials from Florida were received, spurring them to reevaluate Rhoads' (1897) specimens, just as their manuscript was going to press (see Table 2 for additional detail).

Color variation described by Howell is noteworthy and might be interpreted as a reason for caution. Mumford & Whitaker (1982) noted that differences in pelage color of the southeastern myotis in Indiana are likely related to molt, and individuals tend to be grayer in winter and spring and browner in summer. However, based on their captures and four of Hahn's specimens, both grayer and browner individuals are present in August. The timing of molt may vary by sex. The gray color variation contributed to a short-lived subspecies designation of *M. austroriparius mumfordi* for the population in Indiana (Rice 1955; LaVal 1970). Despite the russet tinge, was the specimen Hahn sent to Howell grayer than the other southeastern myotis he captured? We posit he collected these five specimens (and an additional nine southeastern myotis) in part because they were different than bats he typically encountered (Hahn 1909). We wonder about the outcome if any, or all, of the other four (or 13) specimens of southeastern myotis had been sent to Howell. Subtleties in pelage color and texture of

the southeastern myotis, as noted by Rhoads (1897), and initially by Glover M. Allen (Miller & Allen 1928), kept classification of this taxon as a subspecies of the little brown myotis (*M. lucifugus austroriparius*) for 31 years.

Still, limited facts support a conclusion that the bat Hahn sent to Howell was correctly identified as a gray myotis. Hahn reported a right forearm length (RFA) for this postlactating female as 44 mm, which is more typical of gray than southeaster myotis. Three female gray myotis from Indiana had a mean RFA of 43.3 mm (Mumford & Whitaker 1982), and similarly the mean RFA was 43.5 mm for 17 females from Tennessee, Missouri, Illinois, and Alabama (Decher & Choate 1995) (Table 3). However, this too has contradictions. Data of Miller & Allen (1928) for gray myotis from Tennessee were those of Howell (1909). For 10 individuals of both sexes Howell provided an RFA of 41.6 mm, while those data in Miller & Allen are for 11 individuals with a RFA of 42.9 (Table 3). In contrast, 10 female southeastern myotis in Indiana had a mean RFA of 38.1 mm (Mumford & Whitaker (1982), while Jones & Manning (1989) reported 38.6 mm for 29 females. Perhaps the most compelling argument that this bat was a gray myotis is that Hahn chose to send this specimen to Howell for identity confirmation.

Table 3.—Right forearm (RFA) length (mm) for southeastern myotis (*M. austroriparius*) and gray myotis (*M. grisescens*), for comparison with a 44-mm RFA for the bat reported by Hahn.

Species	Sex	Mean	Range	SD	n	Source
<i>M. austroriparius</i>	F	38.1	35.5-40.0	1.5	10	Mumford & Whitaker (1982)
	F	38.6	33.5-40.0		29	Jones & Manning (1989)
<i>M. grisescens</i>	F	43.3	43.0-44.0	0.6	3	Mumford & Whitaker (1982)
	F	43.5	41.8-45.6	1.2	17	Decher & Choate (1995); data from Miller & Allen (1928) for TN, MO, IL, and AL
	F	42.6	41.2-44.4	1.1	5	Miller & Allen (1928) TN data from Howell (1909) bats
	Both	41.6			10	Howell (1909)*
	Both	42.9	40.8-44.4	1.1	11	Miller & Allen (1928) TN data from Howell (1909)

* Howell's morphometric measurements were for an "average of 10" individuals

In some ways, whether a single gray myotis was first in Indiana 114 years ago, 50 years before the second record, can be viewed as little more than an interesting novelty. However, the species is currently expanding into Indiana both during summer (Brack & Brack 2022) and winter (Brack et al. 2019, 2022), just as it is expanding in other portions of its range (Nelson et al. 1991), so historic distributions are of value for several reasons. Is the currently growing population a range expansion or a recolonization? How does it affect other species? Does it change interspecific competition on the landscape and within caves? Should it engender additional conservation and management for this endangered species? Are there conflicts balancing management and conservation with other endangered (Indiana and northern long-eared myotis) and likely-to-be listed (tricolored bats and little brown myotis) species? Why is the range expanding? Is it related to climate change? ... to the fungal disease, white-nose syndrome? ... to wind or solar development? In short, understanding historic distributions contribute to a variety of scientific and regulatory disciplines.

ACKNOWLEDGMENTS

D. Sparks and R. LaVal provided discussion and comments on the manuscript. Environmental Solutions & Innovations, Inc. provided financial support for manuscript preparation and publication. B. Merritt provided access to historic documents. J. Garofalo provided editorial assistance. We thank editors and reviewers for making this a better document.

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Manuscript received 16 March 2022, revised 19 January 2023.