Andrognathus hoffmani, n. sp., A Second Species in the Genus and the First Species of Andrognathidae from México (Diplopoda, Platydesmida, Andrognathidae)

William A. Shear[1]

Department of Biology
Hampden-Sydney College
Hampden-Sydney, Virginia 23943

Paul E. Marek[2]

Department of Biological Sciences
East Carolina University
Greenville, North Carolina 27858

Abstract

Andrognathus hoffmani, n. sp., is described from near Monterrey, Nuevo León, México, and is the second species of the genus to be discovered; *A. corticarius* Cope was named in 1869. Anatomical details of both species revealed through scanning electron microscopy are discussed. Contrary to the assertion of Gardner (1975) that the form of the gonopods in the Andrognathidae is of no taxonomic utility, we found striking differences between the two species discussed here, and differences between two populations of nominal *A. corticarius*. It is possible that *A. corticarius* as presently understood represents a complex of cryptic species.

Key words: Andrognathidae, Andrognathus, Brachycybe, cryptic species, Platydesmida.

Introduction

A surprising number of milliped genera, and even families, are monotypic, containing but a single species. In recent years, increased interest in diplopods and more thorough collecting in many parts of North America have revealed additional species within several of these taxa (e.g., Branneriidae, Shear 2003a; Apterouridae, Shear 2003b). It is a distinct pleasure to add a second species to yet another milliped genus that has remained monotypic for more than a century and a quarter.

The milliped *Andrognathus corticarius* Cope, 1869 was described as the type of a new genus and family, and then, as now, was one of the most distinctive and unusual species of North American millipeds. A member of the Order Platydesmida, this species differs from all others in the order in the peculiar modifications of its tergites, its long, narrow body (about 40 times as long as wide in adults), and its unexpectedly broad distribution. Specimens have been recorded from Virginia west to Indiana, and from central North Carolina south to northern Florida (Gardner 1975, Hoffman 1999), but detailed distribution maps have not been published, nor have populations from this wide area been carefully examined. Perhaps the distinctive body form of *A. corticarius*, as well as its small size, inhibited past investigators from looking closely and caused them to assume that all populations were conspecific.

Andrognathus corticarius went substantively unmentioned in the literature for 60 years after its initial description in 1869, until a brief mention and inclusion in a key by Cook and Loomis (1928), and the publication of a few additional records by Loomis (1936). Any new descriptive details, however brief, had to wait another 47 years until Gardner (1975) published a synopsis of the North American Andrognathidae, but he focused mostly on the rich and diverse fauna of the western United States. Hoffman (1980) presented a

[1] To whom correspondence should be addressed; wshear@hsc.edu.

[2] Present address: University of Arizona, Center for Insect Science, Department of Entomology, Forbes Building, Tucson, AZ 85721, pmarek@email.arizona.edu.

Pp. 155-164, in S. M. Roble and J. C. Mitchell (eds.). 2009. A Lifetime of Contributions to Myriapodology and the Natural History of Virginia: A Festschrift in Honor of Richard L. Hoffman's 80th Birthday. Virginia Museum of Natural History Special Publication No. 16, Martinsville, VA.

revised classification of the family, with a subfamily Androgna thinae for *Androgna thus* alone, apposed to Dolisteninae and Bazillozoniinae. Shelley et al. (2005) reviewed *Brachycybe*—long considered an androgna thid genus—and questioned whether or not Androgna thidae might be divided, probably leaving *A. corticarius* as the sole species under the original family name, with *Brachycybe* and a few related genera placed in the new family Bazillozoniidae. Despite Hoffman's (1980) assurances that the problems in the Androgna thidae were "innocuous" and that "a good revision of the order should not be difficult to achieve", no specialist has stepped forward to accomplish the task.

In 2007, 138 years after the description of *A. corticarius*, Casey Richart of Olympia, Washington, sent WAS a small collection of millipeds that he made in the vicinity of Monterrey, México. Much to our surprise, a substantial sample of *Androgna thus* was included, and closer examination showed that these specimens belonged to an undescribed species. We are delighted to dedicate this significant new species to Richard L. Hoffman on the occasion of his eightieth birthday, and in recognition of his monumental contributions to the study of the Diplopoda.

Family Androgna thidae Cope, 1869

Hoffman (1980) divided Androgna thidae into three subfamilies, Androgna thinae, Dolisteninae, and Bazillozoniinae. *Androgna thus corticarius* was listed as the sole species of Androgna thinae; Hoffman cited the structure of the fifth diplosegment as the crucial character setting off this species from the rest of the family. Certainly, in comparison to other genera in the family and even the order, this character is an apomorphy. Except for the tribe Mitocybeini (Dolisteninae), new at the time, no additional diagnoses were presented. By 1999, he evidently had become unsure of this arrangement, and presented a list of American androgna thid genera in alphabetical order. Curiously, Hoffman (1980, 1999) makes little explicit reference to the posthumously published monograph of the Colobognatha by Attems (1951). This paper is in Gardner's (1975) bibliography, but goes unmentioned in the text. Despite many errors of fact and interpretation, very likely due to the incomplete nature of the manuscript at Attems' death, this monograph must be the starting point for any further work on platydesmids.

It is particularly interesting that Shelley et al. (2005) detected five geographic clusters of samples of the androgna thid *Brachycybe lecontii* Wood (two of these they referred to as "point" localities—single or a few closely clustered samples from a very small area). While suggesting that these clusters represented genetically isolated populations, they did not attempt to assess differences between them (morphological or genetic); the clusters were defined on a geographic basis alone. The distribution of *A. corticarius* has never been mapped in detail. One questions if similar geographic clusters, potentially representing genetically distinct lineages,

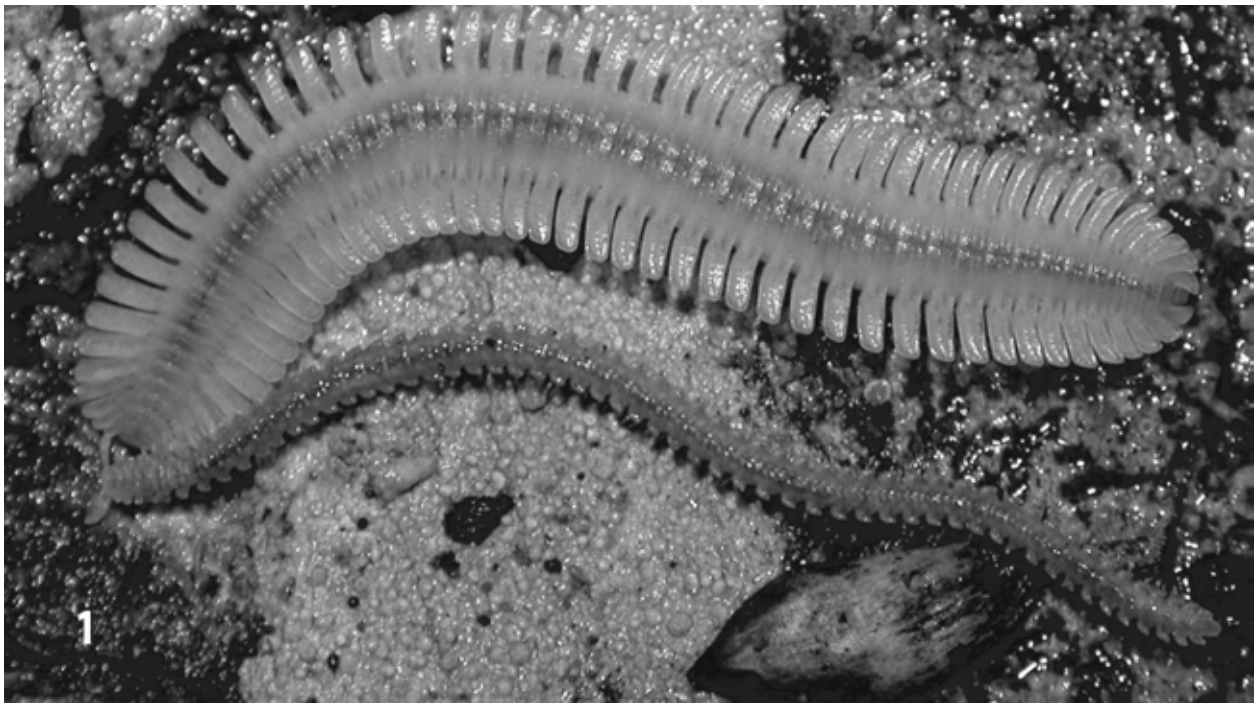


Fig. 1. Androgna thus corticarius (below) and ?confamilial Brachycybe lecontii in nature (photographs by P. Marek).

occur in this genus, and if undetected cryptic species may be present in either *Andrognathus* or *Brachycybe*.

Little attention has been paid to the gonopods of the platydesmids as possible sources of taxonomic characters. Cook and Loomis (1928) offered a synopsis of the colobognath millipeds of North America, but illustrated gonopods for only one species. Gardner (1975) stated flatly that the gonopods of platydesmids were of no use taxonomically and provided illustrations only for a single species of *Brachycybe*. Shelley et al. (2005) also illustrated *Brachycybe* gonopods for one species, and opined that the peculiarly modified setae of the anterior gonopods might be diagnostic of *Brachycybe* (these setae actually occur in a fairly wide range of platydesmidans; see Attems 1951). Working with other colobognath orders, Shelley (i.e., 1995) has found the gonopods rich in species-level characters. We have examined the gonopods of a few species of colobognaths, including platydesmidans, using the scanning electron microscope, and at high magnification under the compound microscope with Nomarski differential interference contrast. We found significant differences between nominal species and also suspect that if samples from various localities occupied by species now thought to have very wide distributions are so examined, cryptic species may be discovered (Bickford et al. 2007, Pfenninger and Schwenk 2007).

Andrognathus Cope, 1869

Until now, the genus has included only the single species *A. corticarius*. The second species described below mandates a few changes in the generic diagnosis presented by Gardner (1975), especially since the modifications of the fifth diplosegment in *A. hoffmani*, n. sp. are not nearly as striking as they are in *A. corticarius*. However, the genus retains several unique characters, including the complex ornament of the tergites, the presence of ozostyles, and the lack of a hypoproct. These characters support the suggestion of Shelley et al. (2005) that Andrognathidae may be a family containing only the type genus.

Emended diagnosis: Small, narrow andrognathids, mature individuals with 45-70 segments (Fig. 1). Head (Figs. 3, 12) broadly rounded, mentum slightly projecting anteriorly, without teeth. Gnathochilarium typical of order. Collum with or without short paranota; segments 2-4 with distinct paranota projecting laterally or anteriorly (Figs. 2, 11). All segments from fifth to penultimate with pronounced peritremata; ozopore openings distinctly rimmed. Pleurotergites dimorphic, fifth pleurotergite paranota bilobed (Fig. 4) or not, if so with peritrematic lobe projecting anteriorly, if not bilobed (Fig. 13), paranotum and peritreme project anteriorly; all subsequent pleurotergites with undivided paranota arising from anterior part of metazonite, projecting laterally or posteriorly, peritremata posteriorly directed. Prozonites with sculpture of small, rounded, flat tubercles; metazonites with this sculpture variable between species, densely set with short, stout, curved setae (Fig. 17). On pleura, sculpture becomes smaller, tubercles acute-triangular. Sternites narrow, leg coxae touching or scarcely separated (Figs. 3, 12), sternites with sculpture of small, acute tubercles raised posteriorly, with tuberculate knobs anterior to and between leg coxae (Fig. 7). All leg coxae from third pair posterior with prominent, eversible coxal glands (Fig. 12). Legless diplosegments anterior to paraproct variable in number; one to three in mature animals, lacking sterna, pleurotergites overlapping in midline (Fig. 5). Epiproct (ultimate segment) cylindrical, without posterior dorsal elongation; hypoproct (ventral preanal scale) absent, presumably fused with epiproct; paraprocts semihemispherical (Figs. 5, 14). Anterior gonopods with six postcoxal podomeres, second podomere with anteriorly-projecting triangular apophyses, distalmost podomere forming sheath or guide for posterior gonopod stylus; posterior gonopod with six postcoxal segments, distalmost forming long stylus, form of which varies between species (Figs. 7, 8-10, 18, 19).

Included species: *Andrognathus corticarius* Cope, *A. hoffmani*, n. sp.

Distribution: United States from Indiana to western Virginia and south to northern Florida; Gardner (1975) cites the states of Alabama, Florida, Georgia, Indiana, Kentucky, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia for *A. corticarius*; vicinity of Monterrey, Nuevo León, México (*A. hoffmani*).

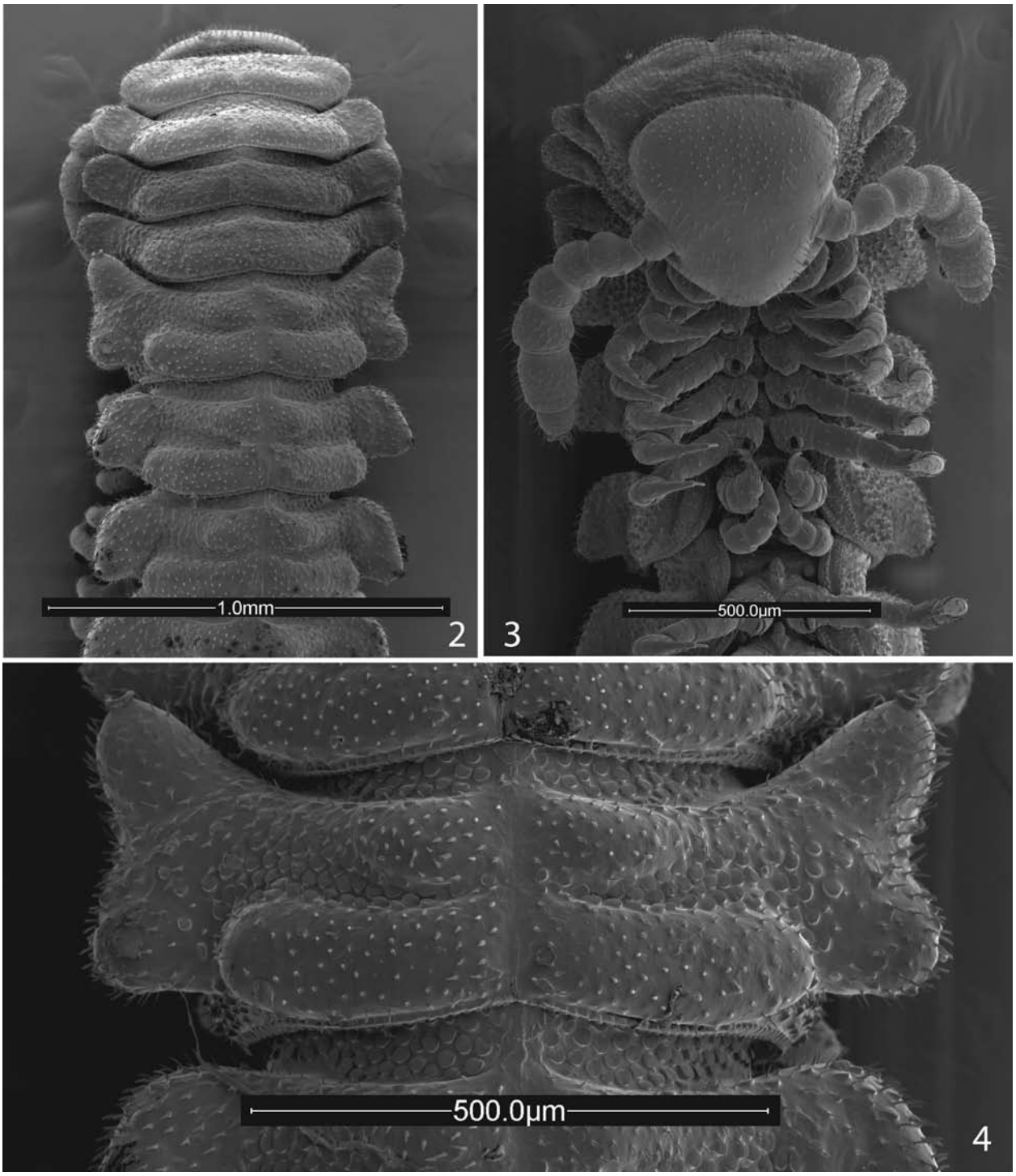
Andrognathus corticarius Cope, 1869

Figs. 1-10

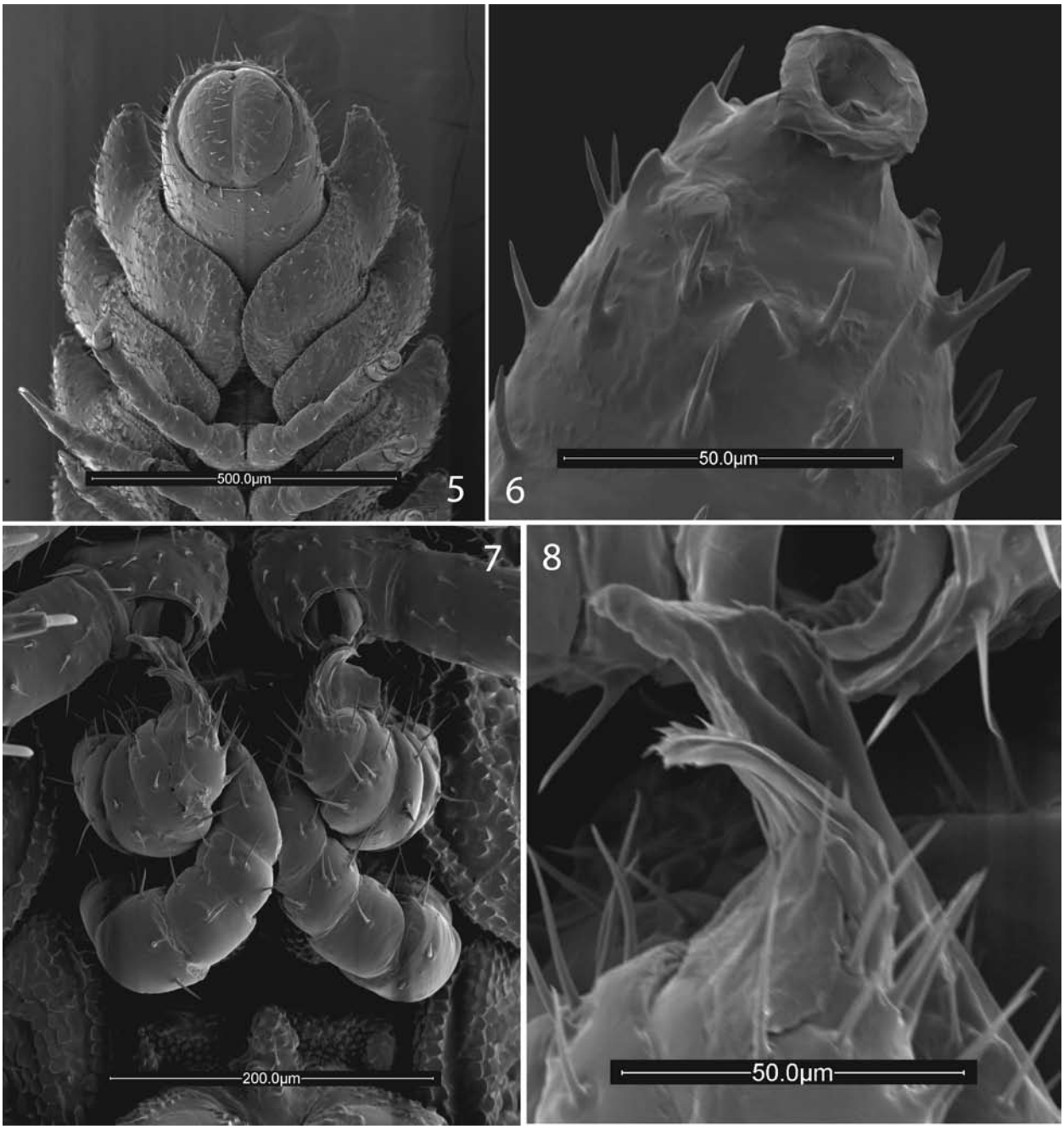
Andrognathus corticarius Cope, 1869. p. 187; Cook and Loomis, 1928, p. 19; Loomis, 1936, p. 364; Gardner, 1975, p. 15; Hoffman, 1999, p. 185.

Type locality: Montgomery Co, Virginia; Hoffman (1999) says "probably at Yellow Sulphur Springs, near Ellett." The type specimen or specimens are lost.

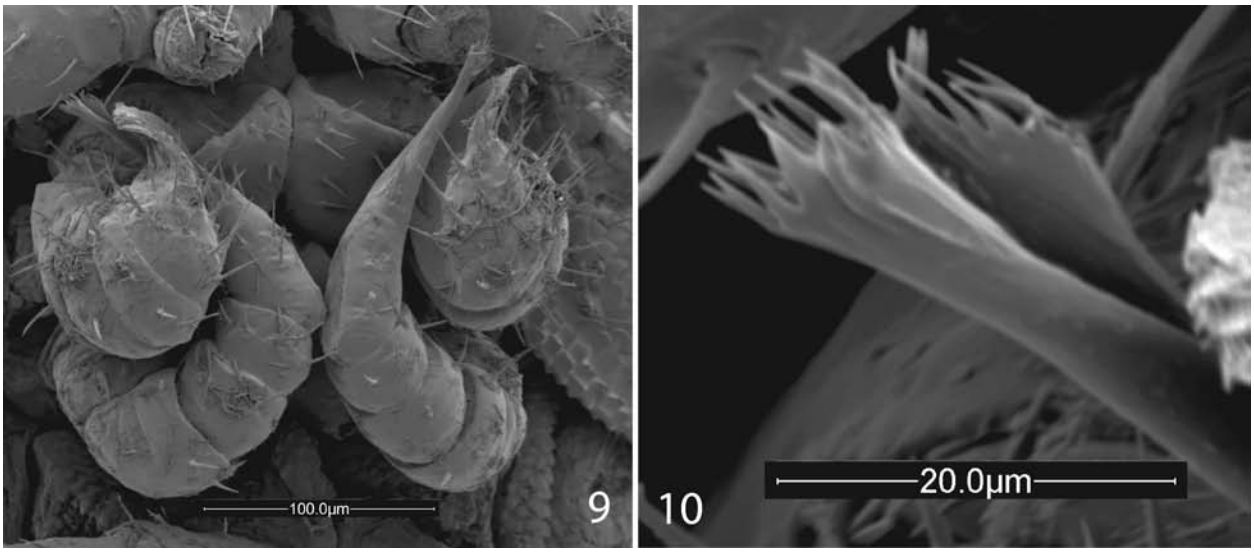
Notes: Gardner (1975) provided a modern and complete description of this species, except for the total lack of mention of the gonopods, illustrated here. He reported locality records by state (see above) and county only; the species occurs from Indiana and Kentucky east to western Virginia and south to northern Florida. However, Gardner (1975) looked only at specimens from the collection of R. L. Hoffman (now in the Virginia Museum of Natural History); *A. corticarius* is well-represented in other public collections, so



Figs. 2-4. *Androgнathus corticarius* from South Carolina. 2. Female, dorsal view of anterior end; 3. Male, ventral view of anterior end; 4. Female, dorsal view of segment five.



Figs. 5-8. *Andrognathus corticarius* from South Carolina. 5. Male, ventral view of posterior end; 6. Right ozopore of segment 5, dorsal view; 7. Gonopods, ventral view; 8. Tips of gonopods, ventral view.



Figs. 9, 10. *Andrognathus corticarius* from Tennessee. 9. Gonopods, ventral view; 10. Tips of gonopods, ventral view.

Gardner's list of counties is incomplete. We examined in detail specimens from only two localities: Great Smoky Mountains National Park in Tennessee, and Sumter National Forest in South Carolina. While the somatic characters of these two populations appear virtually identical, the gonopods differ in a number of details. The posterior gonopods of the Tennessee male are distinctly narrower distally and have a different termination (Fig. 8) compared to the broader posterior gonopods of the South Carolina male (Fig 10.). The median lobes of the anterior gonopod prefemora are longer and more acute in the Tennessee male than in the one from South Carolina (Figs. 7, 9). However, these differences are slight when compared with those separating *A. hoffmani* (Figs. 18, 19) from both populations. Without examining many more individuals of putative *A. corticarius*, we do not know if the differences between the Tennessee and South Carolina specimens represent a range of variation, or if more than one species is involved. Despite these differences, for the time being, we consider both representative of *A. corticarius*, but the situation certainly invites more intensive inquiry. The gonopods of the South Carolina male are further illustrated in Figures 9 and 10.

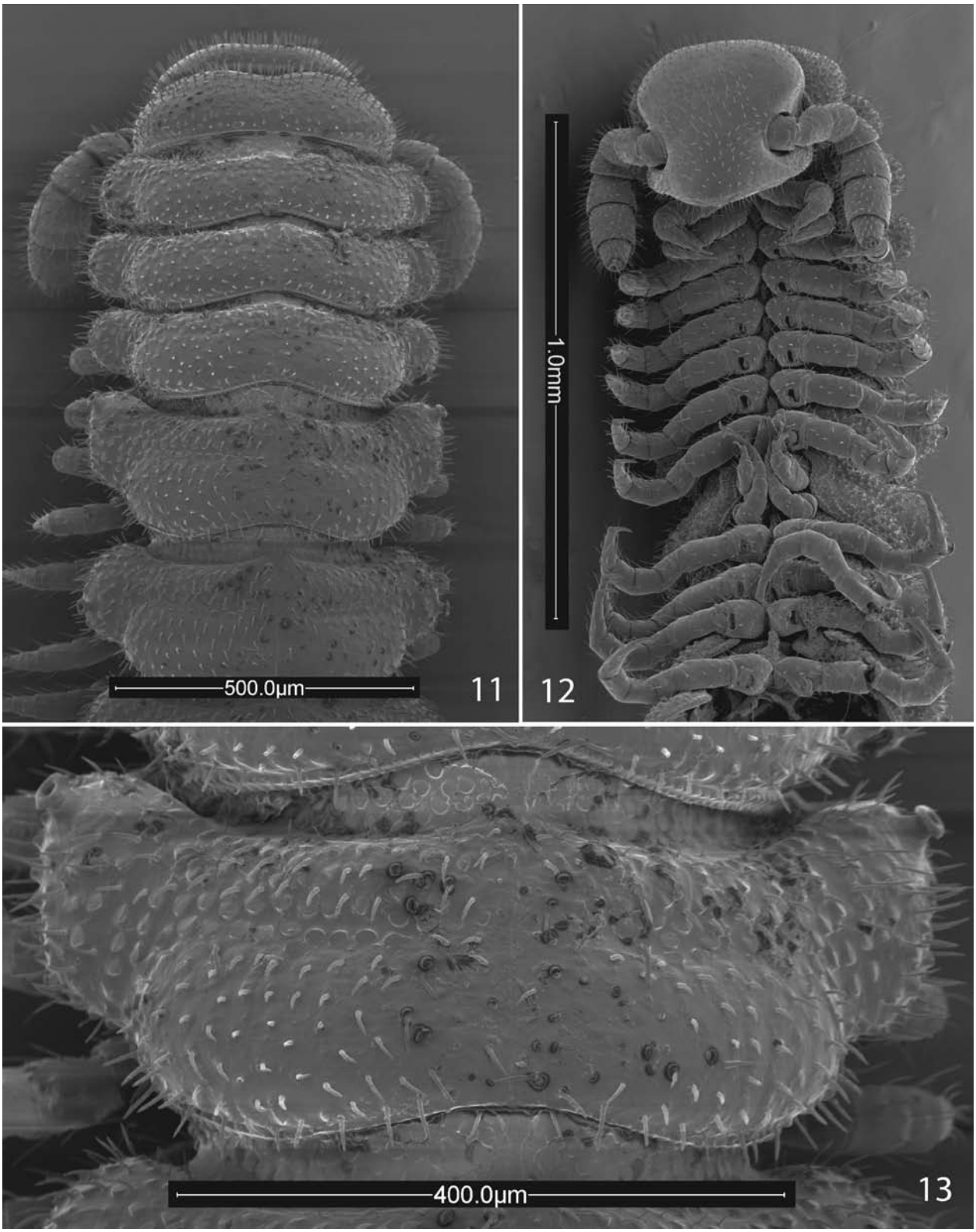
Andrognathus hoffmani, n. sp.

Figs. 11-19

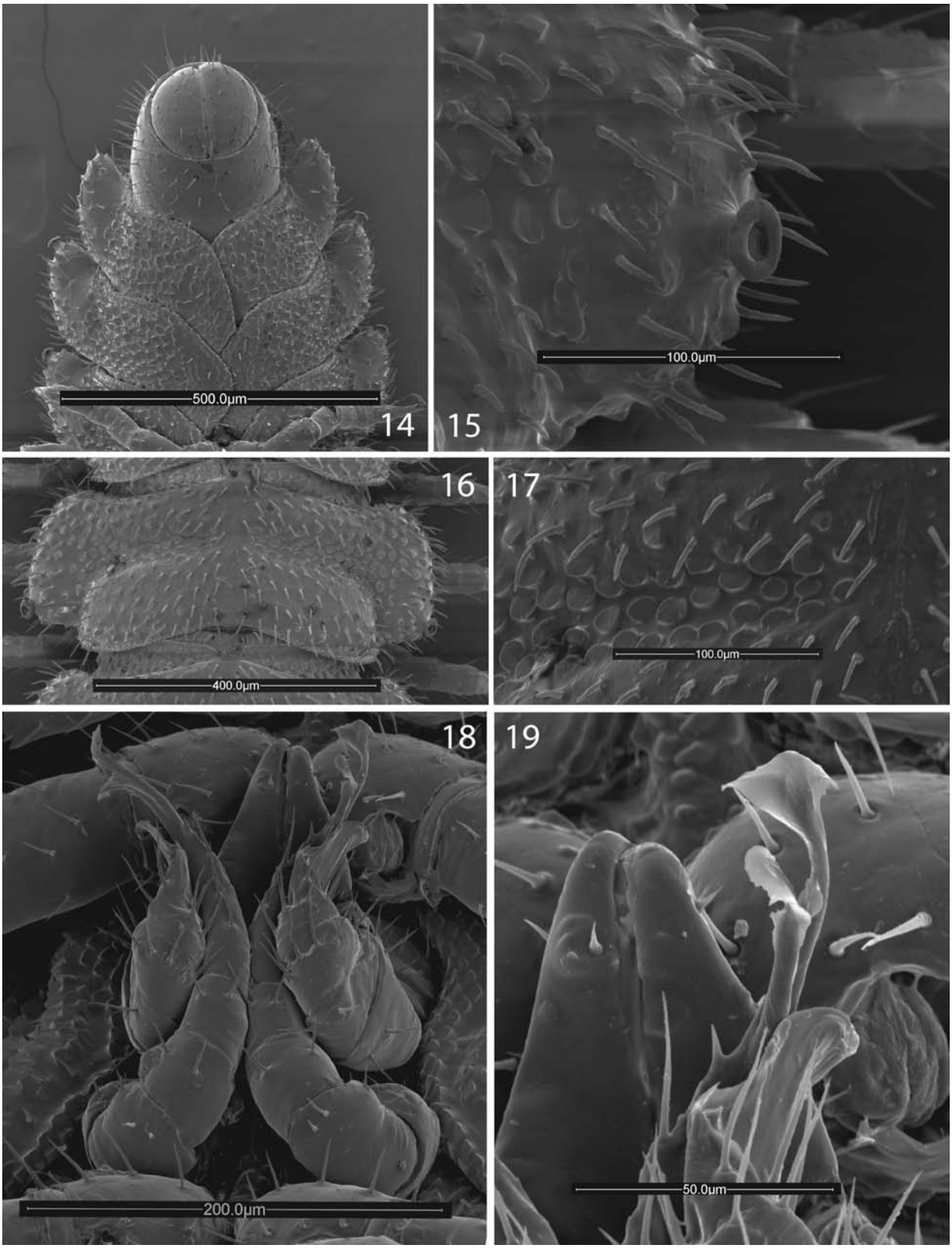
Types: Male holotype (VMNH), three male and four female paratypes (VMNH, Field Museum of Natural History, California Academy of Sciences) from 10 km west of Dieciocho de Marzo on a gravel road, east slope of Cerro el Potosí, Nuevo León, México, 3000 m elev., N24.869°, W-100.217°, collected 9 November 2005 by Casey Richart.

Diagnosis: Distinct from *A. corticarius*, the only other known species in the genus in the form of pleurotergite 5 (Fig. 13) which is not bilobed in *A. hoffmani*; subsequent metaterga in *A. corticarius* are distinctly bipartite, with the paranota arising entirely from the anterior part, while in *A. hoffmani* the paranota arise at least partly from the posterior part and the metatergal anterior lobes are partly suppressed (Fig. 16). The posterior gonopod terminations in the two species are likewise entirely distinct.

Description of male holotype: With the characters of the genus, and: 68 trunk segments (count includes collum, one legless penultimate segment, and epiproct). Approximate length 20 mm, width at midbody 0.6 mm. Head rounded, densely setose, slightly triangular at mentum, labrum without evident teeth. Antennae with 6th segment longest, approximately 1.5 times as long as wide. Collum not covering head, posterior margin straight, anterior margin with slight median embayment. Segments 2-4 with prozonite, metazonite distinct, short paranota arise from metazonites, ozopores absent (Fig. 11). Segment 5 (Fig. 13) abruptly longer, metazonite with slight transverse depression, posterior margin with shallow median embayment; paranota approximately twice length of those of segment 4, directed slightly anteriorly, peritremata at anteriolateral corners, directed anteriorlaterally; paranota arise mostly from anterior part of metazonite. Peritremata constricted, with doughnut-like rim (Fig. 15). Subsequent segments (Fig. 16) with transverse depression more distinct, paranota and peritremata directed laterally; near posterior end, paranota and peritremata sharply directed posteriorly. Metazonites of all segments densely setose, flat discoidal tubercles limited to prozonites and transverse depression



Figs. 11-13. *Andrognathus hoffmani.* 11. Female, dorsal view of anterior end; 12. Male, ventral view of anterior end; 13. Female, dorsal view of segment five.



Figs. 14-19. *Andrognathus hoffmani.* 14. Male, ventral view of posterior end; 15. Right ozopore of midbody segment, dorsal view; 16. Male, midbody segment, dorsal view; 17. Sculpture of midbody metatergite, dorsal view; 18. Gonopods, ventral view; 19. Tips of gonopods, ventral view.

between anterior and posterior parts of metazonite (Fig. 17); setae on posterior part of metazonites arranged in about 7 irregular rows, including marginal row.

Gonopods (Figs. 18, 19): Anterior gonopod sternum with small, subglobular, tuberculate knob anterior and between coxae. Coxae about as long as wide, stout; second gonopod podomere with long, triangular, anteriorly-projecting apophyses that reach anterior margins of coxae of legpair 8. Terminal podomere forms torted, outward-curving sheath process. Posterior gonopods with stout, subglobular coxae, second podomere about as wide as long, subsequent podomeres tapering; terminus of last podomere (Fig. 19) elaborate, with two projecting, flange-like processes.

Female paratype: 63 segments, including a single legless penultimate segment. Approximate length, 24 mm, width at midbody 0.6 mm. Nonsexual structure similar to male.

Notes: The three male paratypes had 45, 47, and 56 segments, including collum and epiproct. The males with 45 and 47 segments had two legless segments preceding the epiproct, the 56-segmented individual only one. The three additional female paratypes had (legless segments included in parentheses) 63(1), 62(2), and 43(2) segments.

The two species of *Andrognathus* differ at a number of levels. While the fifth diplosegment of *A. hoffmani* has anteriorly directed paranota, these are not distinctly bilobed, as they are in *A. corticarius*. The metazonites of *A. corticarius* are very obviously divided into two regions (anterior and posterior); these are further divided by the longitudinal median sulcus so that the impression is of four broad raised regions, the anterior ones narrower, on each metazonite. In *A. hoffmani*, the anterior divisions are very indistinct and the posterior much lower than in *A. corticarius*. In terms of segmental sculpture, the discoid tubercles cover more dorsal area in *A. hoffmani* than in *A. corticarius*; in *A. hoffmani* they extend much farther out on the paranota. The paranota and peritremata are somewhat differently shaped and positioned in the two species. In *A. corticarius*, the paranota of midbody segments are noticeably swollen at the posterior lateral angle to form a blunt cone, at the apex of which is the peritreme, whereas in *A. hoffmani*, this swelling is absent and the peritreme sits directly on the paranotum just anterior of the posteriolateral corner. Other striking differences can be seen by comparing Figures 2-4 and 11-13.

The gonopods of the two species are distinct. The forward-projecting apophyses of the second podomeres of the anterior gonopods are long, covering the eighth leg coxae, and acutely triangular in *A. hoffmani*; in the two populations of *A. corticarius* we studied, the apophyses are short and squared off in the South Carolina male, and short-triangular in the Tennessee male, but not projecting even as far as the posterior borders of the eighth leg coxae. The termini of the posterior gonopods are completely different in the two species, with *A. hoffmani* having much more elaborate ones. Again, the two *A. corticarius* populations differed somewhat from each other, but in neither was the complexity of *A. hoffmani* approached.

As we have already discussed, examination of all specimens of *Andrognathus* from the eastern United States, as well as additional collecting, is a priority for understanding this genus and detecting possible cryptic species now hiding under the name *Andrognathus corticarius*.

References Cited

Attems, C. 1951. Revision systématique des Colobognatha (Myriapodes Diplopodes) et description d'espèces nouvelles. Mémoires du Museum national d'Histoire Naturelle, N.S. 3:193-231.

Bickford, D., D.J. Lohman, N.S. Sohdi, P.K.L. Ng, R. Meier, K. Winker, K.K. Ingram, and I. Das. 2007. Cryptic species, a window on diversity and conservation. Trends in Ecology and Evolution, 22:148-155.

Cook, O.F., and H.F. Loomis. 1928. Millipeds of the Order Colobognatha, with descriptions of six new genera and type species, from Arizona and California. Proceedings of the United States National Museum, 72:1-26.

Cope, E.D. 1869. Synopsis of the extinct Mammalia of the cave formations in the United States, with observations on some Myriapoda found in and near the same, and some extinct mammals of the caves of Anguilla, W. I., and other localities. Proceedings of the American Philosophical Society, 11:171-192.

Gardner, M.R. 1975. Revision of the millipede family Andrognathidae in the Nearctic region. Memoirs of the Pacific Coast Entomological Society, 5:1-61.

Hoffman, R.L. 1980 [1979]. Classification of the Diplopoda. Muséum d'Histoire Naturelle, Genève, Switzerland. 237 pp.

Hoffman, R.L. 1999. Checklist of the Millipeds of North and Middle America. Virginia Museum of Natural History Special Publication, 8:1-584.

Loomis, H.F. 1936. Three new millipeds of the Order Colobognatha from Tennessee, Texas, and Lower California, with records of previously known species. Proceedings of the United States National Museum, 83:361-368.

Pfenninger, M., and K. Schwenk. 2007. Cryptic animal species are homogeneously distributed among taxa and biogeographical regions. BMC Evolutionary

Biology, 7:121.

Shear, W.A. 2003a. *Branneria bonoculus*, n. sp., a second species in the North American milliped family Branneriidae (Diplopoda: Chordeumatida: Brannerioidea). Zootaxa, 233:1-7.

Shear, W.A. 2003b. A second species in the rare milliped family Apterouridae (Diplopoda: Chordeumatida). Proceedings of the Biological Society of Washington, 116:509-514.

Shelley, R.M. 1995. The milliped family Hirudisomatidae in the New World (Polyzoniida). Brimleyana, 23:103-143.

Shelley, R.M., C.T. McAllister, and T. Tanabe. 2005. A synopsis of the milliped genus *Brachycybe* Wood, 1864 (Platydesmida, Andrognathidae). Fragmenta Faunistica, 48:137-166.