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A new subterranean species of *Anillinus* Casey (Carabidae, Trechinae, Anillini) from Florida

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Abstract

A new species of blind subterranean ground beetle in the genus *Anillinus* Casey is described from Florida. *Anillinus albrittonorum* **sp. nov.** (type locality: 6 miles NW High Springs, Columbia County, Florida) has a unique structure of female genitalia and occupies an isolated position within the genus. This new species is illustrated with images of the habitus, body parts, and male and female genitalia. Relationships of *A. albrittonorum* to other members of the genus are discussed.

Keywords

Column trap, distribution, new species, soil fauna

Introduction

The genus *Anillinus* Casey is one of the most speciose North American genera of blind coleopterans. It currently includes more than 55 species, distributed across the eastern and central parts of the United States (Bousquet 2012; Sokolov 2020). Of these, up until now, only two species, *Anillinus dohrni* (Ehlers) and *Anillinus kovariki* Sokolov and Carlton, are reported from Florida. *Anillinus dohrni*, described more than 130 years ago (Ehlers 1884), was the third anilline species reported from North America at that time. Its description was based on a single female specimen originating from the collection of Carl August Dohrn, a German entomologist from Stettin (type now deposited in Szczecin in Poland). This specimen, according to the description (Ehlers 1884, p. 36), was collected in "Florida", but no precise locality was provided. The species was originally placed in the genus *Anillus* Jacquelin du Val and its description written in Latin. This description was only 11 lines long and does not contain currently useful diagnostic species-specific characters. Despite its long history, *A. dohrni* remains one of the "mysterious" species of the genus. One concept of this species was suggested by Jeannel (1937, 1963a), who, doubting the origin of the type specimen, based his re-description on specimens from Georgia, identified as *A. dohrni* by G.H. Horn (Sokolov et al. 2004). Another concept was suggested by Sokolov et al. (2004), who claimed that Ehlers' *A. dohrni* and *A. dohrni* sensu Jeannel (1937, 1963a) represented two different species. The second species from Florida, *A. kovariki*, is currently known from a single specimen from near Tallahassee (Fig. 1), where it was collected in a pocket gopher burrow. This species is well described (Sokolov et al. 2004) and its interpretation does not cause any difficulties.

It appears that these two Floridian species of *Anillinus* are only a part of the anilline fauna of the state. One explanation for the low number of species recorded from Florida, in addition to climatic, ecological, and physiographic factors, could be insufficient sampling of the appropriate habitat. A recent investigation of soil fauna conducted in the state resulted in the collection of a series of anilline specimens, which, after examination, proved to be a new species of *Anillinus*. The description of this new species forms the major content of this paper.

Materials and methods

This study is based on the examination of 23 specimens of *Anillinus* collected near High Springs in Florida. Type material of *Anillinus albrittonorum* is deposited in the following collections:

CUAC Clemson University Arthropod Collection, Clemson, SC, USA;
FSCA Florida State Collection of Arthropods, Gainesville, FL, USA;
KESC Kyle E. Schnepp Collection, Gainesville, FL, USA;
NMNH National Museum of Natural History, Washington, DC, USA.

Terms used in this paper follow Sokolov and Carlton (2008) and Sokolov et al. (2014).

Extractions and processing of genitalia were made using standard techniques as described by Sokolov and Kavanaugh (2014).

Photographs of the external features of specimens were taken with a Macropod Pro photomacrography system (Macroscopic Solutions, LLC). Digital images of genitalia were taken with a Nikon Eclipse N*i*-U light microscope supplied with DS-Fi2 camera and DS-LR3 camera control unit.

All specimens were measured using tpsDig 2.17 (Rohlf 2013) software on digital photographs. Measurements for various body parts are encoded as follows:

ABL	apparent body length, from clypeus to apex of elytra;
WH	width of head at level of first orbital setae;
WPm	maximum width across pronotum;
WPa	width across anterior angles of pronotum;
WPp	width across posterior angles of pronotum;
LP	length of pronotum from base to apex along the midline;
WE	width of elytra at level of 2^{nd} discal seta;
LE	length of the elytra, from the apex of the scutellum to the apex of the left elytron.

Apparent body length (ABL) measurements are given in mm, others are presented as ratios: mean widths – WH/WPm and WPm/WE; body parts – WPa/WPp, WPm/WPp, WPm/LP, WE/LE, LP/LE, LE/ABL, and WE/ABL. All values are given as the mean ± standard deviation.

Results

Order Coleoptera Linnaeus, 1758
Family Carabidae Latreille, 1802
Subfamily Trechinae Bonelli, 1810
Tribe Anillini Jeannel, 1937

Genus *Anillinus* Casey, 1918

Anillinus Casey, 1918: 167. Type species: *Anillus* (*Anillinus*) *carolinae* Casey, 1918, by original designation.

Micranillodes Jeannel, 1963a: 57. Synonymy established by Bousquet (2012: 699) and confirmed by Sokolov et al. (2014: 83). Type species: *Micranillodes depressus* Jeannel, 1963a, by original designation.

Troglanillus Jeannel, 1963b: 147. Synonymy established by Barr (1995: 240). Type species: *Troglanillus valentinei* Jeannel, 1963b, by original designation.

***Anillinus albrittonorum* Sokolov & Schnepp, sp. nov.**
http://zoobank.org/87B4A499-1E9A-46C5-9EC7-3373DFDFF2E4
Figs 1–4

Type material. *Holotype*: male (NMNH), dissected, labeled "FLORIDA: Columbia Co., 6mi NW High Springs, 29.8674°N, 82.6664°W, May 6 – August 5, 2020, underground column trap, Kyle E. Schnepp".

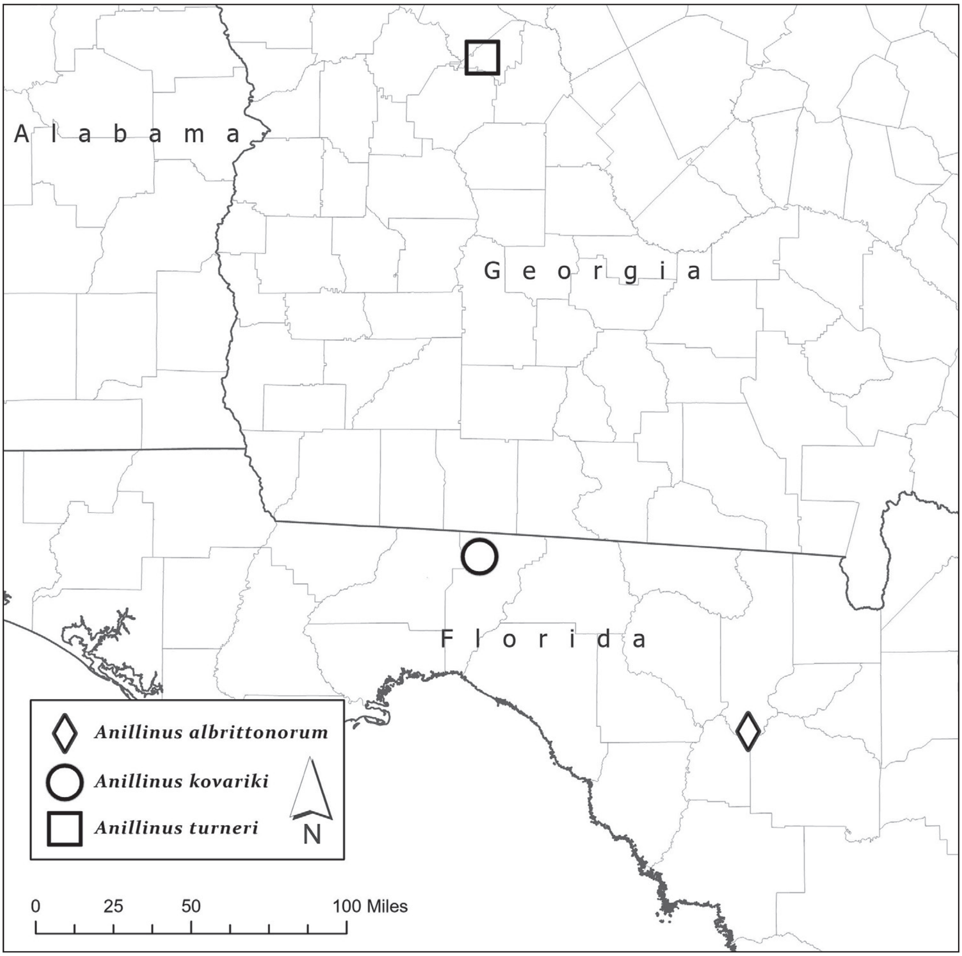

Figure 1. Map of Florida and Georgia showing positions of the known locality records for three species of *Anillinus*.

Paratypes (22 specimens). Same data as holotype [1 male, CUAC; 2 males, KESC; 1 male, 1 female, NMNH]; same data except November 11, 2019 – March 8, 2020 [1 female, FSCA]; March 8 – May 6, 2020 [2 females, CUAC, FSCA]; August 5 – September 25, 2020 [2 males, 3 females, KESC]; September 25 – October 16, 2020 [1 male, 5 females, FSCA]; October 16 – December 3, 2020 [1 male, 2 females, KESC].

Etymology. This species is named in honor of the Albritton family, Matthew, Pam, Rowan, and Henry, whose interest and assistance in collecting brought about the discovery of this beetle.

Type locality. USA, Florida, Columbia County, 6 miles northwest High Springs, 29.8674°N, 82.6664°W (Figs 1, 2).

Diagnosis. Adults of *A. albrittonorum* can be distinguished from both Florida species of *Anillinus* by its subparallel, elongate, only slightly convex habitus. *Anillinus kovariki*

Figure 2. Habitat and type locality of *Anillinus albrittonorum* sp. nov. Underground traps indicated by a pair of flags in foreground and background.

and *A. dohrni* belong to the group of species with ovoid and convex habitus (cf. description of *A. dohrni* "Testaceus, robustus ovatus supra convexus…", Ehlers 1884, p. 36). Additionally, adults of the new species can be distinguished from those of other subterranean members of *Anillinus* by details of the microsculpture of the head and pronotum. The presence of a smooth frons with completely microsculptured vertex of the head and a smooth pronotal disc with a distinctively microsculptured base is distinctive. Males and females of *A. albrittonorum* can also be distinguished from congeners by the structure of their genitalia.

Description. Moderate-sized for the genus (ABL 1.56–1.92 mm, mean 1.71±0.094 mm, n = 17). Males (ABL 1.70–1.92 mm, mean 1.78±0.098 mm, n = 5) slightly larger than females (ABL 1.56–1.88 mm, mean 1.69±0.082 mm, n = 12).

***Habitus*:** Body form (Fig. 3A) slightly convex, subparallel, elongate (WE/ABL 0.33±0.006), head moderately large in comparison to pronotum (WH/WPm 0.77±0.017), pronotum large relative to elytra (WPm/WE 0.88±0.021).

***Integument*:** Body color brunneo-rufous, appendages testaceous. Microsculpture (Fig. 3B, C) present on vertex, base of pronotum, and on elytra where it is represented by isodiametric polygonal sculpticells; and absent from clypeus and frons on head, and from disc of pronotum. Body surface shiny, surface sparsely and finely punctate,

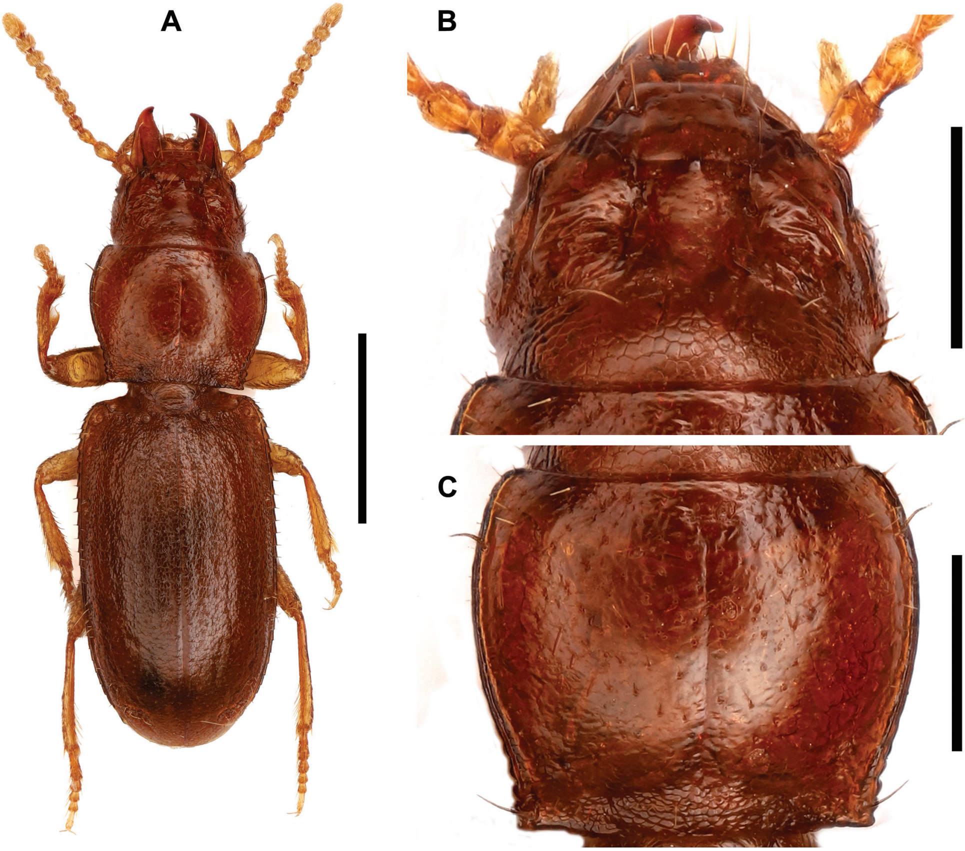

Figure 3. Digital images of external features of *Anillinus albrittonorum* sp. nov. (female, 6 mi NW High Springs, Columbia County, Florida) **A** habitus, dorsal aspect **B** head, dorsal aspect **C** pronotum, dorsal aspect. Scale bars: 0.5 mm (**A**); 0.2 mm (**B, C**).

covered with sparse, yellowish, short setae. Vestiture of elytra short (~0.3× the length of discal setae).

***Prothorax*:** Pronotum (Fig. 3C) moderately convex, of moderate size (LP/LE 0.40±0.012) and moderately transverse (WPm/LP 1.24±0.024), with lateral margins almost rectilinearly and moderately constricted posteriorly (WPm/WPp 1.26±0.025). Anterior angles indistinct, posterior angles almost rectangular (89–100°). Width between posterior angles equals the width between anterior angles (WPa/WPp 1.00±0.023). Basal margin slightly concave in middle.

***Scutellum*:** Externally visible, triangular, with pointed apex.

***Elytra*:** Slightly convex, of average length (LE/ABL 0.58±0.006) and width (WE/LE 0.57±0.011) for the genus, with traces of 5–6 striae. Humeri distinct, rounded, in outline forming an obtuse angle with longitudinal axis of body. Lateral margins subparallel in middle, slightly convergent at basal fifth, evenly rounded to apex at apical third, with shallow subapical sinuation. Basal margination distinct.

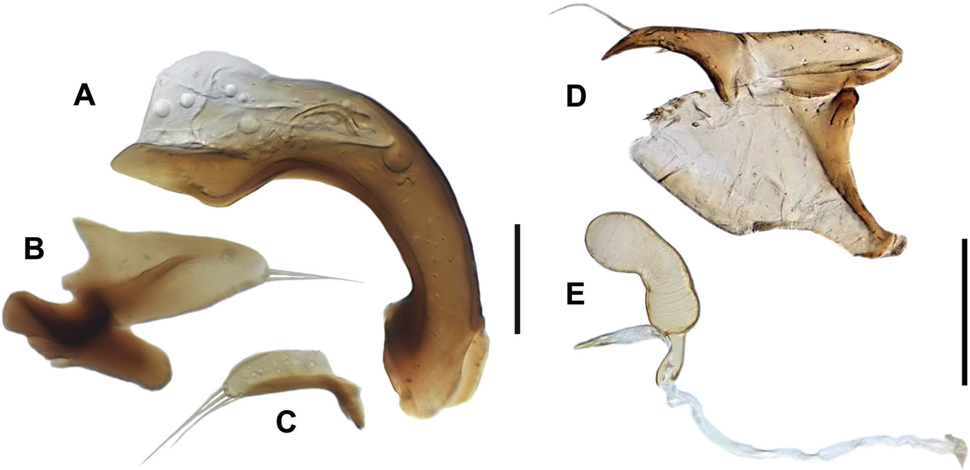

Figure 4. Digital images of male and female genitalia of *Anillinus albrittonorum* sp. nov. (6 mi NW High Springs, Columbia County, Florida). Male genitalia: **A** median lobe, right lateral aspect; apex to upper left and basal bulb to lower right **B** left paramere, left lateral aspect **C** right paramere, right lateral aspect. Female genitalia: **D** ovipositor sclerites **E** spermatheca. Scale bars: 0.1 mm.

***Legs*:** Protarsi of male with moderately dilated tarsomere I. Profemora moderately swollen.

Males with metafemora modified; each bearing a small projection with small tubercles at posterior margin. Females metafemora unmodified.

***Male genitalia*:** Median lobe (Fig. 4A) of aedeagus anopic, moderately arcuate and moderately twisted. Shaft slightly dilated in apical half, enlarged trianguloid apex with sides almost rectangularly tapered to narrowly rounded tip. Apical orifice long, occupies almost half of the shaft length. Ventral margin of median lobe curved, most strongly bent at the middle of shaft, with abrupt enlargement before apex, without poriferous canals. Dorsal copulatory sclerites short, fused to form slightly curved blade-like structure. Spines and scaled membranous folds of internal sac absent. Left paramere (Fig. 4B) of shape common in the genus, paramere apex with two long setae. Right paramere (Fig. 4C) of moderate length, bearing four long setae, which are approximately the length of paramere.

***Female genitalia*:** Spermatheca (Fig. 4E) slightly sclerotized, formed from two compartments of different width and shape. The distal compartment of a bean-like shape, wide and long, occupies two-thirds of the spermatheca length, and presumably corresponds to the cornu of other species of the genus. Proximal part cylindrical, short and narrow, presumably corresponds to the fused ramus and nodulus of other species of the genus (cf. Fig. 4E with the spermatheca of *A. cherokee* Sokolov and Carlton on fig. 11 in Sokolov and Carlton 2008, p. 43). Length of spermathecal gland shorter than length of spermatheca. Spermathecal duct long and uncoiled. Gonocoxite II slightly falciform, more than 2× longer than it is wide basally, with acute ensiferous setae (Fig. 4D). Laterotergite with 7–8 setae (Fig. 4D).

Geographic distribution. This species is known only from the type locality in the High Springs area of Columbia County, Florida (Fig. 1).

Habitat. All specimens of this species were collected from deep sand soil using underground column pitfalls. The underground traps used are comprised of ½ inch hardware cloth tied into a cylinder with PVC plastic pipe on each end. Each section of pipe is 10 inches in length and the hardware cloth is two feet long. The cloth overlaps with each pipe approximately 2 inches, resulting in a trapping length of 20 inches. The effective trapping depth is from 10 inches to 30 inches below the soil surface. A plug of soil the size of the trap is removed from the ground and the trap installed in the hole. A jar containing propylene glycol with a funnel on top the same diameter as the pipe is lowered to the bottom and is used to collect and preserve insects burrowing through the sand. These traps were placed in an area of deep sand on the north end of the northern Brooksville ridge, one of many "islands" of elevated karst and sand that cover Florida. There are numerous ridge systems in Florida, generally running north to south, that were beach dunes formed by past fluctuations in ocean levels (Bousquet and Skelley 2010, 2012). The type locality and surrounding area is mostly disturbed sandhill with secondary growth and pastureland (Fig. 2). Other carabid species collected in the same traps that are regarded as interesting, rare, and indicators of the subterranean habitat include *Clivina choatei* Bousquet and Skelley and *Scarites stenops* Bousquet and Skelley. *Anillinus albrittonorum* is a true endogean species and has never been found in litter samples.

Relationships. The new species belongs to group VII of the endogean *Anillus* species (Sokolov et al. 2004), characterized by a combination of the partly microsculptured head and a smooth disc of the pronotum. However, *A. robisoni* Sokolov and Carlton from Arkansas and species of the *Anillinus moseleyae* group from North Carolina that form group VII of the endogean species have only a superficial similarity to the new species. Within this group, as well as within other groups of the endogean and litter species, *A. albrittonorum* differs in the structure of its spermatheca from all *Anillinus* species where the spermathecae have been examined. Among endogean species with similar habitus, the range of *A. albrittonorum* is geographically (Fig. 1) close to the range of *A. turneri* Jeannel, described from the Atlanta area (Peach County) in Georgia. Externally, both species can be distinguished by the structure of the frons, completely microsculptured in specimens of *A. turneri* but smooth in the specimens of *A. albrittonorum*. Both species can also be distinguished based on the male and female genital structures. The spermatheca of females of *A. turneri* (Peach Co., Georgia, NMNH) have a question-mark shape, typical for *Anillinus*, and thus shows no similarity to the spermatheca of females of *A. albrittonorum*. As it was mentioned above, two Florida species, *A. dohrni* and *A. kovariki*, exemplify ovoid and convex species, i.e. belong to other morphological groups of species, and in comparison with *A. albrittonorum* demonstrate quite dissimilar genital structures. The male median lobes of both Florida species have simple, not enlarged apices, and shafts of different shapes (cf. Fig. 4A with the male median lobe of *A. dohrni* on fig. 64 in Jeannel 1963a, p. 75, and the male median lobe of *A. kovariki* on fig. 28 in Sokolov et al. 2004, p. 194).

Discussion

This new finding increases to three the total number of *Anillinus* species recorded from Florida. Thus, in relation to anilline diversity, Florida occupies the third position among the Gulf States (after Alabama and Texas), and several considerations suggest that additional new species remain to be discovered in the state.

The Florida peninsula has a rather complicated geological history, involving changing ocean levels, isolation from other areas, and the indirect impact of glaciation with periodic multiple marine transgressions, and fluvial and rainfall erosion (Howden 1963, 1966; Bahtijarević and Faivre 2016). All these events have shaped the specific topography of the peninsula characterized by evident north-south monotonous decrease in the absolute altitude of lands above sea level. The northern part of the peninsula is represented by a continuous broad belt of uplands, which become discontinuous southward. In central Florida, the local highlands are mostly represented by sub-parallel ridges separated by broad valleys and in south Florida all the highlands are eventually replaced with lowland (White 1970). This complicated topography is accompanied by a diversity of underlying geologic features, particularly karst relief (Scott et al. 2006) and various terrestrial ecological habitats which result in almost twenty different ecological communities for north and central Florida (Soil and Water Conservation Service 1989). It is no surprise that the northern and central regions are known for their numerous endemic plants (Sorrie and Weakley 2001), vertebrates (Neill 1957), and terrestrial arthropods (Deyrup 1990), including those whose immature stages demonstrate a subterranean way of life (Woodruff 1973; Skelley 2003). Additionally, from a biogeographic point of view, the terrestrial fauna of the Florida Panhandle bears features of a genetic discontinuity, known as the Apalachicola River discontinuity (Soltis et al. 2006). Altogether, the topographical, geological, ecological, and biogeographical patterns of central and northern Florida may impact not only terrestrial but also subterranean fauna and, presumably, the soil fauna of Florida still hides an uninvestigated and unknown diversity. Thus, there are likely a substantial number of Anillini yet to be reported from Florida. Additional trapping and investigation of soils are required to expand distributions and identify new species.

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