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Five new species of *Anillinus* Casey from the Southern Appalachian Mountains and the Piedmont Plateau of eastern U.S.A. (Coleoptera: Carabidae: Trechinae: Bembidiini)

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Abstract. Five new species of anilline ground beetles (Carabidae: Trechinae: Bembidiini) are described from the Appalachian Mountains and Piedmont Plateau of eastern United States. Two species, *Anillinus unicoi* **n. sp.** (from the Unicoi Mountains, North Carolina) and *A. carltoni* **n. sp.** (from the Great Smoky Mountains, North Carolina/Tennessee), inhabit the crests of adjacent mountain ranges, and share similarities with *A. moseleyae* Sokolov and Carlton. These three comprise a high-altitude group of species in the region. The third species *A. chilhowee* **n. sp.** is one of the smallest representatives of the loweae-group of species. It differs from its relatives in characters of male genitalia and inhabits the isolated Chilhowee Mountain ridge between Ocoee and Hiwassee Rivers (Polk County, Tennessee). The fourth and fifth species possess complex arrays of spines on the internal sac of the aedeagus, similar to *A. valentinei* (Jeannel) from caves of Alabama. In the case of *A. smokiensis* **n. sp.** (Gregory Cave, Great Smoky Mountains National Park, Tennessee), the aedeagal similarity suggests a close relationship with *A. valentinei*. *Anillinus chandleri* **n. sp.** from the Piedmont Plateau (Sumter National Forest, South Carolina) is similar to *A. cornelli* Sokolov and Carlton, also described from the Carolina Piedmont region. Keys are provided for the new species, where possible.

Key words. Coleoptera, Adephaga, Carabidae, *Anillinus*, Appalachian Mountains, Piedmont, new species

Introduction

Representatives of the subtribe Anillina (Carabidae: Trechinae: Bembidiini) remain one of the most intensively studied group of ground beetles in the world (Giachino 2003, 2005, 2008; Zaballos 1997, 1998, 2003; Zaballos and Ruiz-Tapiador 1997; Zaballos and Wrase 1998). One of the reasons for such interest is that they are poorly known even in presumably well-studied areas. For example, each year since 2005 several species of Anillina have been described from the Iberian Peninsula (Ortuño 2005; Serrano et al. 2005; Serrano and Aguiar 2006a, b, c; Ortuño and Sendra 2007; Andújar et al. 2008; Serrano and Aguiar 2008; Andújar et al. 2010; Ortuño and Sendra 2010). Also, anilline species tend to have extremely localized distributions and a dynamic, geologically recent history of lineage diversification that provide scientists with valuable biogeographic information. Thus, they are ideal for modeling evolutionary studies of regional biotas (Sokolov et al. 2004, 2007; Sokolov and Carlton 2010).

During the last decade collecting activities of many entomologists in the southeastern United States have produced hundreds of specimens in the genus *Anillinus* Casey that have resulted in establishing the identities of previously described species and the description of 25 new species from the eastern half of the U.S. (Sokolov et al. 2004, 2007; Sokolov and Carlton 2008, 2010; Sokolov and Watrous 2008), effectively tripling the known species diversity. This paper continues the efforts to document the biodiversity of this endemic southeastern U.S. genus by providing descriptions of five new species. This information facilitates a more complete understanding of phylogenetic and biogeographic history of this group in the southern Appalachians.

Material and Methods

Most specimens of the new species were collected in Great Smoky Mountains National Park (**GSMNP**) and adjacent regions using Berlese funnels or hand sifting forest litter. One new species was found among Anillina material from the University of New Hampshire Insect Collection kindly provided by Dr. Donald S. Chandler. Verbatim label data are given for type specimens of all newly described taxa, with label breaks indicated by a slash ("/"). Type depositions are indicated under each species treatment.

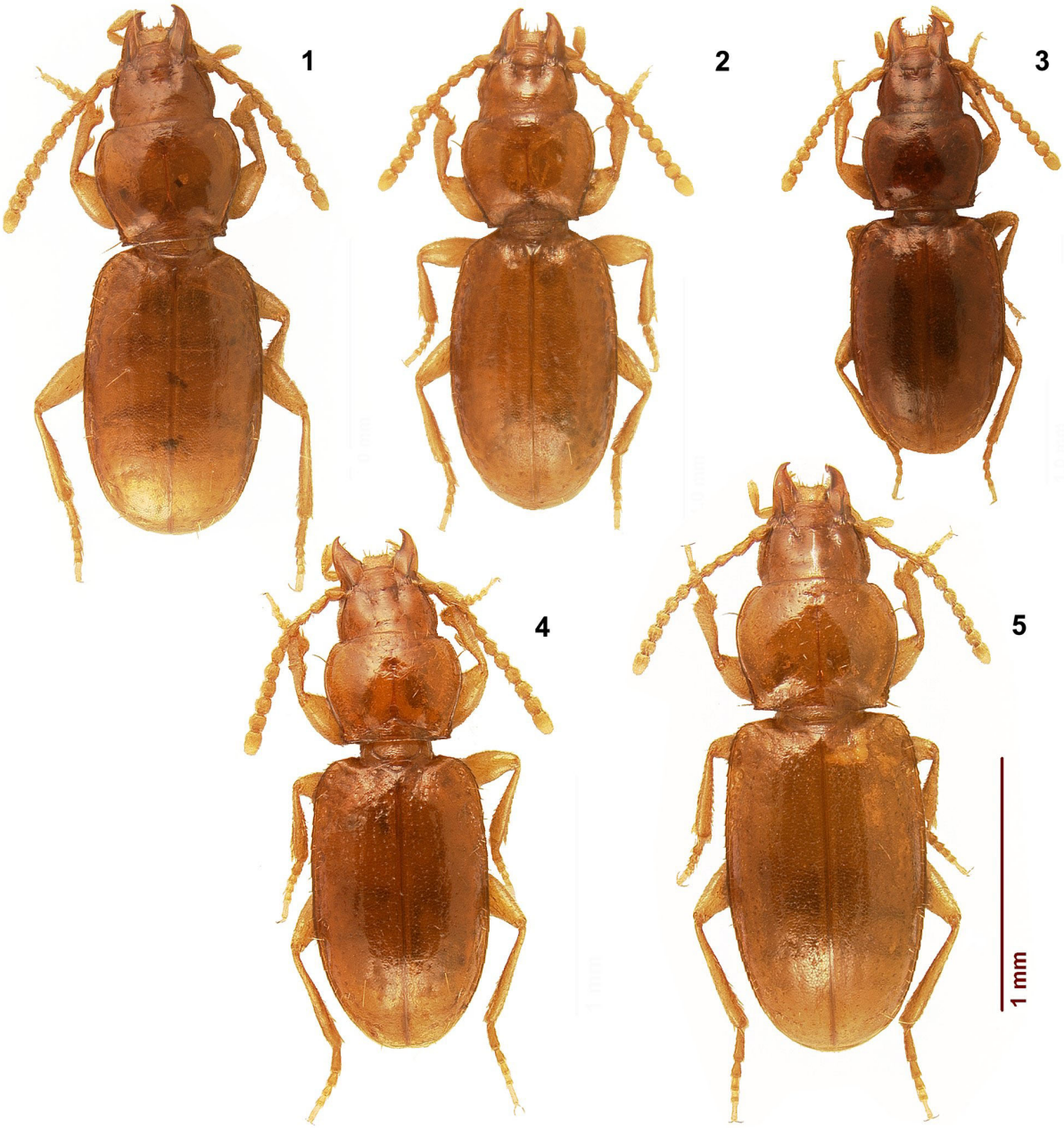

Figure 1-5. Habitus images. **1)** *Anillinus unicoi* (NC, Graham Co., Unicoi Mtns.), holotype. **2)** *A. carltoni* (TN, Blount Co., GSMNP, Thunderhead Mtn.), paratype. **3)** *A. chilhowee* (TN, Polk Co., Chilhowee Mtn.), holotype. **4)** *A. smokiensis* (TN, Blount Co., GSMNP), paratype. **5)** *A. chandleri* (SC, Edgefield Co., Sumter National Forest), holotype.

All specimens were measured electronically using a Leica Z16 APO microscope equipped with a Syncroscopy AutoMontage photomicroscopy system (SYNCROSCOPY, Synoptics Ltd.). 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 = maximal 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 midline; WE = width of elytra, at level of 2nd discal setae; LE = length of the elytra, from apex of scutellum to apex of left elytron. ABL measurements are given in mm; others are presented as eight ratios: mean widths-WH/WPm and WPm/We and body parts-WPa/WPp, WPm/WPp, WPm/LP, LE/ABL and WE/ABL. All values are given as mean ± standard deviation.

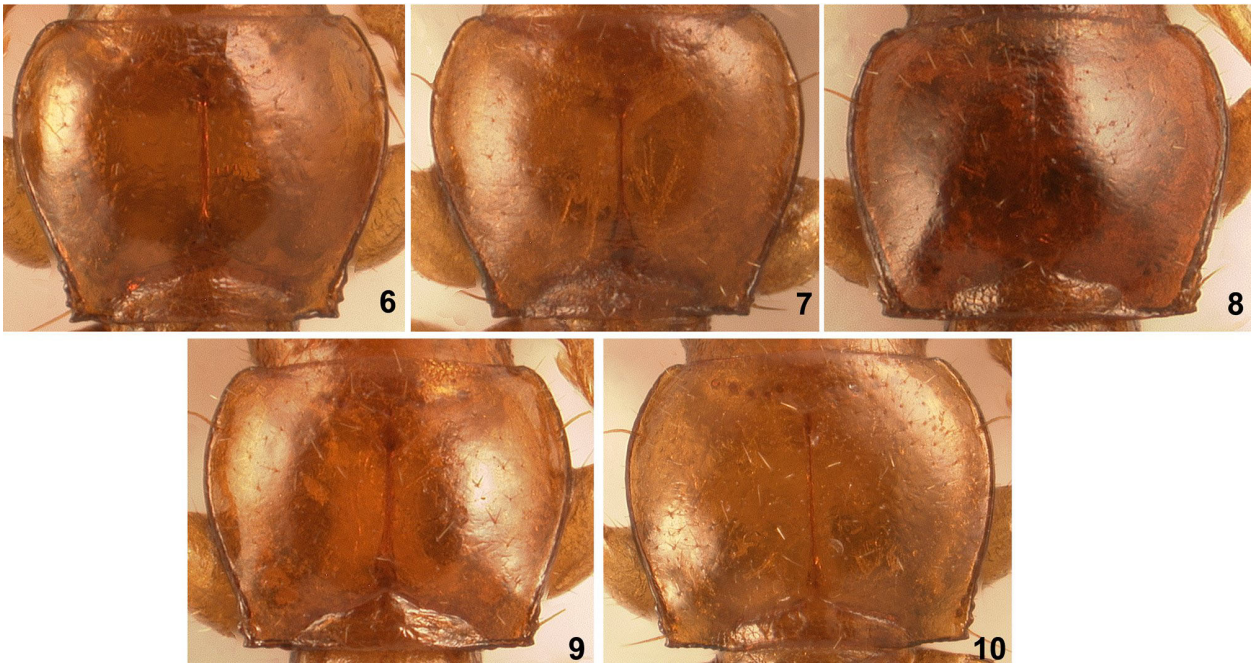

Figure 6-10. Pronotum images. **6)** *Anillinus unicoi* (NC, Graham Co., Unicoi Mtns.). **7)** *A. carltoni* (TN, Blount Co., GSMNP, Thunderhead Mtn.). **8)** *A. chilhowee* (TN, Polk Co., Chilhowee Mtn.). **9)** *A. smokiensis* (TN, Blount Co., GSMNP). **10)** *A. chandleri* (SC, Edgefield Co., Sumter National Forest).

Dissections of genitalia were made using standard techniques as described by Sokolov et al. (2004, 2007).

Photographs of the dorsal habitus of new species were taken with the AutoMontage system. Line drawings of selected body parts were made using a camera lucida on an Olympus BX 50 compound microscope.

Results

Anillinus unicoi Sokolov, new species

Figure 1, 6, 11, 16

Holotype. Male lacks left middle leg and is labeled /USA-NC: Graham Co., Cherokee NF, Cherohala Skyway, Stratton Meadows at 35°20.229'N 84°1.862'W, 1300m, litter berlese, Sokolov I.M. 19 Oct 2007 / Molecular Voucher # 51 Sokolov I. 2008/ HOLOTYPE, *Anillinus unicoi* Sokolov , des. 2009/. The holotype is dissected and bears a plastic rectangle with genitalia mounted in dimethylhydantoin formaldehyde resin. Deposited U.S. National Museum (**USNM**).

Type locality. U.S.A. North Carolina, Graham County, Unicoi Mountains at 35°20.229' N 84°1.862' W.

Etymology. The name of this species is based on the name of the mountain region of where this species occurs.

Description. Large for the genus (ABL = 1.98 mm). Habitus (Fig. 1) subdepressed, subparallel (WE/ABL 0.36), head of normal proportions for the genus (WH/WPm 0.72), pronotum narrow compared to elytra (WPm/WE 0.82). Body color rufotestaceous, appendages testaceous. Dorsal microsculpture partly effaced. Head with polygonal microsculpture on entire vertex and anterior part of frons with area of effaced microsculpture between them. Disc and front part of pronotum with effaced microsculpture, base of pronotum with polygonal microsculpture. Elytra with well-developed polygonal microsculpture.

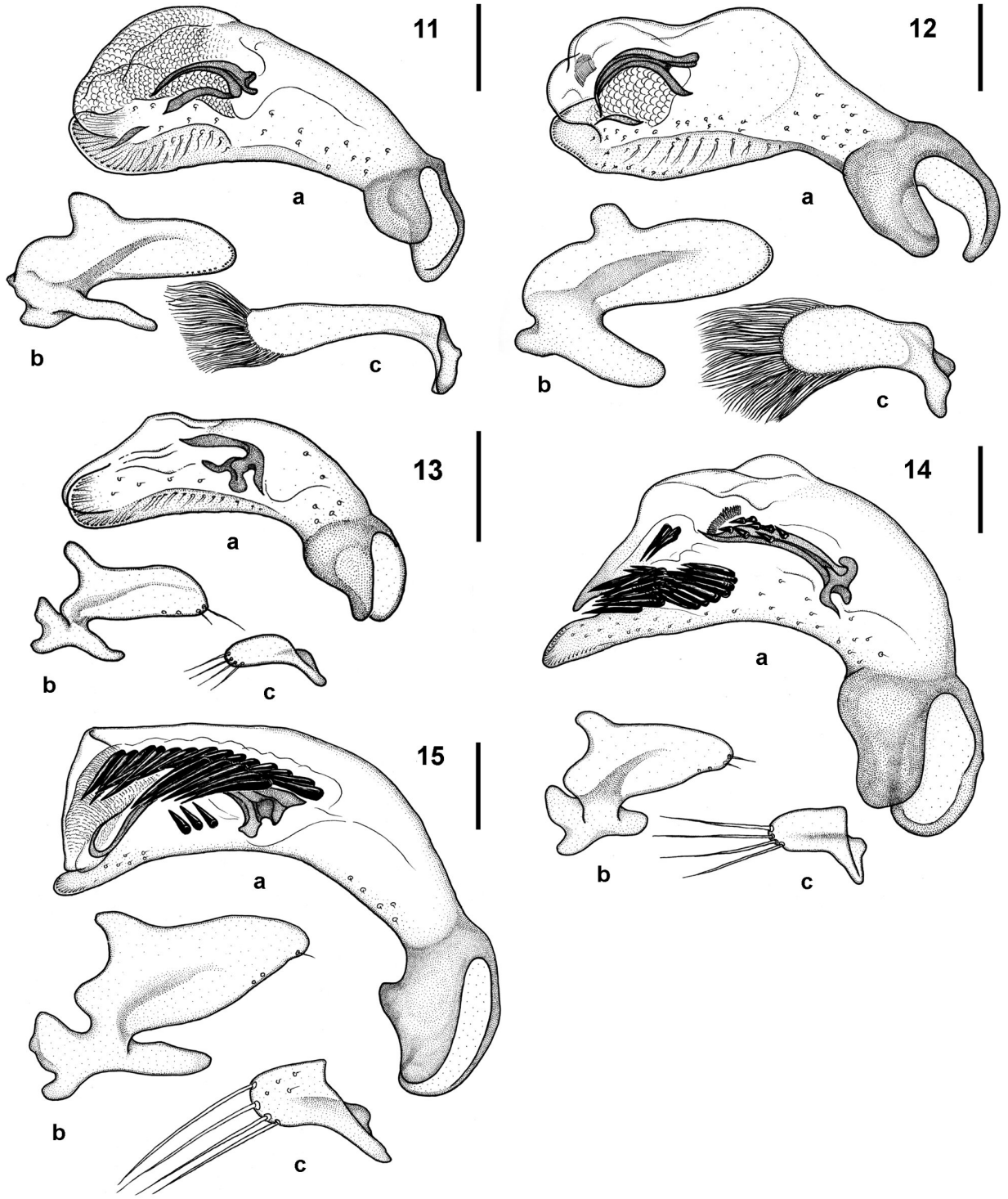

Figure 11-15. Illustrations of male aedeagus. **11)** *Anillinus unicoi* (NC, Graham Co., Unicoi Mtns.). **12)** *A. carltoni* (TN, Blount Co., GSMNP, Thunderhead Mtn.). **13)** *A. chilhowee* (TN, Polk Co., Chilhowee Mtn.). **14)** *A. smokiensis* (TN, Blount Co., GSMNP). **15)** *A. chandleri* (SC, Edgefield Co., Sumter National Forest). **a**-Median lobe, right lateral aspect; **b**-Left paramere, left lateral aspect; **c**-Right paramere, right lateral aspect. Scale = 100 µm.

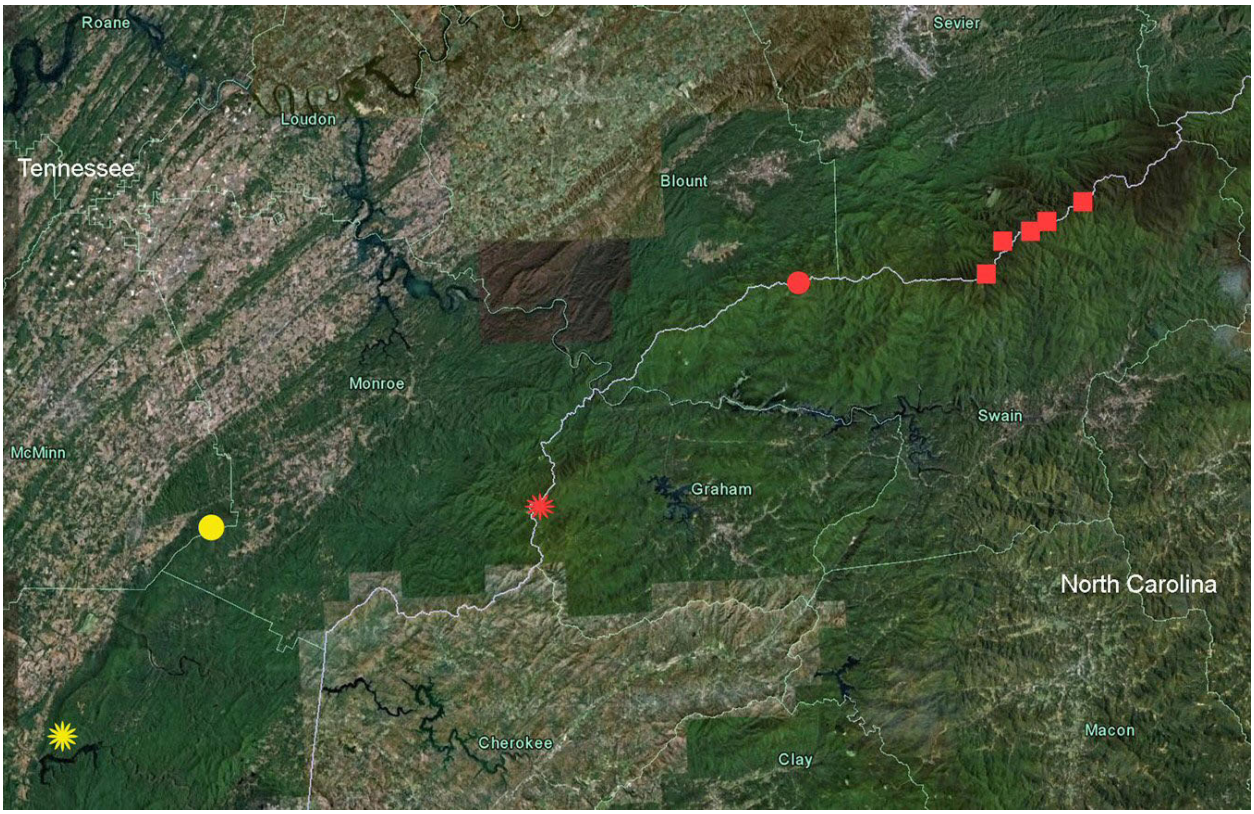

Figure 16. Locality records for the moseleyae-group (red color) and loweae-group species from Chilhowee and Starr Mountains (yellow color). *Anillinus moseleyae* – red quadrangles; *A. carltoni*, new species – red circle; *A. unicoi* – red star; *A. juliae* – yellow circle; *A. chilhowee* – yellow star.

Pronotum (Fig. 6) moderately convex and comparatively elongated (WPm/LP 1.23), with margins strongly constricted posteriad (WPm/WPp 1.45) and slightly sinuate before posterior angles. Anterior angles weak, very slightly prominent. Posterior angles nearly rectangular (95-100°). Width between posterior angles less than between anterior angles (WPa/WPp 1.10).

Elytra slightly convex, depressed along suture, of normal length for genus (LE/ABL 0.54), with traces of 5 interneurs. Humeri oblique and effaced. Lateral margins subparallel, slightly divergent in basal half, evenly rounded to apex in apical third, maximal width of elytra at midpoint. Elytra without subapical sinuation. Vestiture of elytra short (lesser than one-third of discal setae).

Prothoracic leg of male with moderately dilated tarsomere 1. Profemur moderately swollen. Metafemora unmodified. Sternum VII of males unmodified.

Median lobe of aedeagus (Fig. 11a) evenly arcuate and twisted, with apex greatly enlarged, widely rounded and curved upwards. Distinctive small fold extending from base of apex towards its outer margin. Ventral margin of median lobe enlarged only in apical half, abruptly tapering towards base at the middle of median lobe. Enlarged apical part of ventral margin bears numerous poriferous canals, which are also present on walls of median lobe across its ventral side. Dorsal copulatory sclerites forming two curled blade-like structures of moderate length parallel to each other. Ventral sclerite and spines of internal sac absent. Membranous folds of internal sac at apical third of median lobe around ostium are covered with distinctive scale structures. Left paramere (Fig. 11b) not enlarged, paramere apex with numerous poriferous canals, but without any visible setae. Right paramere (Fig. 11c) greatly elongated, with slightly enlarging apical portion, bearing numerous (>20) long setae, which are approximately one-half the length of the paramere.

Distribution. Known only from high altitudes (1300 m) in the central part of the Unicoi Mountains, Graham County, North Carolina (Fig. 16).

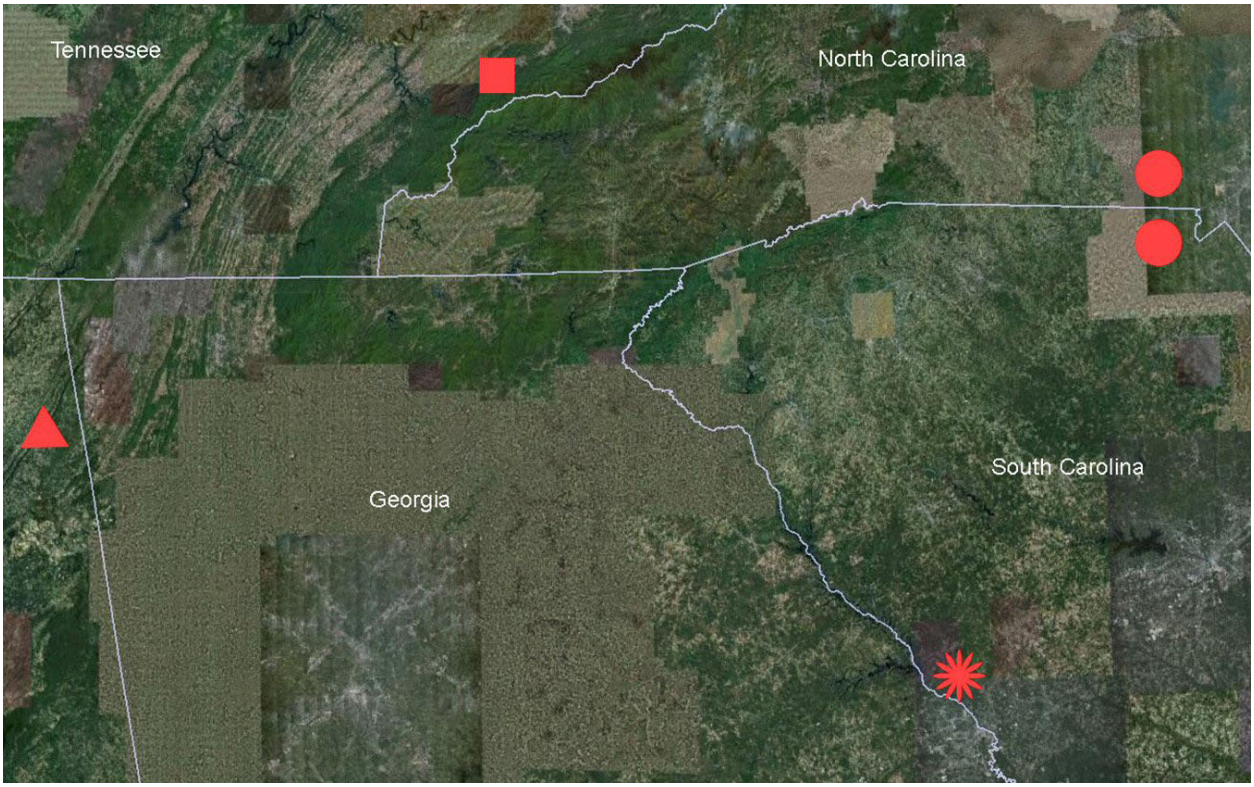

Figure 17. Locality records for the valentinei-group and cornelli-group species. *Anillinus valentinei* – red triangle; *A. smokiensis* – red quadrangle; *A. chandleri* – red star; *A. cornelli* – red circles.

Habitat. A single male was collected by sifting litter under canopy of *Rhododendron* thickets on a flat forested area at the watershed of the ridge. The locality is situated in mixed pine-hardwood forest at relatively high altitude (1300 m).

Differential diagnosis. *Anillinus unicoi* belongs to the moseleyae-group of species (group VII, Sokolov et al. 2004), which is characterized by the smooth disc of pronotum, partly smooth head and by the narrow base of pronotum (WPa/WPp >1.00). It is distinguished from all other species in this group by the form of the median lobe and armature of the internal sac. Externally, it is similar to *A. moseleyae* Sokolov and Carlton, and *A. carltoni* new species, described below. These differences are subtle, but the genitalia of all three species are distinctly different.

Anillinus unicoi occurs sympatrically with one species of *Anillinus* (*A. cherokee* Sokolov and Carlton) and, presumably, one or two species of *Serranillus* Barr. Externally, it can be distinguished from all species of *Serranillus* by the presence of long discal elytral setae. From *A. cherokee* it can be distinguished by the absence of microsculpture on the pronotum, elongated and subdepressed body form and shape of the pronotum.

***Anillinus carltoni* Sokolov, new species**
Figure 2, 7, 12, 16

Holotype. Male labeled /TENNESSEE: Blount Co., GSMNP, Appalachian Tr. ca. 0.5km E Thunderhead Mt., 35°34'3"N 83°42'4"W, 1,510m. Leaf litter sifting. 30 July 2004 A. Tishechkin/ HOLOTYPE, *Anillinus carltoni* Sokolov, des. 2009/. Deposited USNM.

Type locality. U.S.A. Tennessee, Blount County, Great Smoky Mountain National Park, Thunderhead Mountain at 35°34'3"N 83°42'4"W.

Paratypes (22). Eight males and 14 females with the same data as holotype.

Etymology. This species is named for Christopher E. Carlton, Director of the Louisiana State Arthropod Museum, who originally suggested that I direct my efforts on this peculiar group of small, blind carabids, and for his constant and multipurpose help in everyday things during the author's postdoctoral fellowship in the Museum.

Description. Moderate-to large size for genus (ABL range 1.66-1.90 mm, mean 1.79±0.076 mm, n=19). Habitus (Fig. 2) subdepressed, subparallel (WE/ABL 0.37±0.011), head of normal proportions for the genus (WH/WPm 0.75±0.022), pronotum narrow compared to elytra (WPm/WE 0.80±0.018). Body color rufotestaceous, appendages testaceous. Dorsal microsculpture partly effaced. Head with polygonal microsculpture on entire vertex and anterior part of frons with the effaced area between them. Disc and front part of pronotum with effaced microsculpture, base of pronotum with polygonal microsculpture. Elytra with well-developed polygonal microsculpture.

Pronotum (Fig. 7) moderately convex and of normal proportions for genus (WPm/LP 1.26±0.046), with margins rectilinear and strongly constricted posteriad (WPm/WPp 1.42±0.038). Anterior angles weak, very slightly prominent. Posterior angles nearly rectangular (95-100°). Width between posterior angles less than between anterior angles (WPa/WPp 1.08±0.026).

Elytra slightly convex, depressed along suture, of normal length for genus (LE/ABL 0.53±0.020), with traces of 4-5 interneurs. Humeri oblique and effaced. Lateral margins subparallel, slightly divergent in basal half, evenly rounded to apex in apical third, maximal width of elytra at midpoint. Elytra without subapical sinuation. Vestiture of elytra short (lesser than one-third of discal setae).

Prothoracic leg of males with moderately dilated tarsomere 1. Profemur moderately swollen. Metafemora unmodified. Sternum VII of males unmodified.

Median lobe of aedeagus (Fig. 12a) angulate-arcuate and twisted, with apex greatly enlarged, moderately tapering apically and narrowly rounded. Distinctive small fold extending from base of apex towards apex of median lobe. Ventral margin of median lobe greatly enlarged and uneven, bearing numerous poriferous canals, which are also present on walls of median lobe across its ventral side. Dorsal copulatory sclerites forming two curled blade-like structures of moderate length diverging at their base and converging at apices. Ventral sclerite and spines of internal sac absent. Membranous folds around dorsal sclerites are covered with distinctive scale structures. Ostium bears a small field of tiny sclerotized spinules. Left paramere (Fig. 12b) not enlarged, paramere apex with numerous poriferous canals, but without visible setae. Right paramere (Fig. 12c) elongate and enlarged, with subparallel apical portion, bearing numerous long setae that are comparable in length with the apical part of paramere itself.

Distribution. Known only from high altitudes (1500-1600 m) of Thunderhead Mountain, along the state line between Tennessee and North Carolina, within GSMNP (Fig. 16).

Habitat. The type series was collected on the northern slope of the ridge by sifting litter under forest canopy. The locality is situated in northern hardwood forest at relatively high altitudes (1510 m).

Differential diagnosis. *Anillinus carltoni* belongs to the moseleyae-group of species (group VII, Sokolov et al. 2004), which is characterized by the smooth disc of pronotum, partly smoothed head microsculpture and by the narrow base of pronotum (WPa/WPp >1.00).). It is distinguished from all other species in this group by the form of the median lobe and armature of the internal sac. Externally, it is similar to *A. moseleyae* and *A. unicoi*, but is noticeably smaller than either of them. Also the genitalia of all three species are different.

Whether *A. carltoni* occurs sympatrically with any other species of Anillina is unknown. Representatives of *Serranillus*, *A. cieglerae* Sokolov and Carlton, and *A. pusillus* Sokolov and Carlton inhabit altitudes below 1500 m. *Anillinus loweae* Sokolov and Carlton, is known to live at the same altitudes, but is distributed far to the east of Thunderhead Mountain. *Anillinus cherokee* could potentially be sympatric, but it can be distinguished from the latter by the microsculptured pronotum of different proportions.

The key below may be used for the identification of the endogean species with effaced microsculpture on pronotum (including the moseleyae-group species) in the southern Appalachian Mountains (to the South of the French Broad River):

1. Pronotum smooth AND greatly constricted posteriad: ratio WPa/WPp>1.00. ..... **2**
— Pronotum microsculptured OR smooth AND less constricted posteriad: ratio WPa/WPp <1.00 .. .. *other Anillinus species*

2(1). Head totally covered with polygonal microsculpture. Elytral interneurs obvious only mediad discal setae (i.e. between the suture and discal setae). Beetles from low altitudes. Roane Co., Tennessee ..... ***A. sinuaticollis* Jeannel**
— Head with smooth central part of frons. Elytral interneurs obvious also laterad discal setae (i.e between discal setae and the lateral margin of elytra) **3**

3(2). Medium to large-sized beetles (ABL>1.65 mm) from high altitudes. **4**
— Small-sized beetles (ABL<1.60 mm) from low altitudes. Peach Co., Georgia .... ***A. turneri* Jeannel**

4(3). Apex of median lobe noticeably asymmetrical, its upper margin moderately elevated. Unicoi Mountains ..... ***A. unicoi* sp.nov.**
— Apex of median lobe rounded and more or less symmetrical. Great Smoky Mountains **5**

5(4). Larger beetles on average (ABL range 1.80-2.08 mm). Ventral margin of median lobe straight. Clingmans Dome and adjacent areas ..... ***A. moseleyae* Sokolov and Carlton**
— Smaller beetles on average (ABL range 1.66-1.90 mm). Ventral margin of median lobe noticeably angulate. Thunderhead Mountain ..... ***A. carltoni* sp.nov.**

***Anillinus chilhowee* Sokolov, new species**
Figure 3, 8, 13, 16

Holotype. Male labeled /TENNESSEE: Polk Co., Cherokee Natl. Forest, Chilhowee Mt. at 35°7.0'N 84°37.44'W, 715m. 18 Sept 2005. Forest litter. A.K. Tishechkin/ *Anillinus barri* S. and C. A. Tishechkin det./ HOLOTYPE, *Anillinus chilhowee* Sokolov, des. 2009/. The holotype is dissected and bears a plastic rectangle with genitalia mounted in dimethylhydantoin formaldehyde resin. Deposited USNM.

Type locality. U.S.A. Tennessee, Polk County, Cherokee National Forest, Chilhowee Mountain, 35°7.0'N 84°37.44'W.

Etymology. The name of this species is based on the name of the mountain where it occurs.

Description. Small for genus (ABL = 1.64 mm). Habitus (Fig. 3) moderately convex, ovoidal (WE/ABL 0.38), head of normal proportions for the genus (WH/WPm 0.71), pronotum narrow compared to elytra (WPm/WE 0.78). Body color rufobrunneus, appendages testaceous. Dorsal microsculpture well-developed; covering all head, except two paramedial patches without microsculpture on vertex, and all pronotum except medial part of the disc. Elytra with well-developed polygonal microsculpture.

Pronotum (Fig. 8) moderately convex and of normal proportions for genus (WPm/LP 1.26), with margins rectilinear and moderately constricted posteriad (WPm/WPp 1.26). Anterior angles evident, very slightly prominent. Posterior angles obtuse (115°). Width between posterior angles greater than between anterior angles (WPa/WPp 0.92).

Elytra moderately convex, depressed along suture, slightly elongated (LE/ABL 0.58), with traces of 2 interneurs. Humeri rectangular and rounded. Lateral margins subparallel, slightly divergent in basal forth, evenly rounded to apex in apical third, maximal width of elytra at midpoint. Elytra without subapical sinuation. Vestiture of elytra short (lesser than one-third of discal setae).

Prothoracic leg of males with moderately dilated tarsomere 1. Profemur moderately swollen. Metafemora unmodified. Sternum VII of males unmodified.

Median lobe of aedeagus (Fig. 13a) evenly arcuate and twisted, with apex greatly enlarged and widely rounded. Ventral margin of median lobe enlarged bearing numerous poriferous canals, which are also present on walls of median lobe across its lower half. Dorsal copulatory sclerites forming a short, curled blade-like structure with long basal prolongations. Ventral sclerite and spines of internal sac absent. Left paramere (Fig. 13b) not enlarged, paramere apex with four poriferous canals, bearing one long (more distal) and one short setae in apical position. Right paramere (Fig. 13c) elongate, with subparallel apical portion, bearing four long setae that are slightly shorter than the apical part of paramere.

Distribution. Known only from the Chilhowee Mountain, Polk County, Tennessee (Fig. 16).

Habitat. A single male was collected by sifting forest litter.

Differential diagnosis. *Anillinus chilhowee* belongs to the loweae-group of species (Sokolov and Carlton 2010), which is characterized by two paramedial patches of smoothed microsculpture on the head. It is distinguished from all other species in this group by the form of the median lobe and armature of the internal sac, and especially by the smaller size.

Anillinus chilhowee occurs sympatrically with one or two species of *Anillinus*, and undescribed species from the langdoni-group (Sokolov et al. 2007), and, possibly, *A. steevesi* Barr. It is also presumably sympatric with one or two species of *Serranillus*. Externally, it can be distinguished from all species of *Serranillus* by the presence of long discal elytral setae. From the species of the langdoni-group *A. chilhowee* can be distinguished by the presence of areas with smoothed microsculpture on the head and pronotum, and from *A. steevesi*, *A. chilhowee* can be distinguished by the smaller size (1.64 versus 1.67-1.92 mm of *A. steevesi*) and form of the median lobe.

The key to the loweae-group species (Sokolov and Carlton 2010) is modified from couplet 8 to accommodate the *A. chilhowee*:

8. Male median lobe with dorsal sclerites very long, forming filament-like structures with greatly elongated basal processes. Setae of right paramere long, much longer than the length of paramere itself. Beetles from the limestone area at the eastern part of Rich Mountain ridge in Great Smoky Mountains National Park ..... ***A. gimmeli* Sokolov and Carlton**

— Male median lobe with dorsal sclerites shorter, forming blade-like structures. Setae of right paramere shorter than the length of paramere itself **8A**

8A(8). Median lobe with strongly enlarged and symmetrically rounded apex, and without a patch of spines near apical orifice. Beetles from Chilhowee Mountain (Polk County, TN) to the south of the Hiwassee River ..... ***A. chilhowee* sp.nov.**

— Apex of median lobe EITHER with sinuation on dorsal side, OR noticeably asymmetrical, OR not enlarged (its width much lesser than half width of median lobe itself). Beetles from eastern portions of southern Appalachian Mountains to the north and east of the Hiwassee River .... **9** (follow the key)

***Anillinus smokiensis* Sokolov, new species**
Figure 4, 9, 14, 17

Holotype. Male labeled /TENNESSEE: Blount Co., GSMNP, Gregory cave, 35°36.59'N 83°48.35'W, 605m. Litter sifting at entrance. 14 April 2006 A.K. Tishechkin / HOLOTYPE, *Anillinus smokiensis* Sokolov, des. 2009/. The holotype is dissected and bears a plastic rectangle with genitalia mounted in dimethylhydantoin formaldehyde resin. Deposited USNM.

Type locality. U.S.A. Tennessee, Blount County, Great Smoky Mountain National Park, southern slopes of Rich Mountain ridge, Gregory Cave at 35°36.59'N 83°48.35'W.

Paratypes (7). One male with the same data as holotype. Two males and four females labeled /TENNESSEE: Blount Co., GSMNP, Gregory cave, 35°36.59'N 83°48.35'W. Litter sifting at entrance. 28.VII. 2004 V.Bayless C.Carlton A. Tishechkin/ and one male and one female from those bear labels /Molecular voucher # 93/ and /Molecular voucher # 94/, respectively.

Etymology. The name of this species is a Latinized adjective based on the name of the mountain region in which this species occurs.

Description. Large-sized for genus (ABL range 1.86-1.93 mm, mean 1.90±0.029 mm, n=7). Habitus (Fig. 4) moderately convex, subparallel (WE/ABL 0.37±0.012), head of normal proportions for the genus (WH/WPm 0.74±0.019), pronotum narrow compared to elytra (WPm/WE 0.81±0.017). Body color rufotestaceous, appendages testaceous. Dorsal microsculpture mostly effaced, polygonal microsculpture present on a small triangular area at middle of vertex and in frontal furrows on head, and also on base of pronotum; most parts of vertex, lateral parts of head, disc and front part of pronotum with effaced microsculpture. Elytra with well-developed polygonal microsculpture.

Pronotum (Fig. 9) moderately convex and comparatively transverse (WPm/LP 1.33±0.025), with margins rectilinear and moderately constricted posteriad (WPm/WPp 1.31±0.023). Anterior angles indistinct, only slightly prominent. Posterior angles obtuse (100-120°). Width between posterior angles only slightly greater than between anterior angles (WPa/WPp 0.97±0.020).

Elytra moderately convex, slightly depressed along suture, of normal length for genus (LE/ABL 0.56±0.009), with traces of 3-4 interneurs. Humeri rectangular, moderately rounded. Margins subparallel, slightly divergent in basal forth, evenly rounded to apex in apical third, maximal width of elytra at midpoint. Elytra without subapical sinuation. Vestiture of elytra short (lesser than one-third of discal setae).

Prothoracic leg of males with moderately dilated tarsomere 1. Profemur moderately swollen. Metafemora unmodified. Sternum VII of males unmodified.

Median lobe of aedeagus (Fig. 14a) evenly arcuate and twisted, with pointed apex slightly tapering and shortly rounded at tip. The wall of median lobe forming evident incision and characteristic beak like fold above the apex. Ventral margin of median lobe not enlarged, bearing numerous poriferous canals scattered across the ventral side of the lobe. Dorsal copulatory sclerites forming a curled blade-like structure with characteristic basal prolongations. Ventral sclerite of internal sac absent. Spines represented by three groups: 7-8 small spines are nearby the apical part of dorsal sclerites, group of about 20 long spines occupy the space near apex of median lobe, and two spines above the preceding group of spines. Also a small band with minute sclerotized setose structures extends above the end of dorsal sclerites in ostial area. Left paramere (Fig. 14b) not enlarged, paramere apex with four poriferous canals, but bearing only two small setae in distal positions. Right paramere (Fig. 14c) short, with subparallel apical portion, bearing four long setae that are longer than the paramere itself.

Distribution. Known only from Blount County, TN, where it was collected in a cave on the southern slopes of Rich Mountain ridge, within GSMNP (Fig. 17).

Habitat. The series of specimens was collected by sifting a thick, wet layer of leaves along the dry bed of an ephemeral stream near the entrance of the cave. The locality is situated in a limestone area in pine-mixed hardwood forest at relatively low altitude (600 m).

Differential diagnosis. *Anillinus smokiensis* belongs to the troglobitic valentinei-group of species. In addition to *A. valentinei* (Jeanell), the type species of the older genus *Troglanillus* Jeannel, which was synonymized with *Anillinus* by Barr (Barr 1995), the group includes several undescribed species from the caves of Alabama. Besides the habitat, this group is characterized by the combination of comparatively large size, mostly reduced microsculpture on foreparts, and the presence of rows of large spines in the internal sac of median lobe. *Anillinus smokiensis* is distinguished from *A. valentinei* by the form of the median lobe and armature of the internal sac (cf. Jeannel 1963: p.147, fig. 2), and especially by the smaller size (cf. 2.3-2.7 mm of *A. valentinei*).

Anillinus smokiensis apparently is the only cavernicolous anilline species in the Smokies. Many species may be found incidentally in caves, especially near entrances, but are also found in epigean leaf litter not associated with caves. Externally, *A. smokiensis* can be distinguished from all species of *Serranillus* by the presence of long discal elytral setae. From *Anillinus* species inhabiting low and mid elevations of GSMNP, *A. smokiensis* can be distinguished by the effaced microsculpture of the pronotum.

***Anillinus chandleri* Sokolov, new species**
Figure 5, 10, 15, 17

Holotype. Male labeled /USA: SC: Edge. Co., Ft. Sumter Nat. For. Jct. Rds. 235 and 139 / VII-8-1987 RM Reeves, sift. Forest litter/ *Anillinus sp*. det. Bell/ HOLOTYPE, *Anillinus chandleri* Sokolov, des. 2009/. The holotype is dissected and bears a plastic rectangle with genitalia mounted in dimethylhydantoin formaldehyde resin. Deposited USNM.

Type locality. U.S.A. South Carolina, Edgefield County, Sumter National Forest, 33°37.20'N 82°5.55'W.

Etymology. This species is named for Donald S. Chandler, to honor his contributions to knowledge of the litter fauna of the eastern United States of America.

Description. Large for genus (ABL = 2.22 mm). Habitus (Fig. 5) moderately convex, subparallel (WE/ABL 0.38), head of normal proportions for the genus (WH/WPm 0.70), pronotum narrow compared to elytra (WPm/WE 0.81). Body color rufotestaceous, appendages testaceous. Dorsal microsculpture mostly effaced, polygonal meshes present only on a small triangular area at the middle of vertex; other parts of head and pronotum with effaced microsculpture. Elytra with well-developed polygonal microsculpture.

Pronotum (Fig. 9) moderately convex and of normal proportions for genus (WPm/LP 1.30), with margins rectilinear and narrowly constricted posteriad (WPm/WPp 1.23). Anterior angles evident, very slightly prominent. Posterior angles obtuse (115°). Width between posterior angles much greater than between anterior angles (WPa/WPp 0.86).

Elytra moderately convex, depressed along suture, slightly elongated (LE/ABL 0.54), with traces of 4 interneurs. Humeri rectangular and rounded. Margins subparallel, slightly divergent in basal forth, evenly rounded to apex in apical third, maximal width of elytra at midpoint. Elytra without subapical sinuation. Vestiture of elytra short (lesser than one-third of discal setae).

Prothoracic leg of males with moderately dilated tarsomere 1. Profemur moderately swollen. Metafemora unmodified. Sternum VII of males unmodified.

Median lobe of aedeagus (Fig. 15a) evenly arcuate and slightly twisted, with small rounded apex. Ventral margin of median lobe not enlarged with only few poriferous canals. Dorsal copulatory sclerites forming an elongate, curled filament-like structure with a wide base. Most part of distal sclerites concealed by two rows of long spines occupying the apical half of the median lobe and directed ventrally. Also a group of three small spines, directed dorsally, is located beneath the long spines, ahead the base of dorsal sclerites. Ventral sclerite of internal sac absent. Left paramere (Fig. 15b) not enlarged, paramere apex with three poriferous canals, but bearing only one small seta in distal position. Right paramere (Fig. 15c) short, with subparallel apical portion, bearing four long setae that are longer than the paramere itself.

Distribution. Known only from Sumter National Forest, Edgefield County, South Carolina near the Georgia border (Fig. 17).

Habitat. A single male was collected by sifting forest litter.

Differential diagnosis. Based on external characters, *A. chandleri* belongs to the valentinei-group of species characterized by effaced microsculpture on the foreparts and presence of a spine cluster on the inner sac. Because the Anillina fauna of the Piedmont of the Carolinas and Virginia is still poorly known, the exact position of the species within the genus can be determined only after thorough investigations of the region. Probably, the closest known relative of *A. chandleri* is *A. cornelli* Sokolov and Carlton, which also occurs in the Piedmont area along the North Carolina/South Carolina border. Both species share the

same microsculpture pattern, but differ greatly in the internal sac architecture. In *A. chandleri* , the dorsal sclerites are hidden by many long spines, whereas in *A. cornelli* the spines are absent and the dorsal sclerites are clearly visible. Below those, three apically sclerotized tubercles which might represent homologues of the spines of *A. chandleri*, are located. Also, *A. chandleri* (2.22 mm in length) is comparatively larger than *A. cornelli* (1.61-2.08 mm).

Anillinus chandleri is apparently allopatric with respect to other described species of Anillina. The nearest records for other species are known from about 140 km to the north (*A. loweae*, *A. cherokee* and *A. cornelli*) and to the west (*A. turneri*).

Discussion

The discovery of these five new species allows us to suggest some hypotheses about different aspects of taxonomy and evolution of *Anillinus* spp. in the southern Appalachians.

Two species, *A. chandleri* and *A. smokiensis*, that share distinctive spine clusters on the internal sac of the aedeagus are similar to the troglobitic *A. valentinei*. While the apparent cavernicolous *A. smokiensis* may share common ancestry with *A. valentinei*, this is probably not the case for the litter dwelling *A. chandleri*. *Anillinus chandleri* and *A. valentinei* inhabit different geographical regions (Piedmont and Appalachian Mountains respectively) and niches (litter versus caves). As a rule *Anillinus* spp. from the same lineage are allopatric and occupy the same types of habitats. Notably, *A. chandleri* shares external similarity, as well as geographical and ecological characteristics with *A. cornelli* (Fig. 17). Despite the aedeagal differences, *A. chandleri* probably shares a more recent common ancestor with *A. cornelli* than with *A. valentinei*. Sokolov et al. (2004) have shown, that the spines in the internal sac of the aedeagus may appear independently in different lineages of *Anillinus* and are not reliable indicators of taxa above the species level.

The discovery of *A. chilhowee*, a member of the loweae-group is consistent with the isolated position of the Chilhowee Mountain ridge, bordered by the Ocoee River on the south and the Hiwassee River at the north. Chilhowee Mountain is actually a topographic prolongation of Starr Mountain, from the northern slopes of which another species of the loweae-group, *A. juliae* Sokolov and Carlton, was described recently (Sokolov and Carlton 2010). The presumed natural boundary between these congeners is the Hiwassee River valley. Thus, *A. chilhowee* may be prove to be a sister species to *A. juliae* (Fig. 16).

The discoveries of *A. carltoni* and *A. unicoi* are the most important contributions of this paper in terms of the progress in our knowledge of species composition of the genus in a regional context, and possible connections of these species with the *Anillinus* fauna in other regions. Together with *A. moseleyae*, these two new species form a group of high altitude species occupying the crests of ridges and mountain tops. Their external morphology suggests mostly an endogean way of life (sensu Sokolov et al. 2004), so they are only occasionally collected in litter, possibly depending on the season and preceding weather conditions. The ranges of *A. carltoni* and *A. unicoi* are adjacent, with a gap of ~30 km, along the crests of the Unicoi and Great Smoky Mountains, respectively (Fig. 16). Taking into account other lineages of *Anillinus,* both mountain systems are inhabited by at least three lineages of *Anillinus*: (i) the low- and mid-altitude langdoni-group species that are absent from fir-spruce forest communities, (ii) low- to high-altitude loweae-group species, inhabiting all forest communities, and (iii) high-altitude moseleyae-group species, inhabiting forest communities along the crests of the mountains. In GSMNP, one more lineage represented by the cavernicolous species *A. smokiensis* can be added. The proposed composition of species may be used as a guide for anilline collecting efforts in areas of the southern Appalachians where altitudes exceed 1000m. Regions north of the French Broad River lack endogean species of *Anillinus*, at least based on present knowledge, but they are inhabited by the representatives of the loweae- and langdoni-groups. The Piedmont and adjacent lowlands possess yet another composition of *Anillinus* species.

Also noteworthy is the fact that some details of aedeagal morphology of *A. unicoi* are similar to those of *A. aleyae* Sokolov and Watrous (Sokolov and Watrous 2008: p. 540, fig. 2) from the Ozark Mountains, far to the west. These characters include the distinctive shape of the apical part of the median lobe: the shape of its tip and the presence of a small fold nearby. The latter is lacking in all other *Anillinus* species. If these similarities are not the result of convergence, and indicate common ancestry, then this would support a hypothesis of a southern track of anilline ancestral distribution from the southern Appalachian Mountains to the Ouachita Highlands and Ozark Plateau (Sokolov and Watrous 2008). This idea was

first proposed for the diversification pattern of staphylinids *Arianops* ssp. inhabiting the Interior Highlands (Carlton and Cox 1990), though they specifically excluded the Ozarks, due to its independent origin from the Ouachitas.

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