

Descriptions of a new species and previously unknown males of *Nesticus* (Araneae: Nesticidae) from caves in Eastern North America, with comments on species rarity

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Abstract

We describe the new species, *Nesticus pecki*, an apparently cave-limited (but not troglomorphic) species from the southeastern edge of the Cumberland Plateau in southern Tennessee. Previously unknown males of *N. dilutus* Gertsch, *N. stygius* Gertsch, and *N. furtivus* Gertsch are illustrated and described. These male specimens, along with additional females, are all taken from their respective type localities. *Nesticus valentinei* Gertsch is considered a junior subjective synonym of *N. barri* Gertsch [new synonymy]. Several cave-limited species in the region are single-site endemics, including *N. furtivus*, *N. dilutus*, and *N. pecki*. We discuss the conservation status and biological factors that may potentially threaten the continued existence of these populations.

Key words. *Nesticus*, species rarity, caves, southern Appalachians

Introduction

The spider genus *Nesticus* Thorell, 1869 (family Nesticidae) is taxonomically diverse in the southern Appalachian mountains of eastern North America, with at least 30 species distributed over a geographic area extending from southern West Virginia to central Alabama (Gertsch 1984; Coyle & McGarity 1992; Hedin 1997a). Appalachian *Nesticus* are habitat specialists, reflecting apparently strict physiological constraints that limit these spiders to cool, moist microhabitats. These constraints, in combination with habitat discontinuity in both space and over time, have promoted tremendous species diversification and endemism (see speciation models of Wiens 2004a, 2004b). This fine-scale diversification

is particularly apparent in the cave-rich Appalachian Valley and Ridge and Cumberland Plateau geologic provinces. The Valley and Ridge is characterized by a strongly folded and faulted series of parallel valleys and ridges. With exposures of Paleozoic limestone well-developed in valleys, and non-carbonate shales and sandstones separating such exposures, cave systems of the Appalachian Valley and Ridge are generally small and spatially isolated. Cave systems of the Cumberland Plateau, which consists of an elevated tract of nearly horizontal or gently folded strata, are generally larger and more connected. However, the carbonate exposures along the southeastern escarpments are relatively discontinuous (e.g., see Peck 1989). In both regions, a combination of spatial and temporal isolation has spawned a unique fauna of mostly cave-limited, and highly troglomorphic, *Nesticus*. Several of these species are known only from single cave localities (Gertsch 1984), and are thus susceptible to population decline, and perhaps extinction.

Here we describe a new cave-limited (but not troglomorphic) species (*N. pecki* n. sp.), describe the previously unknown males of *N. dilutus* Gertsch 1984, *N. stygius* Gertsch 1984, and *N. furtivus* Gertsch 1984, and discuss the synonymy of *N. valentinei* Gertsch 1984 with *N. barri* Gertsch 1984. We also consider threats to and the conservation status of *N. furtivus*, *N. dilutus*, and *N. pecki*, all of which are apparently single-site endemics in the region.

Methods

Character abbreviations: BL = body length (CL plus length of abdomen measured in dorsal view); CL = carapace length (from posterior edge to front edge of clypeus, measured at midline); CW = maximum carapace width; IFL, IPL, ITL, IML, ITarL = lengths of leg I segments (measured in retrolateral view as a straight-line distance from opposite articulation points on the dorsal surface of each segment); LegI = sum of length of leg I segments, as defined above. All appendage measurements were recorded from the left appendage. Measurements are in mm and were taken with an Olympus SZX12 stereomicroscope with 10x ocular lenses fitted with an eyepiece micrometer. All measurements were performed at 32X. Repeated measures of the same structure suggest that this method is accurate to the nearest ± 0.07 mm. Body colors of dead spiders in 70% EtOH were visually compared (on a computer screen) to a hexadecimal RGB color chart, and verbally described using six-digit HTML hexadecimal color codes (see Walsh 2004).

All drawings of male and female genitalia were made by Nadine Dupérré. A digital camera attached to a stereomicroscope was used to capture images, which were then enlarged and printed. A tracing of the printed image was then detailed and shadowed, with repeated reference to the specimen under the microscope. Epigyna were removed and cleared with lactic acid prior to illustration. The left palp of male spiders was illustrated in all cases. We follow Coyle and McGarity (1992) in describing anatomical structures of male and female genitalia. Holotype, paratype and other described specimens have been

deposited in the American Museum of Natural History, New York (AMNH). All other specimens referenced with MCH numbers are currently housed in the personal collection of the first author. Upon completion of on-going studies of Appalachian *Nesticus*, these specimens will be donated to the AMNH.

Family Nesticidae Simon 1894

Genus *Nesticus* Thorell 1869

***Nesticus barri* Gertsch 1984**

Figs. 1–10

Nesticus barri Gertsch, 1984: 36, figs. 121–123, 161–163.

Nesticus valentinei Gertsch, 1984: 29, figs. 150–152.

Material Examined. — *Nesticus valentinei* Holotype. — Female, **U.S.A: Tennessee: Marion County**, Heatin Stove Monteagle Cave, coll. 30 May 1937, J.M. Valentine (housed at AMNH).

***N. barri* specimens examined** — **U.S.A: Tennessee:** *Franklin County*, Crownover Saltpeter Cave, 35°00' N, 84°54' W, 21 August 1999, coll. W. Reeves (1 female); Salt River Cave, ~ 2.1 km W of Gonce, Alabama, 34°59' N, 85°58' W, elev. 210 m, 24 March 1995, coll. M. Hedin & J. Hedin (3 females, 2 males); Lost Cove Cave, ~ 4.7 km N/NE of Sherwood, 35°07' N, 85°54' W, elev. 240 m, 23 Sept. 1992, coll. M. Hedin, J. Hedin, and S. O'Kane (2 females, 1 male); Keith Cave, 35°07' N, 86°00' W, elev. 320 m, 24 March 1995, coll. M. Hedin & J. Hedin (8 females, 1 male); Custard Hollow Cave, 24 April 1960, coll. T. Barr (5 females); Fishtrap Spring Cave, 6.4 km NNW S. Pittsburg, 28 August 1968, coll. S. Peck; Ranie Willis Cave, on Tennessee-Alabama Line, 13 January 1957, coll. T.C. Barr, Jr. (4 females); *Marion County*, Nickajack Cave, July 29 1967, coll. S. Peck & A. Fiske (3 females); Honeycutt Cave, 7 mi. NW S. Pittsburg, 28 August 1968, S. Peck (1 female); Tate Spring Cave, SE of Monteagle, 35°10' N, 85°48' W, elev. ~ 200 m, 15 August 2004, coll. M. Hedin, L. Hedin, R. Keith, J. Starrett and S. Thomas (2 females, 1 male). **Alabama:** *Jackson County*, Guess Creek Cave, ~ 4.8 km E Trenton, 34°45' N, 86°11' W, elev. 240 m, 25 Sept. 1992, coll. M. Hedin, J. Hedin, and S. O'Kane (8 females); *Marshall County*, Bishop Cave, ~ 4.8 km N of Guntersville Dam, 34°27' N, 86°21' W, elev. 300 m, 25 Sept. 1992, coll. M. Hedin, J. Hedin, and S. O'Kane (9 females).

Remarks — Gertsch (1984) states that the holotype of *Nesticus valentinei* was collected “from Monteagle Saltpeter Cave, 3.9 mi. SE Monteagle, Marion County, Tennessee, 30 May 1937 (J.M. Valentine), in American Museum of Natural History”. Although the holotype specimen matches the species description and illustration, the collection label in the vial does not match Gertsch's cited location. The label, which appears to be original, actually reads "Heatin Stove Monteagle Cave Tenn. V-30-37 J.M. Valentine".

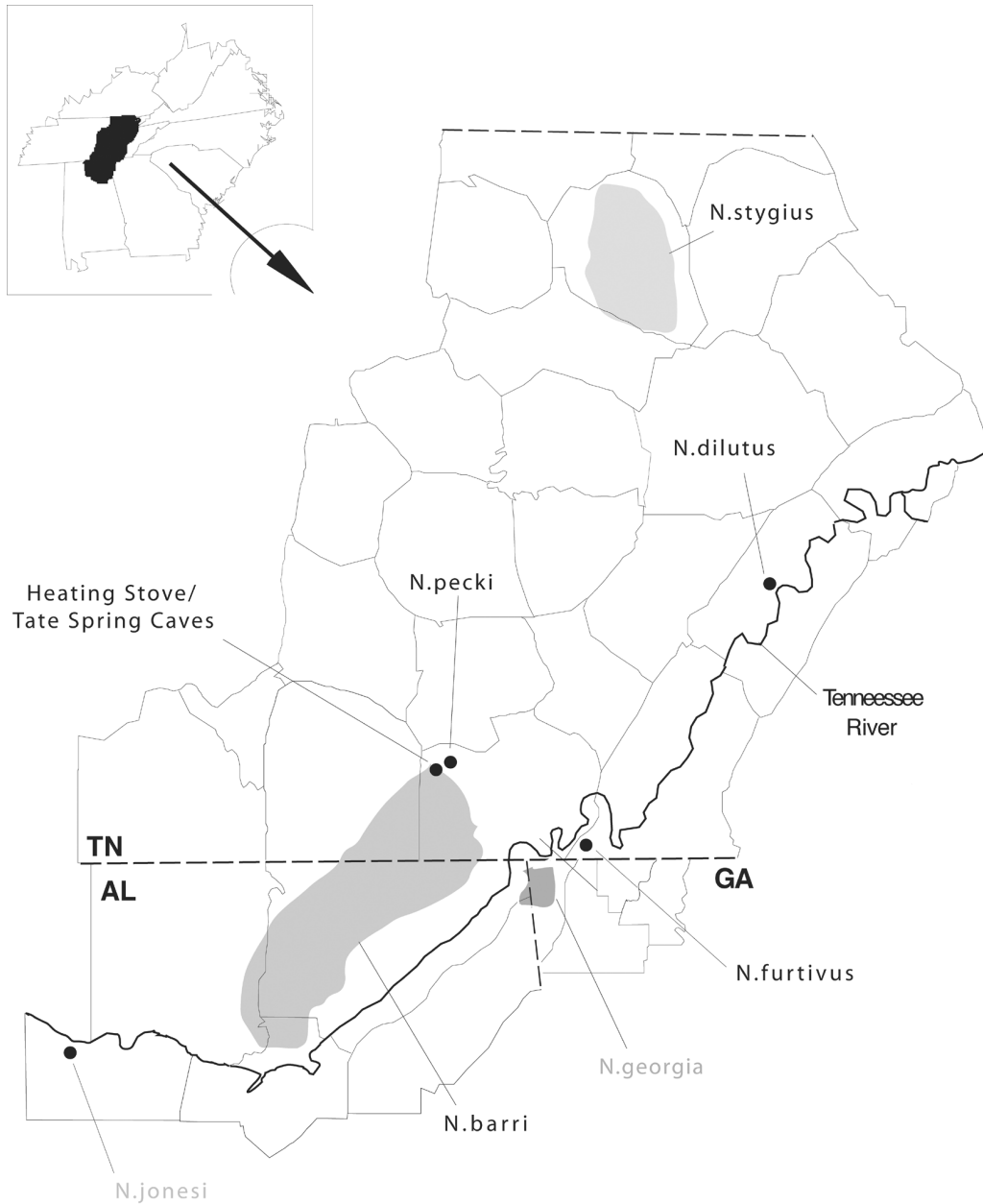
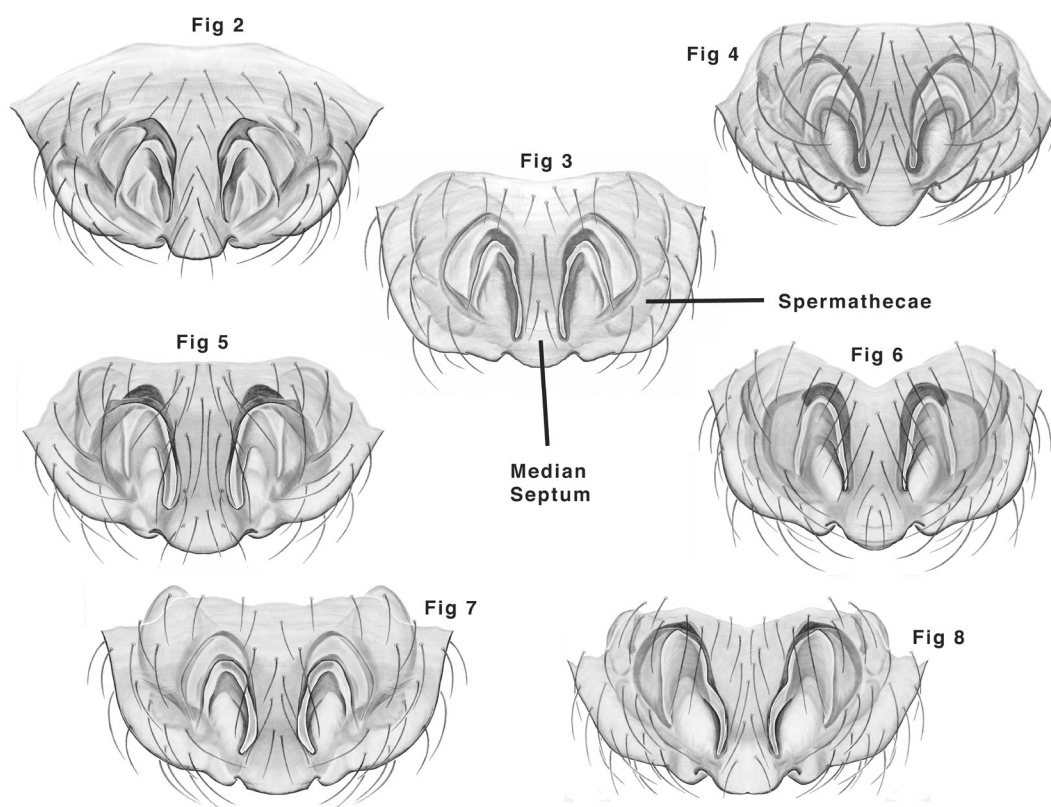


FIGURE 1. — Distribution of *Nesticus* taxa found in study area. Stippling represents approximate distribution of species occurring at multiple sites. Ranges of *N. barri*, *N. jonesi* Gertsch 1984, and *N. georgia* Gertsch 1984 from Gertsch (1984).

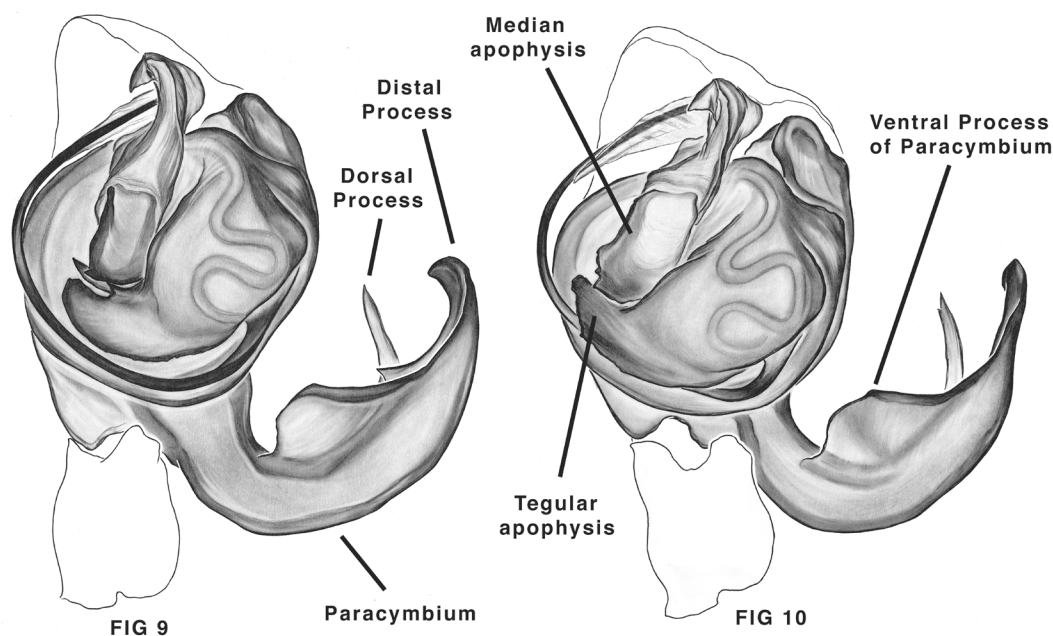
Our research indicates that this discrepancy is most likely the result of an error in label transcription by Willis Gertsch. Heatin' Stove Cave and Monteagle Saltpeter Cave are geographically proximate caves (within ~ 5 km of one another), but are not the same cave. While Monteagle Saltpeter Cave is well-known (see Barr 1961), references to Heatin' Stove Cave cannot be found in the standard literature on Tennessee caves (e.g., Barr 1961;

Matthews 1971, 1994), and the cave location is not known to current members of the Tennessee Cave Survey (C. Akins, T.C. Barr, G. Moni, pers. comm.). However, with the help of T.C. Barr and L. Matthews, we were able to locate a literature reference to a “Heating Stove Cave” that is in Marion County, southeast of Monteagle, Tennessee. The cave description is from the early 1940s, but was not transcribed (by L. Matthews) and published until 1985 (Kirby-Smith 1985). Given the described location of this cave, it is likely that the cave entrance was destroyed during the construction of a major interstate highway (I-24). Our recent survey work is consistent with this scenario — following the landmarks cited in Kirby-Smith (1985) leads one directly to the interstate. We believe that the destruction of the cave entrance explains the current lack of familiarity with this cave by local cavers.



FIGURES 2–8. — Epigynal variation across populations of *N. barri* (including holotype *N. valentinei* and specimens from Tate Spring Cave). Fig. 2: Tennessee, Marion Co., Tate Spring Cave, MCH 04_050 female specimen #1. Fig. 3: holotype female *N. valentinei* (no specimen number). Fig. 4: Tennessee, Franklin Co., Lost Cove Cave, MCH specimen #1587. Fig. 5: Tennessee, Franklin Co., Salt River Cave, MCH specimen # 2102. Fig. 6: Alabama, Jackson Co., Bishop Cave, MCH specimen # 1609. Fig. 7: Tennessee, Franklin Co., Crownover Saltpeter Cave (no specimen number). Fig. 8: Alabama, Jackson Co., Guess Creek Cave, MCH specimen # 1620. All views ventral in perspective.

Kirby-Smith (1985), referring to Heating Stove Cave, notes that “the general slope is to the left ...presumably to Tate Spring Creek”. Also, in reference to Tate Spring, he notes that “this (the spring) is located 200–300 yards down cove from the Heating Stove Cave”. Based on these indications, we reckoned that Heating Stove cave passage might be physically connected to Tate Spring, and recently attempted to re-collect *N. valentinei* in the navigable cave passage that lies behind the spring outlet. These collections were successful, resulting in the collection of two adult female and one adult male *Nesticus*. These specimens are discussed and illustrated below (Figs. 2 & 9). We have also collected in Monteagle Saltpeter Cave. Several adult *Nesticus* specimens have been collected, but all belong to the new species, *Nesticus pecki*, males and females of which differ in many ways from holotype *N. valentinei* and Tate Springs specimens (see species description below).



FIGURES 9 & 10. — Left palp of *N. barri*, ventral view. Fig. 9: Tennessee, Marion Co., Tate Spring Cave, MCH 04_050 male specimen #1. Fig. 10: Tennessee, Franklin Co., Lost Cove Cave, MCH specimen #1586.

Synonymy — Comparing the holotype female of *N. valentinei* (from Heating Stove Cave) to Tate Springs females suggests that these specimens are from the same population (consistent with the continuous cave passage hypothesis). Although the disarticulated holotype is smaller-bodied than Tate Springs females, the holotype is clearly long-legged and troglomorphic, like Tate Springs females (Table 1). More importantly, the epigynum of these specimens is essentially identical (compare Figs. 2 & 3). Additional comparison

of Heating Stove/Tate Springs specimens to specimens of *N. barri* suggests species synonymy. *Nesticus barri* is a troglomorphic species with almost 50 recorded cave-limited populations known from the southern edges of the Cumberland Escarpment in southern Tennessee and northeastern Alabama (Gertsch 1984; Peck 1989; Fig. 1). Several published records from Franklin and Marion counties in Tennessee are from caves close to Tate Springs and Heating Stove caves (within 10 km). The epigynal configuration of *N. barri* varies across populations (see Figs. 4–8), but we consider the condition seen in the Tate Spring/ Heating Stove population as within the realm of this variation. Although one could argue for the existence of multiple cryptic species, mtDNA data gathered from several populations of *N. barri* places these populations together as a single, albeit diverse, genetic clade (Hedin 1997a). We predict that DNA data from the Tate Springs/Heating Stove population will place these specimens into this same genetic clade.

TABLE 1— Specimen Measurements (in mm).

	BL	CL	CW	IFL	IPL	ITL	IML	ItarL	Leg I	Leg I/CW ratio
<i>N. pecki</i> holotype male	2.79	1.18	1.06	2.30	0.45	2.36	2.12	0.91	8.15	7.68
<i>N. pecki</i> paratype female (MCH specimen #1625)	2.58	1.09	0.91	2.03	0.42	1.88	1.73	0.85	6.91	7.59
<i>N. furtivus</i> male (MCH 00_137 male specimen #1)	4.00	1.58	1.39	4.09	0.67	3.94	3.18	0.85	12.73	9.16
<i>N. furtivus</i> female (MCH specimen #1660)	3.94	1.58	1.21	3.64	0.64	3.64	3.27	1.39	12.57	10.39
<i>N. dilutus</i> male (MCH specimen #1307)	3.48	1.45	1.33	3.33	0.70	3.33	3.24	1.39	12.00	9.02
<i>N. dilutus</i> female (MCH specimen #1316)	3.24	1.42	1.21	2.85	0.61	2.73	2.52	1.15	9.85	8.14
<i>N. stygius</i> male (MCH specimen #1882)	3.76	1.64	1.55	5.15	0.79	5.15	4.97	1.82	17.88	11.54
<i>N. stygius</i> female (MCH specimen #1885)	4.33	1.76	1.52	4.91	0.73	4.61	4.55	1.73	16.52	10.87
<i>N. valentinei</i> holotype female	-	1.15	0.91	2.85	-	-	-	-	-	-
<i>N. barri</i> male (Tate Springs Cave, MCH 04_050 male specimen #1)	2.85	1.33	1.27	3.27	0.61	3.58	3.33	1.30	12.09	9.50
<i>N. barri</i> female (Tate Springs Cave, MCH 04_050 female specimen #1)	3.42	1.36	1.33	3.36	0.70	3.33	3.21	1.42	12.03	9.02

An adult male *Nesticus* was never collected from Heating Stove Cave, but consideration of the Tate Springs male specimen further suggests synonymy with *N. barri*. The paracymbium is particularly similar, with a distal and ventral paracymbium that is essentially unmodified, and a simple, thin dorsal process (compare Figs. 9 & 10; also see Gertsch 1984, figs. 121–123). There is variation in the shape of the tegular apophysis across populations (Figs. 9 & 10), but the condition seen in the Tate Springs male is very close to that illustrated by Gertsch (figs. 121–123). Again, we interpret this as geographic variation in a single, dispersal-limited, species.

Although *N. valentinei* has page priority, we prefer to merge the single *N. valentinei* population with the many known *N. barri* populations. This decision is consistent with Article 24.2 (determination by first reviser) of the International Code of Zoological Nomenclature (ICZN, 4th edition).

DNA sequences. — Mitochondrial 16S (Genbank accession numbers AF004596 - 99) and nuclear ITS (AF003769 - 70) DNA sequences for several populations of *N. barri* were reported in Hedin (1997a).

Nesticus stygius Gertsch 1984

Figs. 1, 11–12

Nesticus stygius Gertsch 1984: 36, figs. 170–172.

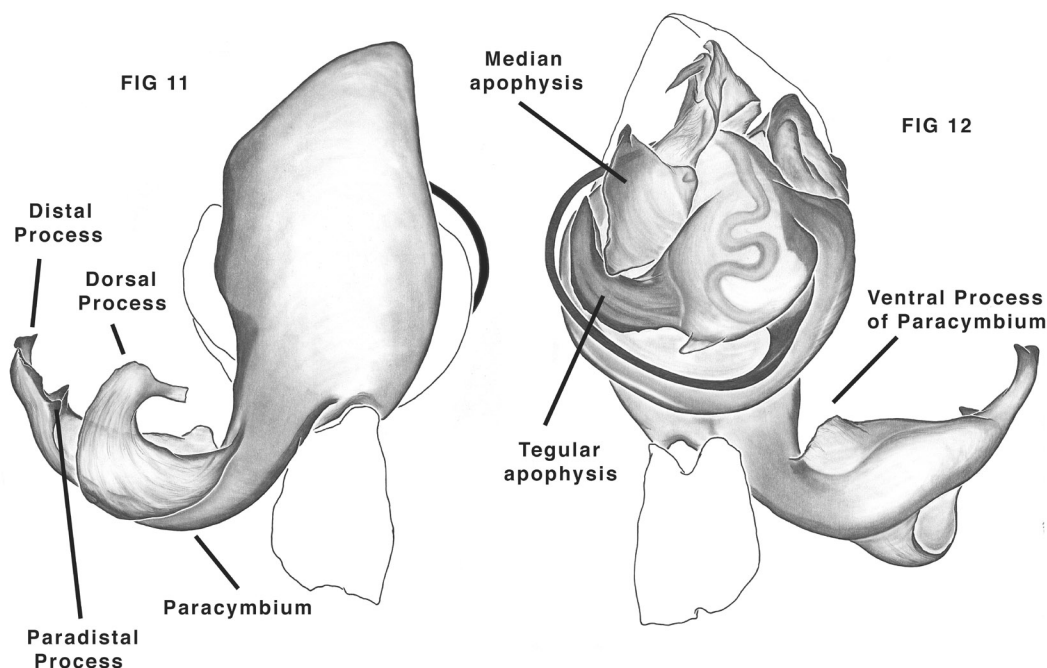
Material Examined: Holotype. — Female, U.S.A: Tennessee: *Overton County*, Obe Lee Cave, coll. 21 December 1958, T.C. Barr, F. Breeding, & C. Kacsur (housed at AMNH).

Additional Type Locality Material Examined. — Male and female, U.S.A: Tennessee: *Overton County*, Obe Lee Cave, 36°12'23" N, 85°15'08" W, elev. ~ 400 meters, coll. 11 October 1993, M. Hedin & C. Phillips (MCH male specimen #1882; MCH female specimen #1885).

Other Material Examined. — U.S.A: Tennessee: *Overton County*, Raven Bluff Cave, NW of Allons, 36°29'33" N, 85°21'36" W, elev. ~ 275 meters, coll. 1 October 1991, M. Hedin, K. Crandall & A. Gerber (MCH female specimen #1018; MCH male specimens #1019, #1020).

Remarks. — Gertsch (1984) lists a female from Webb Cave, Putnam County, Tennessee. Webb Cave is actually in Overton County.

Diagnosis. — The troglomorphic features of *N. stygius* readily distinguish this species from smaller, surface-dwelling *Nesticus* found further east and north in the Appalachians. Compared to other large-bodied Appalachian troglomorphs, males of this species are distinguished by the unique shape of the dorsal paracymbial process (Fig. 11), and the distinctive thickened and chisel-like tegular apophysis (Fig. 12). The narrow median septum and bulging posteriolateral edges of the epigynum distinguish females (Gertsch 1984).



FIGURES 11 & 12. — Left palp of *N. stygius*, Tennessee, Overton Co., Obe Lee Cave, MCH male specimen #1882. Fig. 11: dorsal view, Fig. 12 ventral view.

Description of male from type locality (MCH male specimen #1882) (Figs. 11 & 12; Table 1). — Color of appendages and cephalothorax uniform in coloration, approximating HTML color “dark orange” (#FF8C00). Abdomen darker, more flesh-colored, between “dark salmon” (#E9967A) and “gray” (#808080). Lenses of secondary eyes evident, without pigmentation. No external evidence of median eyes. Leg formula 1423. Legs very long, leg I over 11 times longer than carapace width. Paracymbium of male palpus with translucent dorsal process, bowed dorsally, forward, wide at base then narrowing towards tip, shaped like a duck’s head. Small paradistal process, distal paracymbium with fine serrations. Ventral paracymbium without modification. Tegular apophysis of palp well-sclerotized, thickened, blade-like, curving anteriorly. Small cuticular process arising near posterior origin of tegular apophysis. Median apophysis semi-translucent, approximately triangular, anterioromedial edge thickened.

Redescription of female from type locality (MCH female specimen #1885) (Table 1). — Gertsch (1984) describes the holotype female as a “pale, eyeless, long-legged troglobite”, with “cephalothorax and appendages bright yellow, without pattern”, “eyes obsolete or nearly so”. The redescribed female is mostly consistent with this description, although coloration is not “bright yellow”. Color of cephalothorax and legs similar to male, but with lighter, unpatterned abdomen. Lateral eyes only apparent as small patches of pearl-colored cuticle. No external evidence of median eyes. Leg formula 1423. Leg I

almost 11 times longer than carapace width. Epigynum as illustrated by Gertsch (1984), with narrow median septum, pear-shaped anterior lateral fovea, posteriolateral edges thickened, rounded, and bulging conspicuously.

Variation. — Two males from Raven Bluff Cave, Overton County, Tennessee with paradistal process of paracymbium more pronounced, drawn into three-sided sharp point, otherwise similar to described male.

Natural History. — Both Obe Lee and Raven Bluff caves are moist caves, Raven Bluff with a small (permanent?) stream, Obe Lee with a wet weather stream that flows into the mouth. Spiders were found beyond the twilight zone in both caves, occupying vertically-oriented webs in relatively high humidity crevices along cave walls. A female collected on 1 October, 1991 from Raven Bluff Cave carried an eggsac containing 22 eggs.

Distribution. — This species is known only from four caves on the western margin of the Cumberland Plateau in Overton county, north-central Tennessee (Fig. 1).

DNA sequences. — Mitochondrial 16S (Genbank accession numbers AF004648-49) and nuclear ITS (AF003817) DNA sequences were reported in Hedin (1997a).

Nesticus dilutus Gertsch 1984

Figs. 1, 13–14

Nesticus dilutus Gertsch 1984: 27, figs. 94–96.

Material Examined: Holotype. — Female, U.S.A: Tennessee: *Rhea County*, Grassy Creek Cave, south of Old Washington, coll. 5 October 1959, T.C. Barr (housed at AMNH).

Additional Type Locality Material Examined. — Two males, ten females, U.S.A: Tennessee: *Rhea County*, Grassy Creek Cave, south of Old Washington, 35°31'40" N, 84°54'44" W, elev. ~ 210 meters, coll. 23 August 1992, M. Hedin & J. Hedin (MCH male specimens # 1306, 1307; MCH female specimens # 1308 -1317).

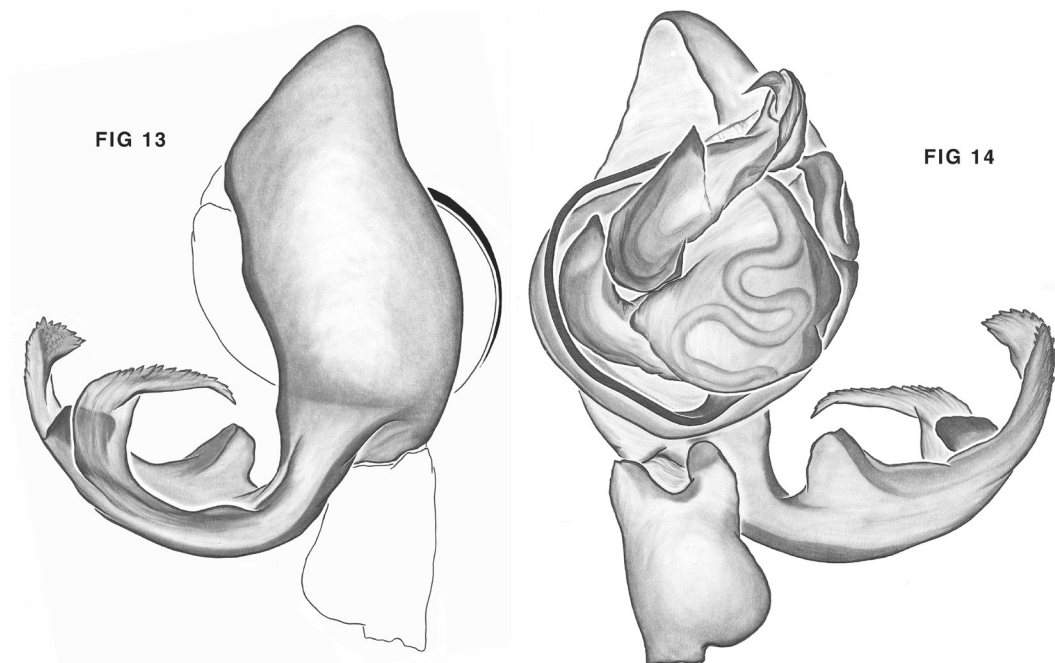
Remarks. — Previously known only from the holotype female, collected in 1959 from Grassy Creek Cave, Rhea County, Tennessee.

Discussion. — *Nesticus dilutus* is a member of the close-knit *N. tennesseensis* species group, a clade with both morphological (Gertsch 1984) and molecular synapomorphies (Hedin 1997a, 1997b). Both male and female genitalia of *N. dilutus* closely resemble conditions found in the geographically variable *N. tennesseensis* (Petrunkevitch), a species with a relatively widespread distribution in northeastern Tennessee and southwestern Virginia. Given the extent of variation seen within *N. tennesseensis* (see Gertsch 1984), it might be hypothesized that *N. dilutus* is simply a southern geographical isolate of *N. tennesseensis*. We reject this hypothesis, and consider *N. dilutus* to be distinct at the species level, for the following reasons. First, DNA sequence data from both the mitochondrial and nuclear genomes suggests that *N. dilutus* forms a genetic clade exclusive of, and sister to, the *N. tennesseensis* genetic clade (Hedin 1997a, 1997b). These species are clearly

close genetic relatives, but are both diagnosable at the DNA level. Second, as the southernmost representative of the species complex, separated from the nearest *N. tennesseensis* population by several hundred kilometers (see fig. 1 of Hedin 1997b), *N. dilutus* clearly occupies a unique and highly disjunct geographical position. This geographical separation is consistent with the evolutionary isolation of *N. dilutus*. Finally, the troglomorphic features of *N. dilutus* are more extreme than any such condition found in *N. tennesseensis*, again consistent with the evolutionary isolation of *N. dilutus*.

Diagnosis. — The troglomorphic features (pigmentation patterns, lack of median eyes, proportionately long legs) of *N. dilutus* separate this species from the closely related *N. tennesseensis*. Diagnostic DNA characters are reported in Hedin (1997a, 1997b).

Description of male from type locality (MCH male specimen #1307) (Figs. 13 & 14; Table 1). — Color of appendages and carapace uniform in coloration, between HTML colors “orange” (#FFA500) and “dark orange” (#FF8C00). Abdomen more flesh-colored, tending towards “dark salmon” (#E9967A). Lenses of lateral eyes evident, without pigmentation. No external evidence of median eyes. Leg formula 1423. Leg I about 9 times longer than carapace width. Palpus with translucent dorsal paracymbial process that parallels the cymbium, diverging medially at an approximately 90 degree angle, anterior edge serrate. Short, blade-like, paradistal process underlies dorsal process. Distal end of paracymbium curved dorsally, with serrate edge. Ventral paracymbium with translucent basal flange. Tegular apophysis curving medially, then anteriorly, closely following median apophysis.



FIGURES 13 & 14. — Left palp of *N. dilutus*, Tennessee, Rhea Co., Grassy Creek Cave, MCH male specimen #1307. Fig. 13: dorsal view, Fig. 14 ventral view.

Redescription of female from type locality (MCH female specimen #1316) (Table 1). — Gertsch (1984) describes the holotype female as “a possible troglobite with median eyes of both rows missing and lateral eyes evascent, near relative of *N. tennesseensis*”, with “cephalothorax and appendages bright yellow, abdomen grayish”. The redescribed female described is mostly consistent with this description, although the coloration is not “bright yellow”. Color of carapace and legs similar to male, unpatterned abdomen lighter and creamy in coloration. Lenses of lateral eyes evident, but without pigmentation. No external evidence of median eyes. Leg formula 1423. Leg I about 8 times longer than carapace width. Epigynum as illustrated by Gertsch (1984), relatively squat (short from anterior to posterior), with broad median septum.

Variation. — Examination of additional material from the type locality (nine females and a single male) reveals no significant genitalic differences from the described or holotype specimens.

Natural History. — Spiders were collected past the twilight zone in the vicinity of a cave stream, found in vertically-oriented webs spanning small vertical spaces. Spiders common, about 20 individuals observed in less than 15 minutes. Two females carrying eggsacs collected, with 41 and 20 eggs, respectively.

Distribution. — Known only from the type locality in east-central Tennessee, in the southern Appalachian Valley and Ridge geologic province (Fig. 1).

DNA sequences. — Mitochondrial 16S (Genbank accession number U40507) and nuclear ITS (AF003790) DNA sequences were reported in Hedin (1997a).

Nesticus furtivus Gertsch 1984

Figs. 1, 15-16

Nesticus furtivus Gertsch 1984: 27, figs. 97–99.

Material Examined: Holotype. — Female, U.S.A: Tennessee: *Hamilton County*, Crystal Caverns (= Raccoon Mountain Caverns), Black Creek Valley, Raccoon Mountains, coll. 14 April 1938, J.M. Valentine (housed at AMNH).

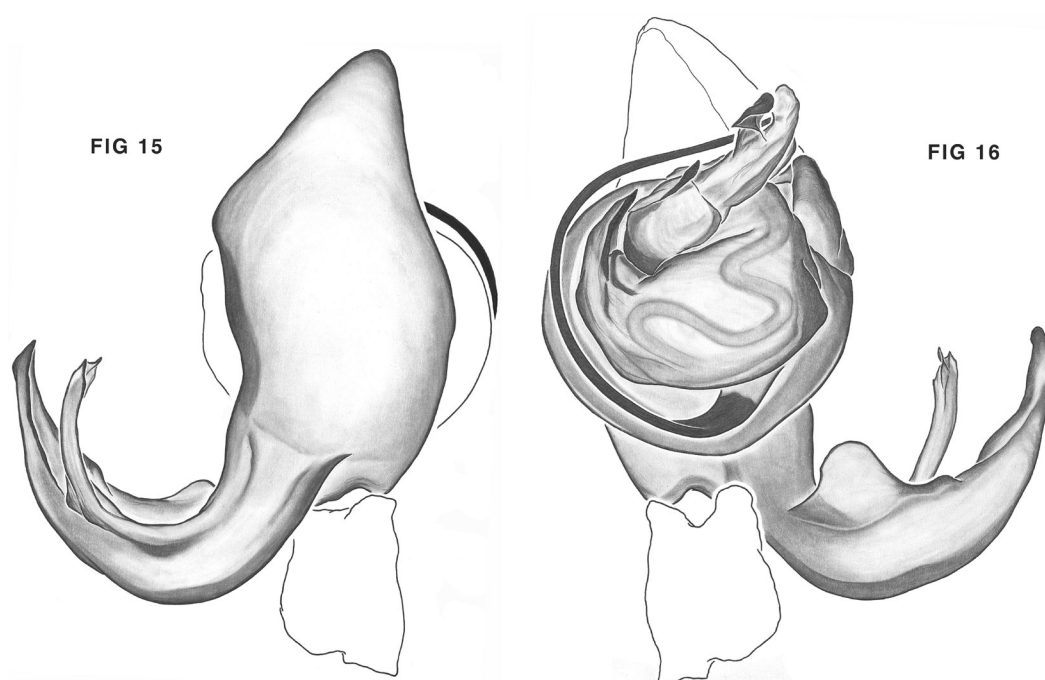
Additional Type Locality Material Examined. – Female, U.S.A: Tennessee: *Hamilton County*, Raccoon Mountain Caverns, 35°01'27" N, 85°24'47" W, elev. ~ 260 meters, coll. 28 March 1993, M. Hedin & M. Wolinsky (MCH female specimen # 1660); Male, data as for female, coll. 25-26 July 2000, M. Hedin, D. Wood, B. Dellinger, S. Perlaky, P. Perlaky, & C. Varnell (MCH 00_137 male specimen #1).

Remarks. — Previously known only from the holotype female, collected in 1938 from Crystal Caverns (= Raccoon Mountain Caverns), Black Creek Valley, Raccoon Mountains, Hamilton County, Tennessee.

Diagnosis. — The troglomorphic features of *N. furtivus* readily distinguish this species from smaller, surface-dwelling *Nesticus* found further east and north in the Appala-

chians. As compared to other Appalachian troglomorphs, the male palpus of this species is most similar to that of *N. barri* Gertsch (1984: figs 121–123; Figs 9 & 10). In particular, the distal and ventral paracymbium is essentially unmodified, and the dorsal paracymbium includes a simple, thin process (compare Figs. 9, 10 & 16). However, the tip of this process is modified and twisted in *N. furtivus*, but unmodified in *N. barri*. In addition, the tegular apophysis is laterally flattened and closely follows the median apophysis in *N. furtivus*, unlike the condition seen in *N. barri*. As suggested by Gertsch (1984), the tubercle at the posterior margin of the median septum of the epigynum is diagnostic for *N. furtivus*.

Description of male from type locality (MCH 00_137 male specimen #1) (Figs. 15 & 16; Table 1). — Color of appendages and carapace almost uniformly pale tan to orange, approximating HTML color “dark orange #FF8C00”. Abdomen slightly paler, without markings. Secondary eyes visible only as minute white patches of cuticle. No external evidence for principal eyes. Leg formula 1423. Leg I about 9 times longer than carapace width. Palp with an approximately translucent, elongate dorsal paracymbial process that parallels cymbium, with a thin distal projection. Distal end of paracymbium without processes. Ventral paracymbium with translucent basal flange. Tegular process compressed laterally, wrapping closely around median apophysis, shape approximating a sickle blade.



FIGURES 15 & 16. — Left palp of *N. furtivus*, Tennessee, Hamilton Co., Raccoon Mountain Caverns, MCH 00_137 male specimen #1. Fig. 15: dorsal view, Fig. 16 ventral view.

Redescription of female from type locality (MCH female specimen #1660) (Table 1). — Gertsch (1984) describes the holotype female as with “cephalothorax and appendages whitish, without pattern; abdomen grey. Eyes obsolete.” The legs of the holotype

female are relatively long (e.g., leg IV is 9.85 mm). The redescribed female is mostly consistent with this description. Color of carapace and legs similar to male, unpatterned abdomen lighter and more creamy in coloration. Secondary eyes visible only as minute pearl-colored patches of cuticle. No external evidence for principal eyes. Leg formula 1423. Leg I over 10 times longer than carapace width. Epigynum as described by Gertsch (1984: fig 97), with “medium septum produced at posterior end into narrowly rounded projection”.

Natural History. — Both male and female described specimens were collected deep in the cave, beyond the commercial section in the vicinity of the “Skylight Dome”. Skylight Dome is a high-humidity room, with considerable litter accumulation on the floors, washed in with surface flooding. Spiders were found fairly high in the room, occupying webs spanning small (15–30 cm) vertical spaces. Additional specimens (not collected) have been observed over a 10-year time period in other locations deep within this cave (see Discussion).

Distribution. — Known only from the type locality in southeastern Tennessee, near the junction of the Tennessee, Alabama, and Georgia borders (the “TAG” region). This location is a commercial cave that has had multiple prior names, including “Tennessee Caverns”, “Crystal City Caverns”, and “Crystal Caverns”, and is now called “Raccoon Mountain Caverns”. The cave is formed in limestone exposures at the eastern edge of the Cumberland Plateau (Fig. 1).

DNA sequences. — Mitochondrial 16S (accession number AF004621) and nuclear ITS (AF003791) DNA sequences were reported in Hedin (1997a).

Nesticus pecki new species

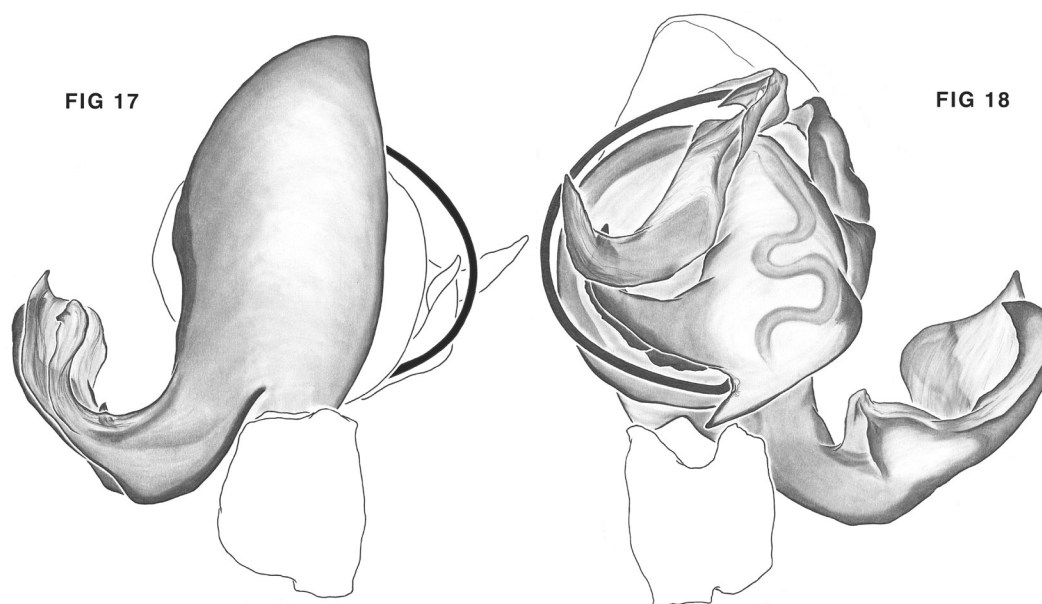
Figs. 1, 17–20

Type Material. Holotype. — Male, U.S.A: Tennessee: Marion County, Monteagle Salt-peter Cave, 6.4 km SE of Monteagle, 35°11' N, 85°46' W, elev. approximately 265 meters, coll. 26 September 1992, M. Hedin, J. Hedin & S. O’Kane (MCH male specimen #1624).

Paratypes. — Female, data as for holotype (MCH female specimen #1625); 2 females, data as for holotype, coll. 29 September 1991, M. Hedin, K. Crandall & A. Gerber (MCH female specimens #1012, #1013).

Diagnosis. — Small-bodied spiders with well-developed eyes, a rare condition in *Nesticus* of the Cumberland Plateau (the only other known taxon with such features is *N. cart-eri* Emerton 1875). Males distinguished by dorsal paracymbial process that swings laterally towards the distal paracymbium, split at the base into overlapping translucent processes, the most dorsal process much less broad than the underlying process (Fig. 17). The tegular apophysis is thickened and chisel-like, diverging strongly in an anterior direction (Fig. 18). Medium septum of the epigynum is conspicuously broad, and flares posteriorly (Fig. 19).

Description of male holotype (Figs. 17 & 18; Table 1). — Color of appendages and carapace uniform in coloration, between the HTML colors “orange” (#FFA500) and “dark orange” (#FF8C00). Abdomen paler, with dark dorsolateral markings towards posterior end. All secondary eyes approximately equal in size, with dark peripheral pigmentation. Principal eyes about one-fifth diameter of secondary eyes, with dark underlying pigmentation. Leg formula 1423. Leg I less than 8 times longer than carapace width. Palp with dorsal paracymbial process that swings laterally towards the distal paracymbium, split at the base into overlapping translucent processes, the most dorsal process much less broad than underlying process. Distal end of paracymbium dark, well-sclerotized, shape approximating an insect mandible. Ventral paracymbium thickened basally. Tegular apophysis dark, thickened, chisel-like, diverging anteriorly. Median apophysis blade-like, overlapping tegular apophysis, pointed medially.



FIGURES 17 & 18. — Left palp of *N. pecki*, new species, Tennessee, Marion Co., Monteagle Salt-peter Cave, holotype male (MCH male specimen #1624). Fig. 17: dorsal view, Fig. 18 ventral view.

Description of female paratype (MCH female specimen #1625) (Figs. 19 & 20; Table 1). — Female slightly paler than male, uniformly light tan to creamy white, including abdomen. Secondary eyes approximately equal in size, peripheral pigmentation cloudy grey to black. Principal eyes much smaller, perhaps one-tenth diameter of secondary eyes. Leg formula 1423. Leg I less than 8 times longer than carapace width. Epigynum wide, occupying over half width of the abdomen. Median septum conspicuously broad anteriorly, broadening further posteriorly (i.e., appears to flare). Ear-shaped pockets lateral of median septum, with slender spermathecae beneath and visible at lateral edge.

Variation. — Examination of two other females from the paratype series reveals no significant genitalic differences from the paratype female described.

Natural History. — The male and female specimens collected in 1992 were found in the twilight zone of the main cave passage, approximately 180 meters from the main entrance, in small tangle webs under wooden debris. Spiders collected in 1991 (two females, multiple immatures) were found in the relatively moist, subparallel passage south of the main passage, only 15–30 meters from a second small entrance, hanging inverted in vertically-oriented webs along passage walls.

FIG 19

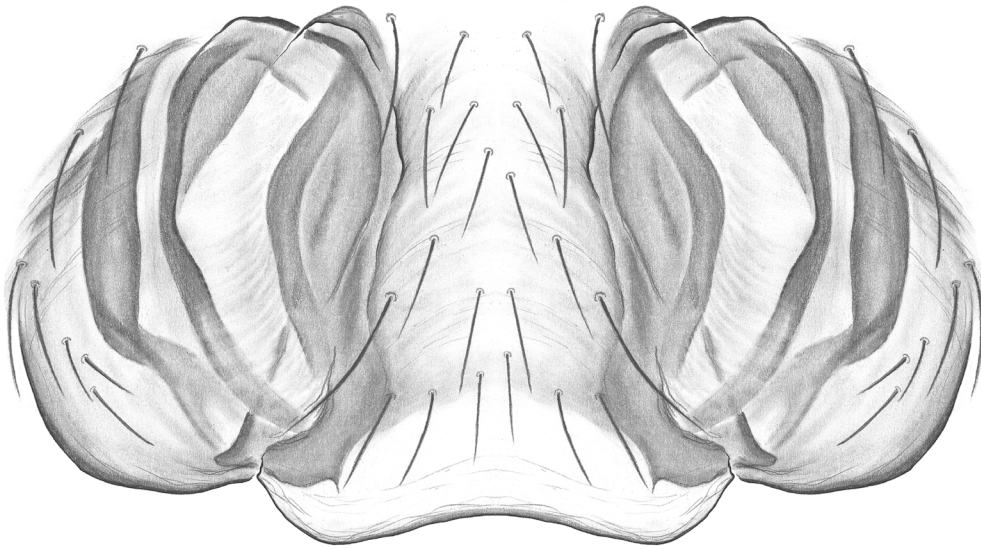
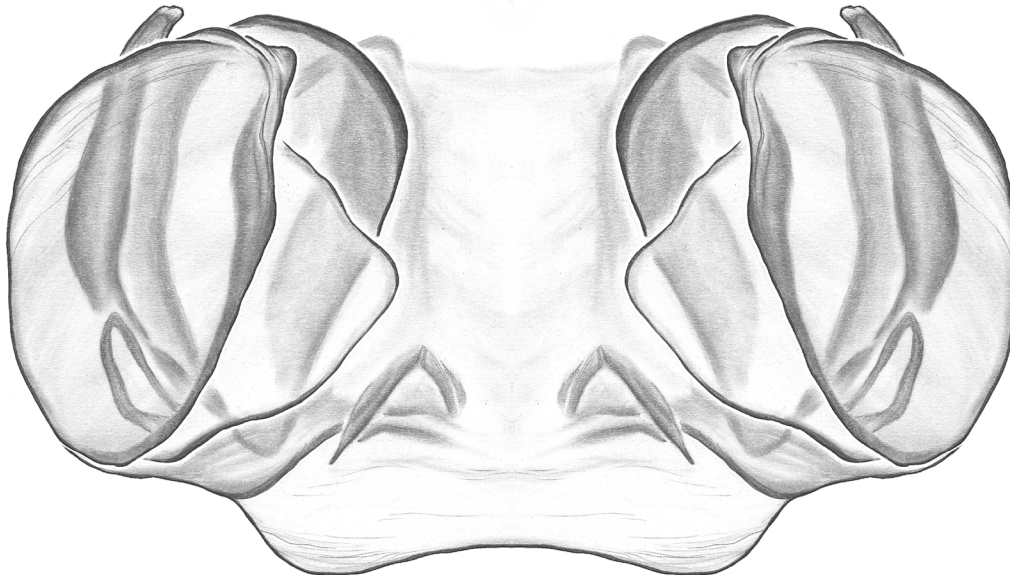


FIG 20



FIGURES 19 & 20. — Epigynum of *N. pecki*, Tennessee, Marion Co., Monteagle Saltpeter Cave, paratype female (MCH female specimen #1625). Fig. 19: ventral view, Fig. 20: dorsal view.

Distribution. — Known only from the type locality in southeastern Tennessee, along the edge of the Cumberland Plateau (Fig. 1).

DNA sequences. — Mitochondrial 16S (Genbank accession number AF004654) and nuclear ITS (AF003821) DNA sequences were reported in Hedin (1997a), under the species name *N. valentinei*. This was a misidentification.

Etymology. — Named after Dr. Stewart B. Peck, biospeleologist from Carleton University, Canada, in recognition of his pioneering work on the diversity and evolution of invertebrate cave faunas from the TAG region of the southern Appalachians.

Discussion

Caves represent extreme examples of functionally simple, easily perturbed habitats (see Culver 1982; Gibert & Deharveng 2002). Although general ecological processes across regional cave systems may be fairly similar, the faunistic composition of any particular cave or cave system is often unique. This individuality follows from the fragmented nature, and thus extraordinarily high species-level endemism, of cave systems. Such endemism is notoriously high in terrestrial invertebrates, particularly in cave systems of eastern North America (Peck 1998; Culver *et al.*, 2000; Hobbs *et al.*, 2003). In the age of human-induced environmental degradation, we might expect highly endemic, but readily perturbed faunas, to be imperiled. This appears to be the case in North America, where, for example, eleven of twelve arachnids with formal U.S. Federal protection are cave obligate taxa (www.endangered.fws.gov/wildlife.html#Species).

Because of both extreme endemism and unique biological characteristics (troglomorphy in particular), we feel that several Appalachian *Nesticus* species deserve special conservation attention, and in some cases, perhaps legal action. We highlight our concerns for three such taxa below. Our goal is to prompt other biologists, and appropriate agencies, to learn more about these distinctive species.

***Nesticus pecki*.** — This species is known only from the type locality, the well-visited, highly-impacted, and currently unprotected Monteagle Saltpeter Cave in Marion County, Tennessee. During survey work on separate single-day trips in 1991 and 1992, MH and colleagues surveyed the majority of accessible cave passage, observing less than 10 spiders total. At this time, most of the cave passages were found to be very dry and eroded with foot traffic, with many of the cave walls covered with spray paint graffiti. We feel that immediate efforts are required to document the continued persistence of *N. pecki* in Monteagle Saltpeter Cave, and to attempt to collect this species from nearby caves. Because this species is not actually troglomorphic, surveys in neighboring “surface” habitats (e.g., under rocks in moist microhabitats) might also prove fruitful.

***Nesticus dilutus*.** — The type locality, Grassy Creek Cave, has been visited once by the authors (MH in 1992). The spider population was observed to be large, with only a limited section of the available cave habitat surveyed. Unless conditions have changed

over recent years, it appears that Grassy Creek Cave is relatively pristine, partly because cave visitation is illegal during certain times of the year due to the presence of a protected bat species. However, the cave is privately owned (to the best of our knowledge) and is readily accessible (i.e., the entrance is not gated). The status of *N. dilutus* should continue to be monitored in the future. A possible management activity might involve the integration of *N. dilutus* monitoring with in-place efforts for bat protection.

Nesticus furtivus. — The authors have been part of four reasonably thorough surveys of Raccoon Mountain Caverns over the past several years. At least five people surveyed portions of the "wild" (i.e., non-commercial) sections of this cave in April, 1999. In total, this team counted 20 spiders (1 adult male, 10 adult females, 9 subadults), including 2 females with egg sacs. A 6-person team re-surveyed the cave in July 2000, finding 12 spiders (3 males, 6 females (4 with eggsacs), 3 subadults). Interestingly, only two immature spiders were found in the part of the cave that contained the highest spider densities in 1999. A 6-person team counted 13 spiders (1 male, 5 females (1 reproductive), 7 immatures) in August 2002. Most recently (August 2004), a 7-person team counted 11 spiders (6 females (1 with an eggsac), 5 immatures).

Our observations suggest that *N. furtivus* is extremely scarce in most parts of this cave, with higher densities in stable areas which receive the greatest food input (e.g., not far from entrances) but little human disturbance. Although commercialization has likely perturbed at least the spatial distribution of *N. furtivus* within the cave (no spiders have even been seen in lighted areas of the cave, although we have no evidence that spiders ever existed there), it is also apparent that a reproducing population of the species exists in less-impacted portions of the cave. Because this is the only known population of *N. furtivus*, and because the population seems very limited in size, we feel that continued monitoring is imperative. The current owner of the cave is sympathetic to these efforts, and strives to maintain low human visitation in areas of the cave with high observed spider densities.

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