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Katianna maryae n. sp. (Collembola: Katiannidae), a southern Appalachian species of a Gondwanan genus

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Abstract

Katianna maryae n. sp. is described from turf and grassy fields in eastern Tennessee, USA. This species is the first of its genus to be noted from temperate North America. It is distinguished from other described *Katianna* spp. by a combination of the following characters: color pattern of body an intricate mosaic of purple-brown, yellow-orange and white; copper-brown median stripe between eye patches; fourth antennal segment annuliform but not subsegmented; region between interantennal and clypeal region devoid of setae, clypeal region with six rows of setae; fore and middle feet with 8 clavate tenent hairs, hind foot with 6; apical filament of unguiculus long on fore and middle tibiotarsi, short on hind tibiotarsus; unguis with intricate multidentate pseudonychia; posterior face of dens with one proximal seta and a pair of subapical setae.

Key words: North America, taxonomy, temperate zone

Introduction

Katianna Börner, 1906 is a genus of some 40 known species (Bellinger *et al.* 1996–2013) distributed on several Gondwanan land masses, with 20 species described from South and Central America (Mari Mutt & Bellinger 1990), 11 from Australia (Greenslade 1994), six from New Zealand, two from southern Atlantic islands and one from Java. No species are reliably known from Africa. *Katianna australis* Womersley, 1932 was described from Australia and also has been reported from New Zealand, but a European presence (Bellinger *et al.* 1996–2013) was not indicated in a recent compilation (Bretfeld 1999). The most northern record in the western hemisphere is *K. puella* (Denis, 1933), described from Costa Rica.

Many species of *Katianna* are brightly colored and patterned (Bellinger *et al.* 1996–2013, Delamare Deboutteville & Massoud 1963, Womersley 1939), but despite its visual appeal the genus has never been studied as a whole; the only recent key is derived from the literature and covers only South America (Heckman 2001). The most recently recognized species are those described nearly a half-century ago by Najt (1967).

Katianna differs from *Sminthurinus* Börner, 1901 in having 2+2 or 3+3 heavy spines on the postocular lobes, whereas *Sminthurinus* spp. have typical thin setae. *Katianna* spp. also have cephalic seta sd1 enlarged and spinelike, rather than slender as in other Katiannidae. *Katianna* spp. have a subsegmented Ant. IV, or at least the segment is expanded (annuliform) at the setal whorls (see Delamare Deboutteville & Massoud 1963), and they lack the abdominal neosminthuroid seta. On the small abdomen seta a0 is simple, not bifurcate. *Katianna* also is similar to the North American *Neokatianna* Snider, 1989, but lacks a spur on the cephalic posterior and has a simple seta a0 on Abd. VI; in *Neokatianna* a0 is bifurcate (Snider 1989). Over a span of several years numerous specimens that fit the current concept of *Katianna* were collected in several areas of eastern Tennessee. The purpose of this paper is to describe these specimens as a new species.

Material and methods

Specimens were cleared in Marc Andre I solution, then dissected and the individual parts mounted separately on slides in Hoyer's medium. Slides were dried in a 50°C oven for three days, then ringed with sealant. Minimally distorted heads and bodies were used for drawn illustrations. Whole specimens were imaged with a Canon EOS T3i camera mounted on a Zeiss Stemi 2000 stereo microscope. Body details were imaged with a 14-megapixel Q-Camera on an Olympus BX-63 DIC microscope system. Measurements were made with the measuring software on the Olympus microscope system. Full body images are provided in corrected color; colors of detail images were adjusted for clarity of structures and may not represent the actual color of the feature presented. Most high-magnification images were contrast-enhanced with software in the Olympus system.

Names of setae and setal groups are adapted from Baquero et al. (2003), Betsch & Bretfeld (1991) and Betsch & Waller (1994). Abbreviations used in this paper are as follows: Ant. I, Ant. II, Ant. III, Ant. IV for antennal segments; Th. II, Th. III for the mesothorax and metathorax; Abd. I, Abd. V, Abd. VI for the first, fifth and sixth abdominal segments.

The holotype and numerous paratypes are deposited in the U.S. National Museum of Natural History, Washington, D.C. Other paratypes and additional specimens are deposited in the Illinois Natural History Survey, Great Smoky Mountains National Park Entomology Museum, and the University of Tennessee, Knoxville.

Systematics

Katianna maryae n. sp.

Figs. 1–6

Specimens examined. Holotype female and numerous paratypes, USA, Tennessee, Knox County, Knoxville, University of Tennessee, west (agricultural) campus, between Morgan Hall and Ellington Plant Sciences, pan sweeps of grassy lawns with scattered herbaceous dicots, May 1995, C. L. Williver, M. M. Gibbs, E.C. Bernard, collectors; many additional specimens collected from same locality in following years in all seasons, E.C. Bernard, collector; 25 specimens, Tennessee, Anderson County, Oak Ridge, leaf litter, 19 February 1995, M.M. Gibbs, collector; 7 specimens, Tennessee, Blount County, Great Smoky Mountains National Park, Abrams Falls ranger station, grass lawn, 10 August 2007, E.C. Bernard, collector.

Description of female. Length 1.1–1.3 mm. Large abdomen rounded (Figs. 1A, 2G); Abd. V and VI separate (Figs. 2G, 3G). In ethanol, head posterior largely gray-violet with violet-black network of lines (Fig. 4B); gray-violet color extending anteriorly and surrounding orange spot on gena (Figs. 1A, B); fronto-clypeal region with median violet stripe flanked by orange stripes; copper-brown median stripe between black eye patches, flanked by white stripes sometimes ornamented with small black spots (Fig. 1B); postocular tubercles white. Antennal segments I–III orange-brown, Ant. IV violet or orange-brown basally then violet. Body with intricate mosaic of violet-black, orange and white in varying proportions (Figs. 1A–C), with narrow median stripe extending to midbody, this stripe usually crossed by transverse white stripe in region of Th. III–Abd. I; midbody generally with G or J-shaped black figures (Figs. 1B, C); small abdomen black dorsally with two rectangular orange spots. Leg color variable, usually whitish proximally and light violet distally, sometimes with orange pigment. Ventral tube and furcula white or lightly washed with violet. Each macrosetal socket set in small white dot.

Color of live females similar but body with mosaic of yellow, orange and dark violet (Fig. 1E). Median abdominal stripe yellow, transverse stripe yellow-orange.

Cuticle finely granulate over most of its surface (Figs. 5A, B); antennal segments and leg segments distal to coxae with numerous and more prominent circular or oval granules extending above surface (Fig. 4D); raised base of bothriothrix D with granules in partial spiral arrangement (Fig. 5C); more posteriorly, small abdomen with pattern of raised clusters of granules (Fig. 5C, E).

Antennal segment IV about twice the length of Ant. III (Figs. 6A, D), annule-like but not subsegmented; basal fourth with parallel sides, more anteriorly with nine equally spaced enlargements each bearing a whorl of seven pointed setae; subapically, two slender distal sensilliform setae on exterior side (Figs. 6A, B), segment apparently devoid of other specialized sensillum-like setae; apex of Ant. IV with two conical processes, apical bulb absent

(Fig. 6C). Papilla of Ant. III simple, unlobed (Fig. 6D); Ant. III sense organ composed of two exposed oval sense clubs and two sensillum-like setae slightly posterior to clubs (Fig. 6E). Base of Ant. II with apparent sense organ consisting of pit and conical projection (Figs. 4C, 6D–F); this projection exposed when antenna is outstretched (Fig. 4C, 6F), covered by Ant. I and partially in pit when antennae angled at the Ant. I–II joint (Fig. 6G). First antennal segment with seven setae, dorsally and Laterally with three thicker and three thinner setae, ventrally with one small seta at apex (Fig. 6D). Three proprioceptors (oval organs) near antenna base (Fig. 2A).

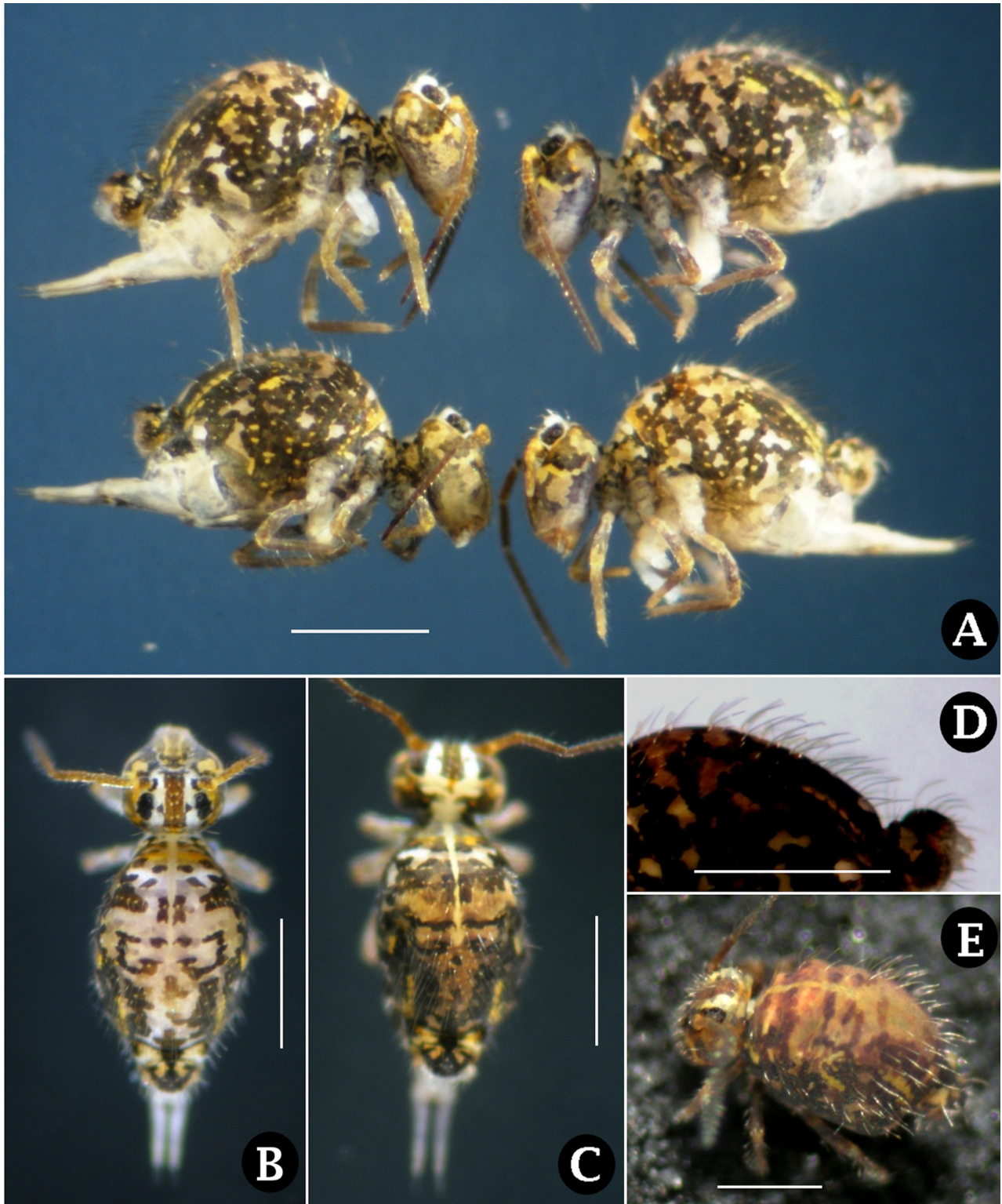


FIGURE 1. *Katianna maryae* n. sp. A) Females preserved in ethanol, lateral views showing variation in pigmentation. B) Females preserved in ethanol, dorsal views. C) Long macrosetae of abdomen in profile. E) Living specimen. All scales equal 500 μ m.

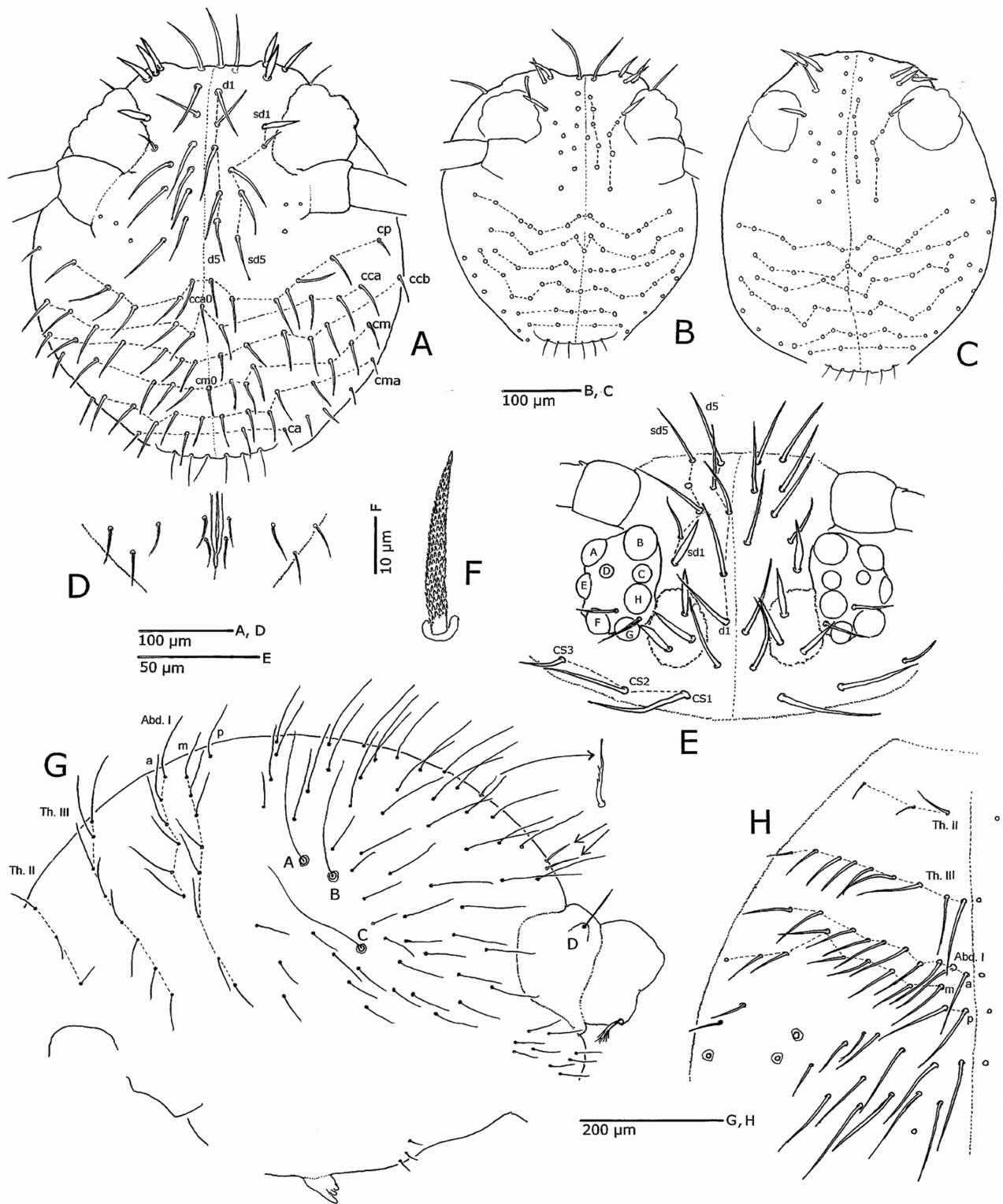


FIGURE 2. *Katianna maryae* n. sp. A–C) Head, frontal view. D) Head, posterior view of setal arrangement posterior to labium. E) Head, dorsal view. F) Spine-like seta of head. G) Chaetotaxy of thorax and abdominal segments I–IV, lateral view. Arrows indicate unusual median seta and short posterior setae. H) Chaetotaxy of thorax and anterior half of abdomen, dorsal view.

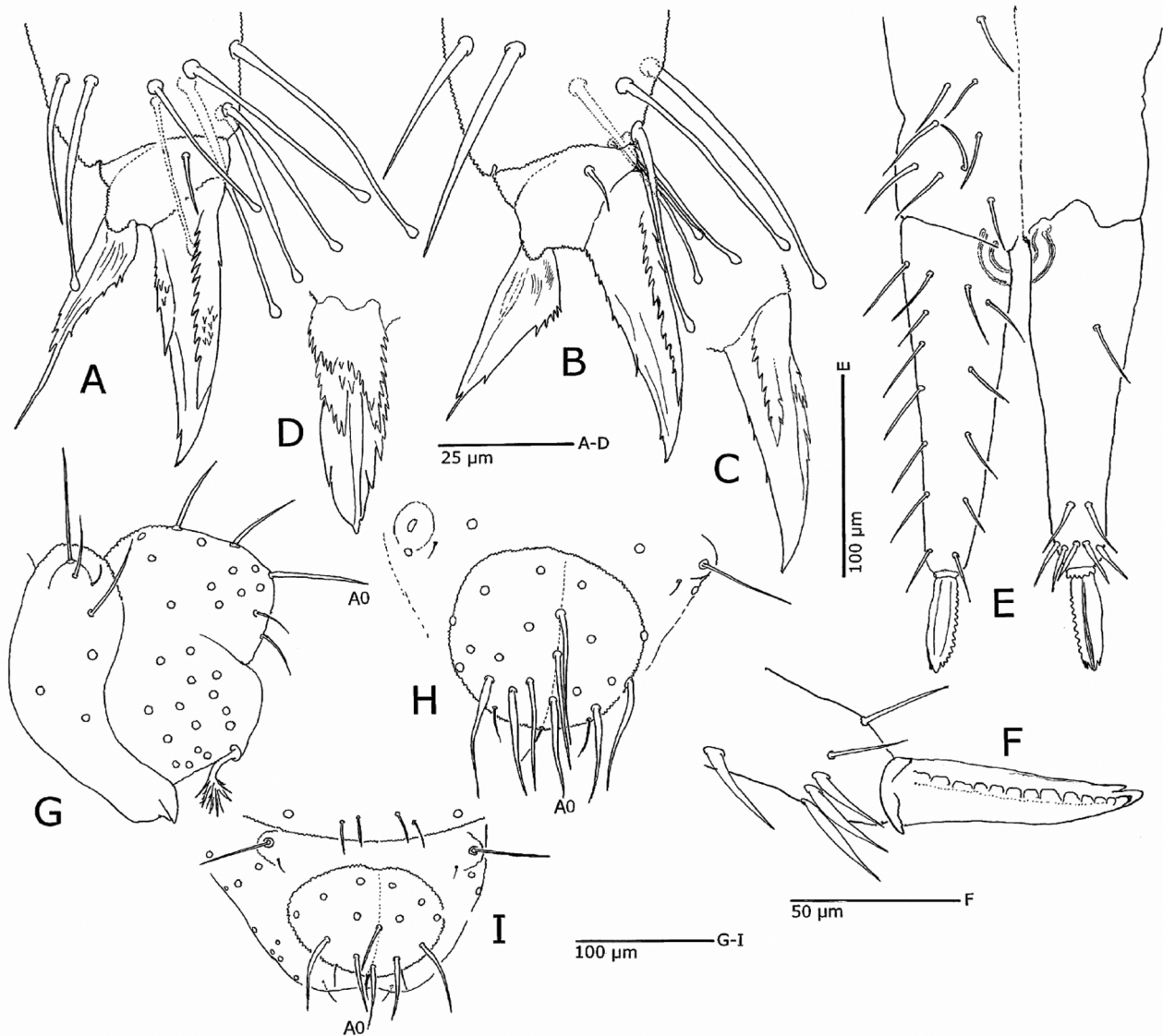


FIGURE 3. *Katianna maryae* n. sp. A) Forefoot, exterior view. B) Hind foot, exterior view. C) Hind unguis, interior view. D) Front unguis, dorsal view. E) Furcula, dorsal view (left), ventral view (right). F) Mucro and apex of dens. G) Abdominal segments V and VI, female, lateral view. H) Abdominal segments V and VI, female, dorsal view. I) Posterior edge of great abdomen and abdominal segments V and VI, male, dorsal view.

Labial palpus with all papillae and guard setae (Fig. 6H); proximal region with five stout, slightly curved setae, basolateral field with four setae. Guard seta a1 straight, spike-like; b1 long, on papillate base; d3 micro serrated on most of its length; lateral process granulate, reaching base of e3 (Fig. 6I). Maxillary outer lobe with simple palpus and two sublobal hairs, the more basal hair straight (Fig. 6J). Maxillary lamellae not extending past teeth of maxillary head. Usually six prelabral setae present (Fig. 6K), occasionally median seta present to give seven. Labral setae in three rows, proximal to distal 5-5-4 setae; middle three setae of basal row and median seta of middle row shorter than other setae; outer setae of distal row thickened, spike-like, on small papillae. Dorsal edge of labrum with five acute lobes and apical fringe; ventral edge sinuate, with three teeth at each corner (Fig. 6K). Eight ocelli in each eyepatch, ocelli E and G slightly smaller than adjacent ocelli, C and D strongly reduced, D smaller than C (Fig. 2E). Linea ventralis without spine-like process (Fig. 4B).

Middle coxa with two setae and conical papilla (Fig. 5A), hind coxa with two setae, forked sensillum in circular pit and conical papilla (Figs. 5B, 6O). Middle and hind trochanters with similar trochanteral organs composed of oval or heart-shaped pit surrounding thick serrated seta (Fig. 6O); middle trochanter with three setae, hind trochanter with four setae (Figs. 6N, O). Fore, middle and hind femora with 13, 15, and 13 setae, respectively; interior middle seta of middle femur twice the length of its hind femur counterpart (Figs. 6N, O). Tibiotarsi each

with six whorls of setae and with a pair of minute subventral, sub-basal setae. Ventral surface of fore, middle and hind tibiotarsi with 3, 4, 5 spine-like setae (Figs. 6M–O) and distally with 8, 8, 6 clavate tenent hairs, respectively (Figs. 3A, B). Foot structure similar on all legs, except filament long and reaching tip of unguis on fore and hind unguiculi, very short on hind unguiculus (Figs. 3A, B). Unguis with two teeth on inner side, multiple proximal denticles in line or clustered along inner edge, and prominent multidentate pseudonychia on both lateral sides (Figs. 3A–D), terminating in large lateral teeth (Fig. 3D); viewed from exterior side pseudonychia often fused into several multiserrated layers. Pseudonychial region often with clusters of minute denticles (Fig. 3A). Unguiculus with rows of denticles along one or both edges.

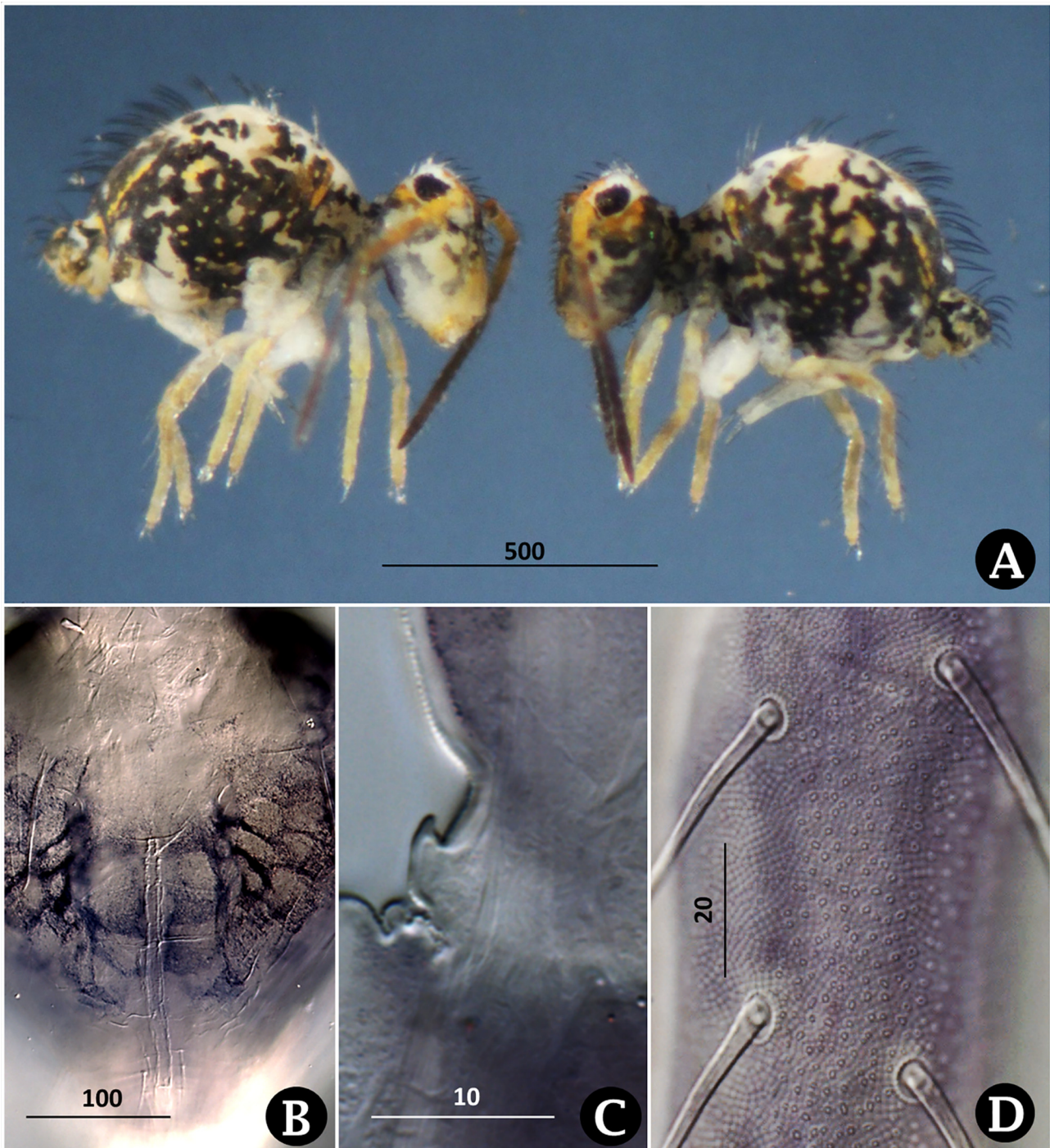


FIGURE 4. *Katianna maryae* n. sp. A) Males, lateral view. B) Head, posterior view. C) Basal organ of Ant. II. D) Cuticular granulation on leg. Scales in μm .

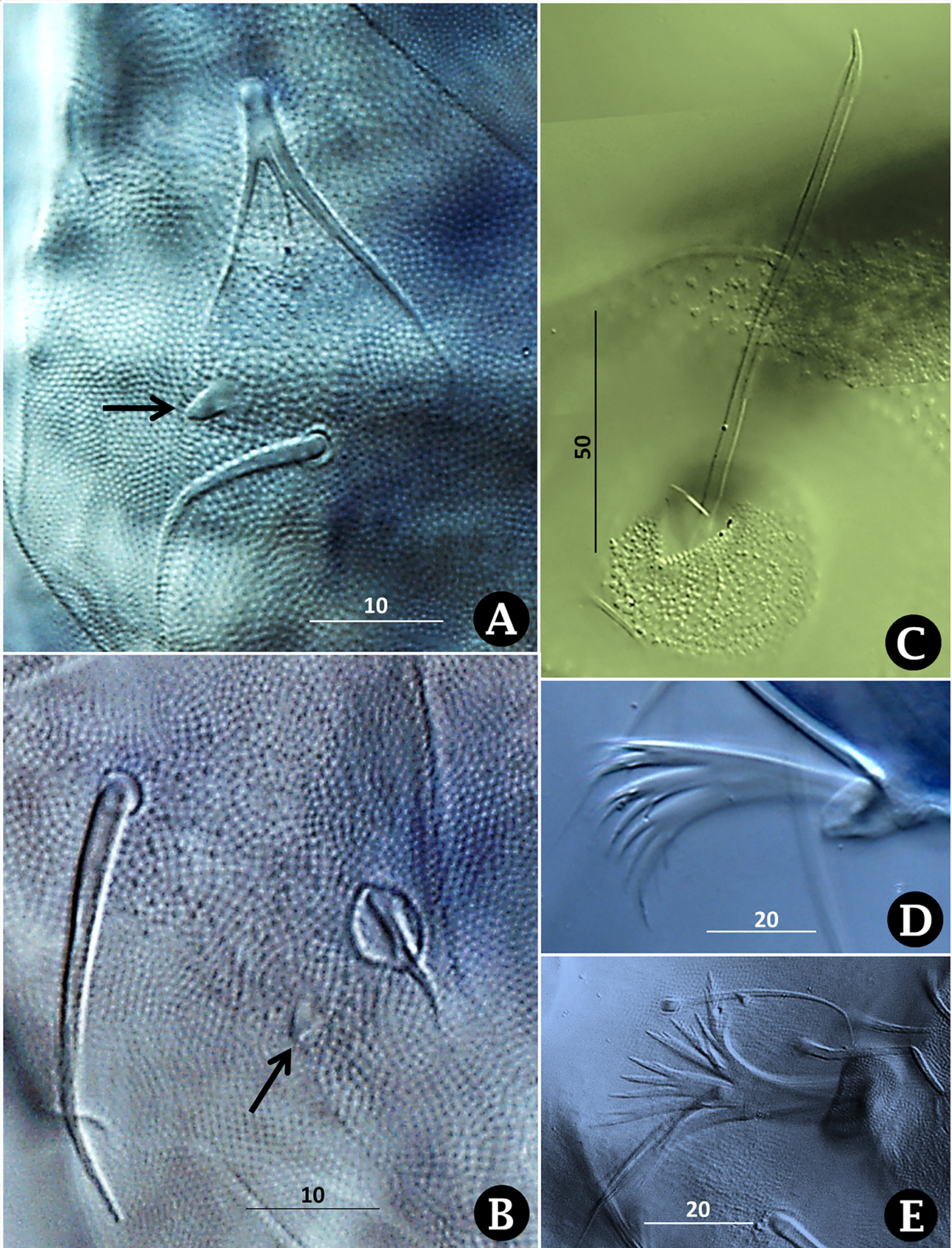


FIGURE 5. *Katianna maryae* n. sp. A) Sense organ region of middle coxa; arrow indicates peg. Forked seta is not typical. B) Sense organ region of hind coxa; arrow indicates peg. C) Bothriothrix D and base. D, E) Subanal appendages. Scales in μm .

Ventral tube with 2+2 laterodistal setae (Fig. 6L). Tenaculum with 3+3 teeth and two setae. Manubrium with 8+8 dorsal setae; dens ventrally with two subapical setae and one proximal seta, dorsally with six exterior, two inner dorsal, one dorsal, and five lateral setae (Fig. 3E). Mucro notched at apex, with smooth exterior edge, coarsely toothed inner edge; mucronal seta absent (Fig. 3F). Subanal appendage palmate with three multifurcate major branches (Figs. 5D, E).

Chaetotaxy. Setae appearing smooth at low magnification; slender setae roughened at high magnification, cephalic spines minutely scaled in spiraling rows (Fig. 2F); setae normally simple, antennae or legs rarely with a random forked seta (Fig. 5A). Setae of head and body usually displaying minor asymmetry. Clypeal region with six transverse rows of setae posterior to pre-labral setae (Figs. 2A–C): anterior clypeal (ca), anterior clypeal-medial (cma), clypeal-medial (cm), anterior clypeal-central 1 (ccb), posterior clypeal-central 2 (cca) and clypeal-posterior (cp); genal row absent; medial setae cm0 and cca0 usually present (Figs. 2A, B), occasionally absent or displaced (Fig. 2C). Interantennal-interocular area with d and sd setal rows, seta sd1 spine-like (Figs. 2A–C); medial seta occasionally present (Fig. 2B); sd' row and seta a0 absent. Postocular tubercles each with 3 stout spine-like setae; 2+2 setae between tubercles (Fig. 2E). Cervical setae 3+3, divergent, innermost pair (CS1, CS2) longer than CS3 (Fig. 2E). Posterior of head with 2+2 setae near the linea ventralis and 3 postgenal setae arranged in a triangle on each side (Fig. 2D).

Mesothorax with 3+3 setae, metathorax with 8+8 or 9+9 setae in a single row; Abd. I with three rows of setae, each side with 14–18 setae in a+m rows and 1 or 2 p-setae (Figs. 2G, H). Bothriothrix B slightly posterior to line of bothriothrix A and C; B-C distance twice that of AB. Region of Abd. II–IV with numerous long setae not arranged in discernible pattern; posterior margin with 2+2 short, smooth setae (Figs. 2G, 3I). One specimen with small, serrate, clavate medial seta (Fig. 2G). Venter of abdomen usually with 3+3, occasionally 2+2 short setae.

On Abd. V bothriothrix D straight, tip tapering, slightly bent (Fig. 5C), arising from small rounded papilla bearing one long seta and one short basal seta (Fig. 3G). Four medial setae on Abd. VI, A-row setae slightly swollen near base; A0 simple, not bifurcate (Figs. 3G, H).

Description of male. Males similar to females in most respects. Length 0.7–0.9 mm. Head with variable violet patches on gena; large abdomen with large white patches; legs pale orange (Fig. 4A). Three medial setae on Abd. VI (Fig. 3I).

Etymology. This species is named in loving memory of the late Mary Fitzpatrick, spouse of the noted nature photographer Kevin Fitzpatrick and a skilled photographer in her own right.

Relationships. Because of the relatively little attention given to *Katianna* for many years, the relationships of *K. maryae* n. sp. to other species of the genus are difficult to determine. In the key to South American species (Heckman 2001) *K. maryae* n. sp. traces to *K. willincki* (Delamare Deboutteville & Massoud, 1963). Based on length (~700 µm) and less complex head chaetotaxy the single specimen probably is a juvenile, and thus may not be comparable to adults of *K. maryae* n. sp. The two species have a somewhat similar color patterns, both have G or J-shaped markings on the dorsum of the large abdomen, and they have the same ventral setal arrangement on the dens. However, they differ in the following ways, which may be due to the juvenile status of *K. willincki*: nine annule-like enlargements on Ant. IV in *K. maryae* n. sp. (six in *K. willincki*); hind tibiotarsus with six clavate tenent hairs (seven in *K. willincki*); two internal teeth and complex pseudonychia on the unguis (one tooth, no pseudonychia in *K. willincki*), hind unguiculus triangular, much shorter than unguis, several denticles on inner edge (in *K. willincki*, hind unguiculus tapering, same length as unguis, without denticles). Morphologically *K. maryae* n. sp. is similar to *K. jeanneli* Delamare Deboutteville & Massoud, 1963 in the presence of pseudonychia and numerous denticles and minute teeth on the unguis and unguiculus, but *K. maryae* n. sp. has only six clavate tenent hairs on the hind tibiotarsus (seven in *K. jeanneli*). Additionally, the mucronal tip of *K. maryae* n. sp. is straight, not hooked as in *K. jeanneli*. The color patterns are also different, with *K. jeanneli* having a stripe of black pigment on each side of the large abdomen as well as a black blotch toward the posterior end. Delamare Deboutteville & Massoud (1963) described but did not illustrate the habitus of *K. jeanneli*; however, they stated that the pattern much resembled *K. wygodzinskyi* Delamare Deboutteville & Massoud (1963), which they did illustrate as having dark lateral bands and a large medial spot on the large abdomen.

Katianna maryae n. sp. differs from the Australian and New Zealand species in color pattern and in number of clavate tenent hairs (eight on foreleg in *K. maryae* n. sp., six or less in the Australian and New Zealand species).

Discussion

Betsch & Waller (1994) proposed a system for naming setae of the fronto-clypeal region of Symphypleona, which included up to seven rows of clypeal setae (a–g), three rows of interantennal setae and six rows of frontal setae. Within the order, they indicated that Katiannidae had five rows of clypeal setae and five rows of interantennal and frontal setae. This system was modified by Baquero *et al.* (2003) for a bourletiellid, *Deuterosminthurus bisetosus*; they homologized the interantennal and frontal setae with the basic arrangement seen in Poduromorpha (Yosii 1960, Jordana *et al.* 1997) and renamed clypeal rows a–g as ca, cma, cm, ccb, cca, cp and g. I have used this arrangement in this paper as it seems to fit reasonably well. Baquero *et al.* (2003) also figured a zig-zag lateral row, which may be valid, but in *K. maryae n. sp.* the clypeal seta rows seem to track smoothly to the lateral setae.

Given this arrangement, *K. maryae* has six rows of clypeal setae, not five as indicated for Katiannidae by Betsch & Waller (1994), and lacks the sd' row present in *D. bisetosus* (Baquero *et al.* 2003). The sd setal row in *K. maryae n. sp.* is more in the location of the sd' row than is the sd row of *D. bisetosus*, but labeling it as sd maintains congruence with the basic design seen in Poduromorpha.

In *Katianna maryae n. sp.* the setae of the interocular-interantennal group are clearly separated from the fronto-clypeal setae by a band of cuticle devoid of setae (Figs 4A–C). This arrangement is different from that found in the South American *Katianna* spp. illustrated by Delamare Deboutteville & Massoud (1963), in which setae are found rather evenly distributed. The South American species do not have a non-setaceous band on the front of the head, and appear to have the g-row of clypeal setae. Row g is absent in *K. maryae n. sp.*, thus creating a transverse band without setae.

Delamare Deboutteville & Massoud (1963) illustrated the spine-like setae of the *Katianna* head as having spiraling lines extending up the setal shaft. At high magnification the spines of *K. maryae n. sp.* appear to have the same spiral architecture, but with oil immersion and enhanced differential interference contrast the spirals resolve into ascending ranks of minute, fixed scales.

The occurrence of a *Katianna* sp. in temperate North America does not seem to make biogeographic sense, since all previously described species have come from Gondwanan land masses. *Katianna maryae n. sp.* is a relatively conspicuous species and it seems surprising that it was not noticed before the 1990s. At least two possible explanations can be given for its late discovery. The first is that North America has been only sparsely collected despite the efforts of specialists such as J. W. Folsom, D. L. Wray, K. A. Christiansen, and R. J. Snider. I have seen at least one other *Katianna* sp. from the U.S., but this taxon is known only from a very few specimens collected from the vicinity of Charleston, SC. The absence of cephalic g-row setae supports the hypothesis that *K. maryae n. sp.* is native to North America and not closely related to the South American fauna, as the South American forms seem to have it. The second possibility is that *K. maryae n. sp.* is not native but rather is an invasive species introduced from South America or the Australian region. Supporting this hypothesis is the fact that *K. maryae n. sp.* is found mostly in repeatedly disturbed turf and grassy areas, not in the natural vegetation for the area. The presence of a *Katianna* sp. near Charleston can also be explained by introduction, especially since that city is a major seaport. Likewise, *Katianna*-like taxa from the United Kingdom and imaged in Bellinger *et al.* (1996–2013) may well be introductions from South America or one of the southern hemisphere Commonwealth countries. Collection of these taxa in the southern hemisphere would demonstrate that northern *Katianna* spp. are introductions, not endemics.

Acknowledgements

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Literature cited

- Baquero, E., Moraza, M.L. & Jordana, R. (2003) A new species of *Polydiscia* (Acari, Prostigmata, Tanaupodidae) with reference to its host: a new species of *Deuterostminthurus* (Collembola, Symphypleona, Bourletiellidae). *Zootaxa*, 188, 1–16.
- Bellinger, P.F., Christiansen, K.A. & Janssens, F. (1996–2013) Checklist of the Collembola of the World. Available from: <http://www.collembola.org>. (accessed 23 September 2013)
- Betsch, J.-M. (1980) Éléments pour une monographie des Collemboles Symphypléones (Hexapodes, Aptérygotes). *Mémoires du Muséum National d'Histoire Naturelle Nouvelle Série, Série A, Zoologie*, 116, 1–227.
- Betsch, J.M. & Bretfeld, G. (1991) A proposal for a standard system of chaetotaxic nomenclature in the Symphypleona (Insecta: Collembola). In: Veeresh, G.K., Rajagopal, D. & Viraktamath, C.A. (Eds.), *Advances in management and conservation of soil fauna*. Oxford & IBH Publishing, New Delhi, pp. 31–38.
- Betsch, J.M. & Waller, A. (1994) Chaetotaxic nomenclature of the head, thorax and abdomen in Symphypleona (Insecta, Collembola). *Acta Zoologica Fennica*, 195, 5–12.
- Börner, C. (1906) Das System der Collembolen, nebst Beschreibungen neuer Collembolen des Hamburger Naturhistorischen Museums. *Mitteilungen aus dem Naturhistorischen Museum in Hamburg*, 23, 147–188.
- Bretfeld, G. (1999) Synopses on Palaearctic Collembola. Vol.2. Symphypleona. *Abhandlungen und Berichte des Naturkundemuseums Görlitz*, 71, 1–318.
- Delamare Deboutteville, C. & Massoud, Z. (1963) Collemboles Symphypléones. *Biologie de l'Amérique Australe*, 2, 169–289.
- Greenslade, P. (1994) Collembola. In: Houston, W.W.K. (Ed.), *Zoological Catalogue of Australia. Vol. 22. Protura, Collembola, Diplura*. CSIRO, Melbourne, pp. 19–138.
- Heckman, C.W. (2001) *Encyclopedia of South American insects: Collembola*. Kluwer Academic Publishers, Dordrecht, The Netherlands, 408 pp.
- Jordana, R., Arbea, J.I., Simón, S. & Lucíañez, M.J. (1997) *Collembola Poduromorpha. Fauna Iberica Vol. 8*. Museo Nacional de Ciencias Naturales, Madrid, 807 pp.
- Mari Mutt, J.A. & Bellinger, P.F. (1990) *A catalog of the Neotropical Collembola*. Sandhill Crane Press, Gainesville, FL, 237 pp.
- Najt, J. (1967) Colembolos Symphypleona neotropicales. *Physis*, 27 (74), 71–86.
- Snider, R.J. (1989) Link between *Sminthurinus* and *Katianna* collected from Alabama (Collembola: Katiannidae). *Florida Entomologist*, 72, 541–547.
<http://dx.doi.org/10.2307/3495194>
- Womersley, H. (1939) *Primitive insects of South Australia*. Frank Trigo, Government Printer, Adelaide, 322 pp.
- Yosii, R. (1960) Studies on the collembolan genus *Hypogastrura*. *American Midland Naturalist*, 64, 257–281.
<http://dx.doi.org/10.2307/2422661>