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Speleonectes williamsi, a new species of Remipedia (Crustacea) from the Bahamas

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Abstract

We describe a new species of the genus *Speleonectes* (Crustacea, Remipedia, Nectiopoda) from an anchialine cave on Grand Bahama Island in the northern Bahamas. *Speleonectes williamsi* **n. sp.** is morphologically highly similar to *Speleonectes emersoni* from the Dominican Republic. However, morphological differences between the two species were detected in dissected body parts, such as the setal patterns of the antennae and trunk limbs, the terminal claws of maxillae and maxillipeds, and the frontal filaments.

Key words: remipede, cryptic species, pseudo-cryptic species, glands, Speleonectidae

Introduction

The crustacean class Remipedia (Yager, 1981) currently consists of 24 described species in three families. The largest of these families, Speleonectidae Yager, 1981 is made up of 18 species in four genera, *Speleonectes* Yager, 1981, *Lasionectes* Yager and Schram, 1986, *Cryptocorynetes* Yager, 1987, and *Kaloketos* Koenemann et al., 2004. This diverse family is both globally distributed and relatively speciose within the Bahamas region, the center of remipede diversity. Confamilial and congeneric sympatry is remarkably common (Neiber et al. 2011) considering the narrow ecological niches available in anchialine cave ecosystems.

In addition to the obvious morphological divergence between many species, morphologically highly similar but genetically divergent "cryptic" species are now coming to light (Koenemann et al. 2009). Here we describe a new species, *Speleonectes williamsi*, from the Bahamas. These specimens are morphologically very similar to *S. emersoni* found in the Dominican Republic, however, careful examination revealed morphological differences between the two species, and highlights the problem of diagnostic characters in Remipedia.

Systematics

Speleonectes williamsi, new species

Type locality. Sagittarius Cave, Sweetings Cay (N 26.9, W -77.8), Grand Bahama Island, Bahamas.

Type material. Holotype (US Natural History Museum 1155294), 8.9 mm. Paratype 1 (private collection SK, ID: BH 51), 10.2 mm, dissected for description. Paratype 2 (private collection SK, ID: BH 52), 8.5 mm, dissected for description. Paratype 3 (private collection SK, ID: BH 53), 8.0 mm. Paratype 4 (ID: BH 54), 8.1 mm, used for

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DNA extraction. Paratype 5 (private collection SK, ID: BH 55), 9.0 mm. Paratype 6 (USNHM 1155295), 11.2 mm. Paratype 7 (USNHM 1155296), 10.6 mm, 20 trunk segments. Paratypes 1–5 with 22 trunk segments; holotype, paratypes 6 and 7 with 20 trunk segments. Holotype and paratypes were collected from the type locality by Dennis Williams on 12 September 1987.

Etymology. The specific epithet *williamsi* is chosen to honor the memory of cave diver Dennis Williams (1943–2005), who explored numerous anchialine cave systems and assisted with discoveries of remipede crustaceans.

Diagnosis. A comparatively small and slender species. Prehensile cephalic limbs sparsely setose, maxillules well developed. Sternal bars isomorphic. Antennules short, about 1/5 of body length; dorsal ramus with 10–11 segments, ventral ramus with 5 segments.

Description. Body slender, up to 11.5 mm and 22 trunk segments (Fig. 1). Pleurae of tergites well developed, with rounded distolateral corners, becoming slightly pointed around mid-trunk. Head shield subrectangular, tapering anteriorly, with concave lateral margins (Fig. 2A). First trunk segment partially covered by head shield (Fig. 2A). Sternites unmodified. Sternal bars isomorphic. Female gonopores on protopods of seventh trunk limbs; male gonopores behind cone-like cuticular projections on protopods of 14th trunk limbs.

Frontal filaments with medial process inserted near tip of main filament (Fig. 2B).

Antennules (Fig. 2C): Peduncle with small field of long ribbon-like aesthetascs. Dorsal ramus about 20–25% of body length, composed of 10–11 segments. Ventral ramus approximately half the length of dorsal ramus, composed of 5 segments; proximal-most segment elongate. Segments of both rami with 2–3 distal compound aesthetascs and several fine, short setae along margin.

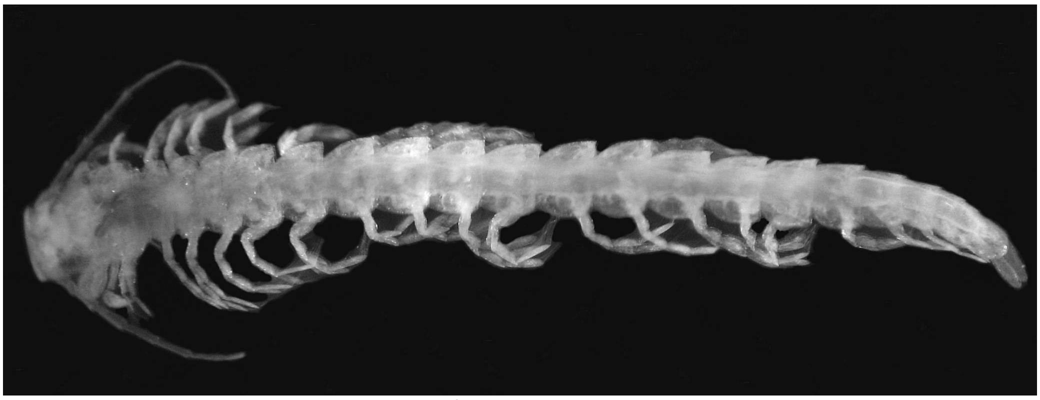

FIGURE 1. *Speleonectes williamsi* **n. sp.** Photograph of paratype 1 (10.2 mm), dorsal view.

Antennae (Fig. 2D): Proximal segment of protopod with 3 setae, distal segment with 6 setae. Exopod 1.5 times longer than distal segment of protopod, with about 26 setae along margin. Endopod slightly curved; proximal and medial segments each with 5 setae; distal segment with 19 setae, of which 12 originate as pairs. All setae plumose.

Labrum (Fig. 2E, F) prominent, bearing fields of fine setules on posterolateral corners and medial lobes; funnel-shaped medial cavity with unilateral field of sharp denticles.

Mandibles asymmetrical (Fig. 2G–I). Left incisor process with 4 large denticles; left lacinia mobilis v-shaped or 2-cusped, with indistinct denticles. Right incisor process and lacinia mobilis each with 3 denticles. Molar processes of both mandibles well-defined, apical surface equipped with field of plumose setae.

Maxillules (Fig. 3A) much more robust than maxillae and maxillipeds. Segment 1 with long, slender medial endite bearing 7 apical spine-like setae, posterior-most seta long and robust, anterior-most serrate. Segment 2 with broad plate-like endite, bearing a row of 7 spine-like setae along posterior apical margin and many small simple subterminal setae, anterior-most seta serrate; 1 plumose seta and several short simple setae along posterior margin; 4 long and several short setae on anterior apical margin. Segment 3 short, with reduced conical endite bearing 2 robust sclerotized setae with serrations on distal half and 2 slender simple setae. Segment 4 (lacertus) robust, with conical medial margin, bearing 2 robust sclerotized setae and 3–4 long simple setae. Segment 5 well developed, expanded, with a cluster of few setae on distomedial margin. Segment 6 greatly reduced, about 1/5 as long as segment 5, with clusters of setae on distomedial and distolateral margins. Terminal claw slightly longer than segment 6, with 2 clusters of long setae at base.

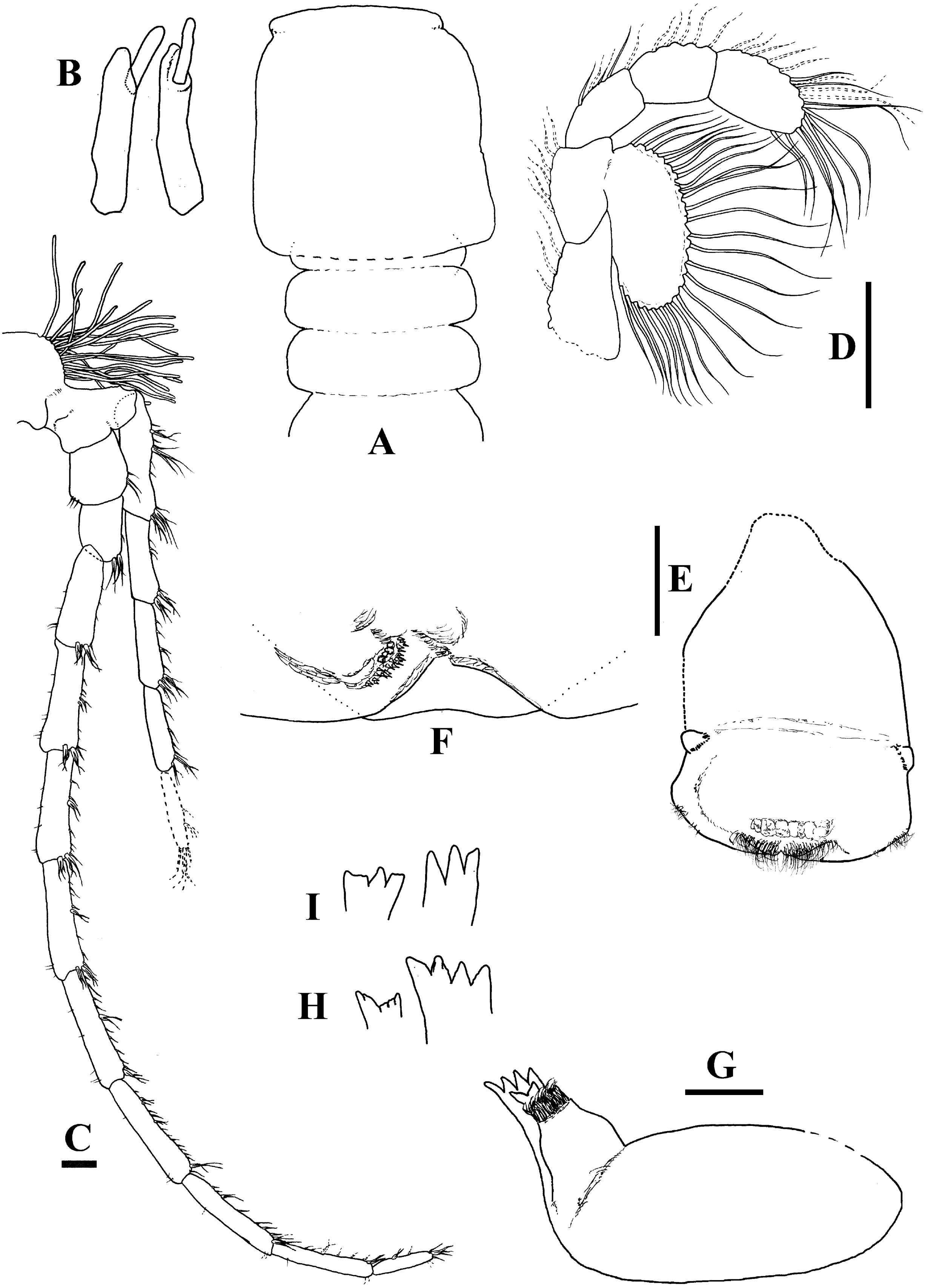

FIGURE 2. *Speleonectes williamsi* **n. sp.**, paratype 1 (10.2 mm). A: Head shield and anterior trunk segments (dorsal view). B: Frontal filaments. C: Antennule. D: Antenna. E: Labrum. F: Enlarged posterior margin of labrum. G: Left mandible. H: Lacinia mobilis (left) and incisor process (right) of left mandible. I: Lacinia mobilis (left) and incisor process (right) of right mandible. Scale bars C–G = 0.1 mm.

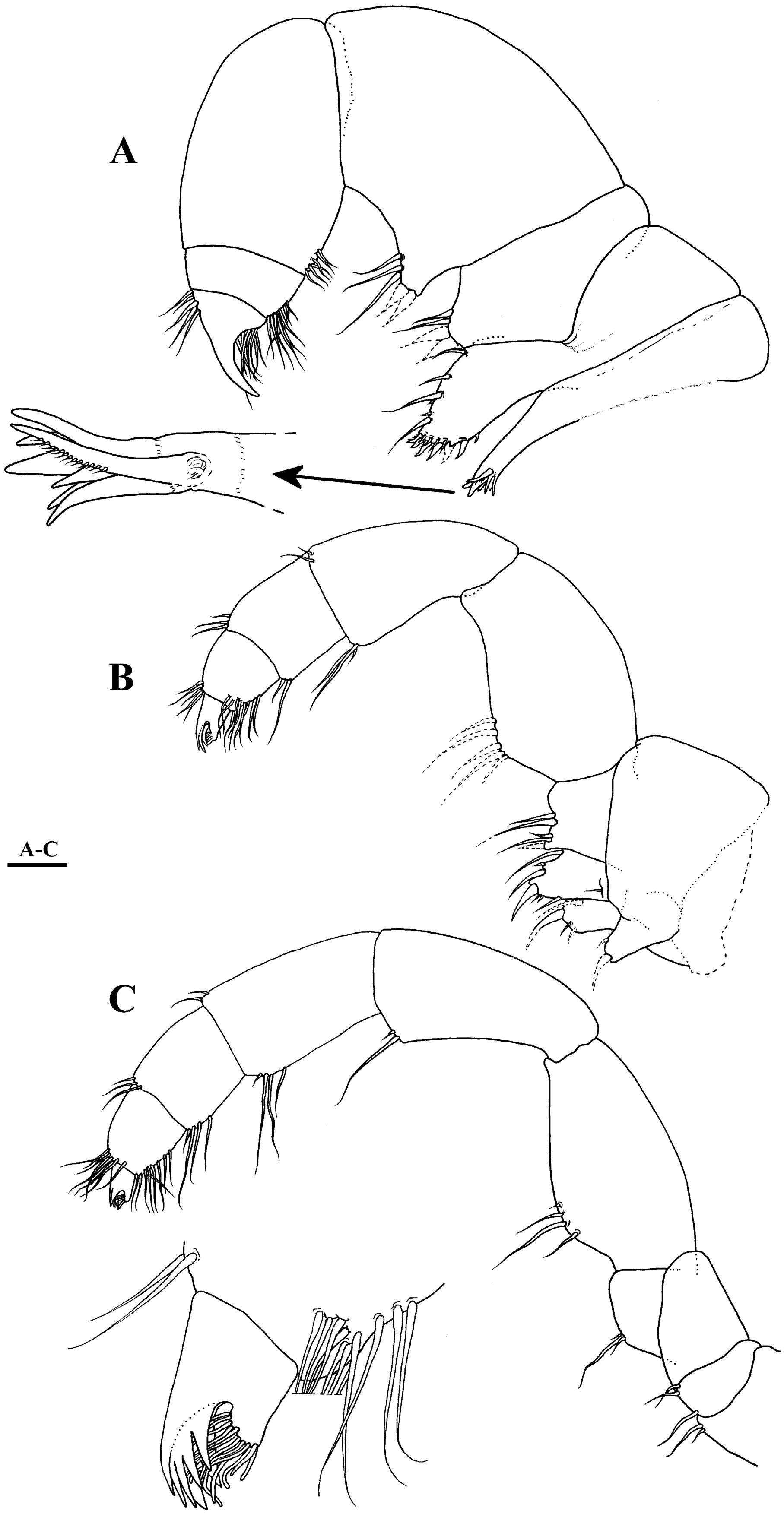

FIGURE 3. *Speleonectes williamsi* **n. sp.**, paratype 1 (10.2 mm). A: Maxillule, arrow pointing at enlarged endite of segment 1. B: Maxilla. C: Maxilliped, with enlarged terminal claw. Scale bar A–C = 0.1 mm.

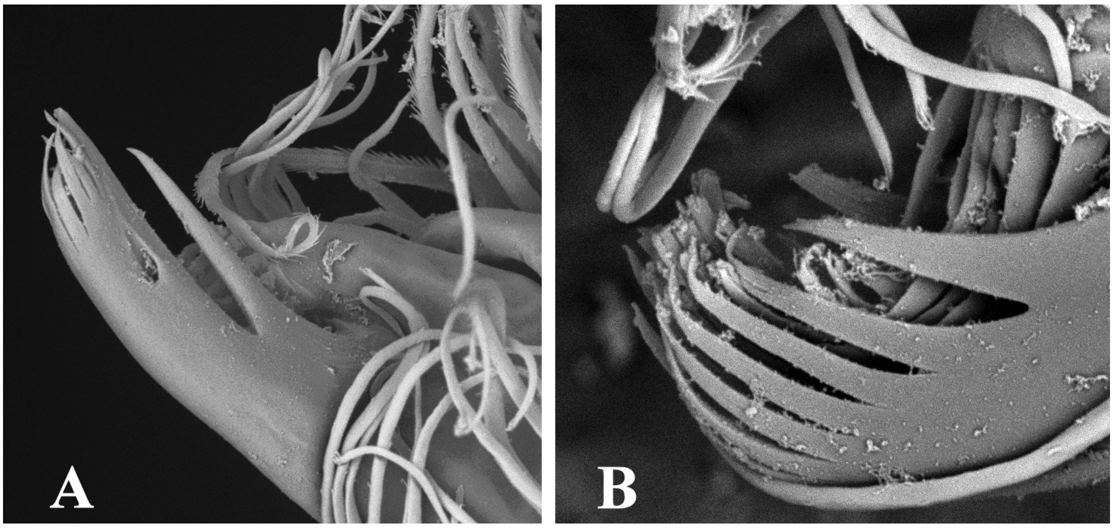

FIGURE 4. *Speleonectes williamsi* **n. sp.**, paratype 7. Claw of maxilla. A: Anterior view, showing putative sensory pit. B: Enlarged posterior view.

Maxillae (Fig. 3B): Segment 1 with three long digitiform endites each with 1 robust sclerotized curved spine-like seta, with 1–2 short setae and 1–2 long subterminal setae. Segment 2 short with conical medial endite bearing 1 or 2 stout spine-like setae and several subapical long and short setae. Segment 3 long, slightly expanded medially, sparsely setose with 3–4 long setae. Segment 4 trapezoidal with clusters of several distal setae. Point of flexure between segments 3 and 4.

Segments 5 and 6 both nearly square, bearing clusters of short and long distal setae and several setae on disto-medial half of each segment. Segment 5 about 1/2 as long as segment 4. Segment 6 slightly smaller than segment 5 and more setose. Distal claw complex consisting of an arc of approximately 8–10 incised denticles with robust anterior and posterior, subterminal spines, a large anterior subterminal pit (putative sensory pore; see Fig. 4), and a short setose thumb-like pad.

Maxillipeds (Fig. 3C) approximately 1.5 times as long as maxillae; 9-segmented with point of flexure between segments 5 and 6. Segments 1–3 forming convoluted joint complex. Segment 1 short with a few medial setae. Segment 2 oblique, with several medial setae. Segment 3 slightly expanded medially with a few medial setae. Segment 4 (lacertus) elongate, rounded medially with about 4 long and several short medial setae. Segment 5 slightly shorter than segment 4, slightly expanded, with several long distomedial setae. Segment 6 slightly shorter than segment 5 with distomedial and distolateral clusters of setae. Segment 7 slightly shorter than segment 6, with distal clusters of setae. Segment 8 shorter than segment 7, bearing a medial row of setae and cluster of many distolateral setae. Terminal claw complex similar to that of maxillae.

Limbs of first post-cephalic trunk somite biramous, with relatively slender rami (Fig. 5A). Endopod 4-segmented; endopods of all trunk limbs slightly shorter and narrower than exopods; exopod 3-segmented; both rami bearing long, plumose setae on margins. Limbs of mid-trunk region with broad, expanded segments (Fig. 5B); exopod with up to 5 short serrate setae on distolateral corners; endopod bearing both short plumose and short serrate setae on distolateral and distomedial corners (Fig. 5C, D).

Anal segment nearly as wide as it is long (Fig. 5E). Caudal rami slightly longer than anal segment.

Additional observations. Most specimens of *S. williamsi* **n. sp.** have two very visible rust-colored glands extending from the head to the second trunk segment (Fig. 6). Yager (1991) previously described these glands in the specimen known here as Paratype 6. The presence of these glands was documented in other species of Remipedia by Schram and Lewis (1989) and van der Ham and Felgenhauer (2007). However, no other species described to date has such distinct glands and ducts visible in the head and anterior trunk segments as those of *S. williamsi*.

Morphological comparison with other species. *Speleonectes williamsi* **n. sp.** does not share any of the apomorphies that define the families Godzilliidae Schram et al., 1986 or Micropacteridae Koenemann et al., 2007, including in particular the reduction and modification of the post-mandibular cephalic limbs. The prehensile cephalic limbs of *S. williamsi* also lack conspicuous characters such as the presence of discoid organs (in *Cryptocorynetes* Yager, 1987), dense fields of plumose setae (in *Kaloketos* Koenemann et al., 2004), or irregularly shaped terminal claws (in *Lasionectes* Yager and Schram, 1986). Therefore, the new species is placed in the genus *Speleonectes* Yager, 1981 within the family Speleonectidae.

From among the 12 species currently assigned to the genus *Speleonectes*, *S. williamsi* is morphologically closely related to *S. emersoni* Lorentzen et al., 2007. Both species are relatively small, with a nearly identical habitus. They both have isomorphic sternal bars, and at a first glance, all appendages exhibit a striking resemblance in shape, relative sizes, and setal and segmentation patterns.

Upon closer examination, however, we found a number of morphological differences in the antennules, antennae, prehensile cephalic limbs and the anal somite (Tab. 1). The ventral flagellum of the antennule has 5 segments in *S. williamsi* but 6 in *S. emersoni*. The setae on the expods of the antennae in *S. williamsi* are numerous (26) and all long, while *S. emersoni* possesses a total of 18 long and short setae. The outer denticle of the right lacinia mobilis of the mandible has a flattened apical surface in *S. williamsi* but a pointed tip in *S. emersoni*. The fourth maxillary segment in *S. williamsi* is as long as the lacertus and only slightly expanded, however that of *S. emersoni* is shorter than the lacertus and is distinctly expanded distally. The terminal claws of maxillae and maxilipeds of *S. williamsi* all have deeply incised denticles whereas those of *S. emersoni* are small (fused). In *S. williamsi*, the anal somite is nearly square, while the anal somite of *S. emersoni* is longer than it is wide.

At the type locality, *S. williamsi* occurs sympatrically with *Godzilliognomus frondosus*, *Pleomothra apletocheles*, *Cryptocoynetes haptodiscus*, and *S. benjamini*. Grand Bahama Island is more than 1100 km northwest of the only known populations of *S. emersoni*, in anchialine caves near the southern coast of the Dominican Republic (island of Hispaniola). Recognition of *S. williamsi* and *S. emersoni* as distinct species, in spite of their high degree of morphological similarity, suggests that the islands on which they are found may be inhabited by a series of cryptic or pseudo-cryptic species. Unfortunately, we were unable to extract usable DNA from paratype 4. Remipede dispersal and colonization patterns, based on DNA sequence analyses, remain the subject of ongoing investigation.

The discovery of two apparently closely related but geographically disjunct species highlights our ignorance of the evolutionary trajectories within Remipedia. It also emphasizes our uncertainty about which traits are truly diagnostic and which are plastic within a species. In the 30 years since their discovery, the boundaries between intraspecific and interspecific variation in remipedes remain unclear due to the very small number of individuals that have been collected for most species. The difficulty of accessing remipede habitat and the desire to avoid depleting what may be small populations within a given cave ensure that this will remain a problem for some time to come. The case of *S. williamsi* and *S. emersoni* suggests that expanding the character set to include molecular in addition to morphological variation may result in a more complete picture of remipede diversity and biogeography.

TABLE 1. Comparison of morphological similarities and differences between *S. williamsi* **n. sp.** and *S. emersoni*.

	Speleonectes williamsi **n. sp.**	*Speleonectes emersoni*
Adult body length	8.1–11.2 mm	9.5–12.5 mm
Number of trunk somites, adults	20–22	19–21
A1, dorsal ramus	10–11 segments	11 segments
A1, ventral flagellum	5 segments	6 segments
A1, peduncular aesthetascs	ca. 20	ca. 30
Setae of A2, exopod	26 long	15 long, 3 short
FF, main filament	3.1 times longer than wide	5 times longer than wide
FF, medial process	40% length of main filament	32% length of main filament
Mandibles, right lacinia mobilis	outer denticle with flattened apical surface	outer denticle with pointed tip
Max, segment 4	as long as lacertus, slightly expanded	shorter than lacertus, with distinct distal expansion
Max, segment 6	shorter than segment 5	as long as segment 5
Max, Mxp, terminal claws	with ca. 8 deeply incised denticles	with 7–10 small (fused) denticles
Trunk limbs, short stout corner setae	plumose and serrate types	serrate type
Trunk limbs, shape	sturdy, robust	comparatively slender

Abbreviations: A1 = antennule (first antenna); A2 = antenna (second antenna); FF = frontal filament; Max = maxilla (second maxilla); Mxp = maxilliped. See Morphological Comparisons for further explanations.

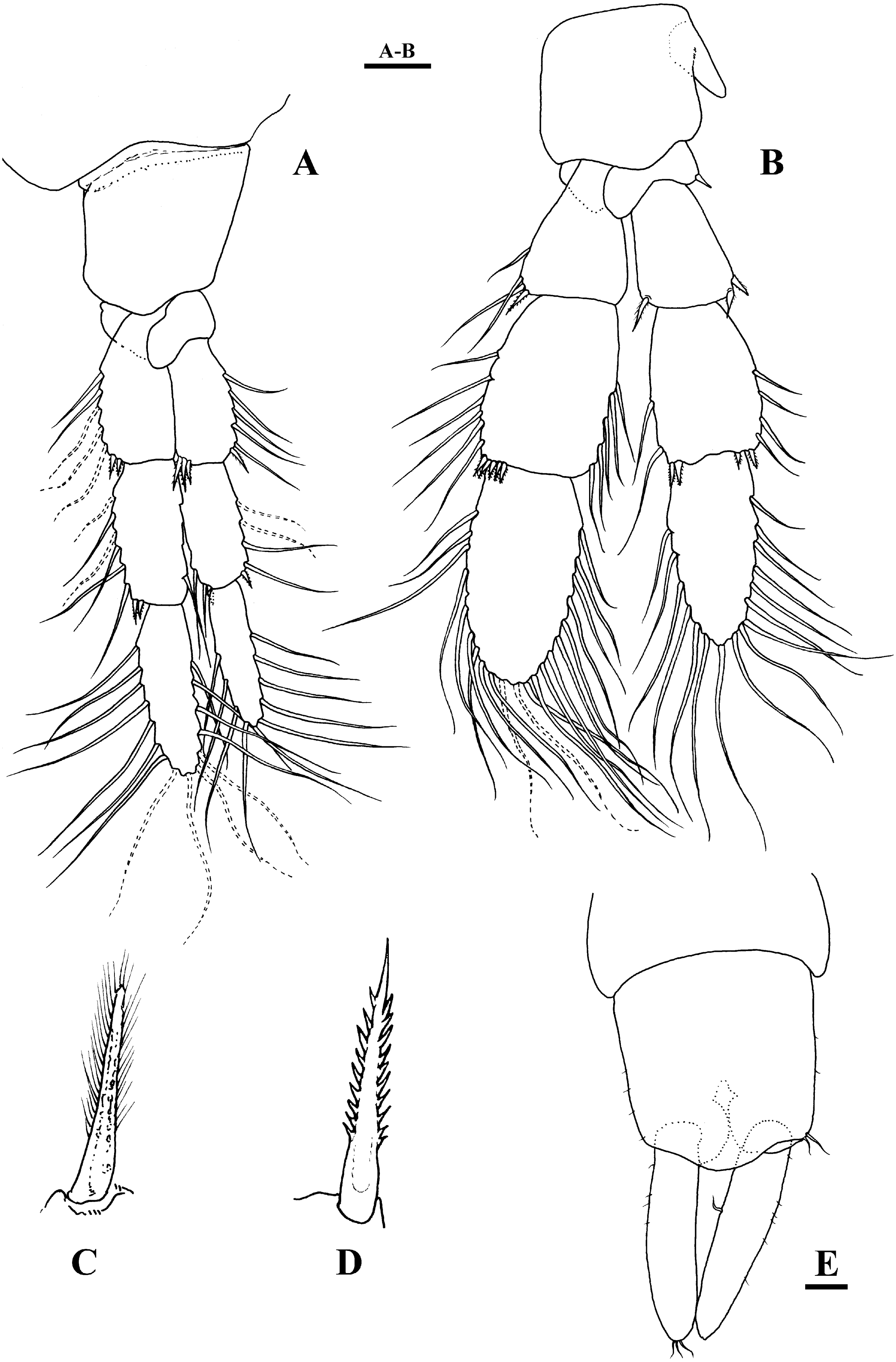

FIGURE 5. *Speleonectes williamsi* **n. sp.**, paratype 1 (10.2 mm). A: Limb of first trunk somite. B: Limb of fourteenth trunk somite, with enlarged short, stout plumose (C) and short, stout serrate seta (D). E: Anal somite. All scale bars = 0.1 mm.

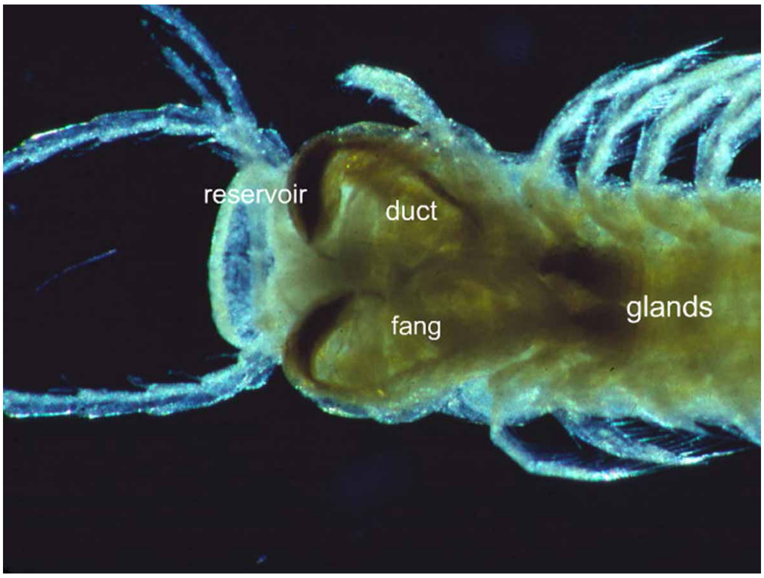

FIGURE 6. *Speleonectes williamsi* **n. sp.**, paratype 6. Detail of head and first trunk segments showing conspicuous glandular structures (see also Yager, 1991).

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References

Koenemann, S., Bloechl, A., Martinez, A., Iliffe, T.M., Hoenemann, M. & Oromi, P. (2009) Discovery of a new species of *Speleonectes* (Remipedia, Crustacea) on the Canary Islands. *Marine Biodiversity*, 39, 215–225.

Koenemann, S., Iliffe, T.M. & Yager, J. (2004) *Kaloketos pilosus*, a new genus and species of Remipedia (Crustacea) from the Turks and Caicos Islands. *Zootaxa*, 618, 1–12.

Lorentzen, D., Koenemann, S. & Iliffe, T.M. (2007) *Speleonectes emersoni*, a new species of Remipedia (Crustacea) from the Dominican Republic. *Zootaxa*, 1543, 61–68.

Neiber, M.T., Hartke, T.R., Stemme, T., Bergmann, A., Rust, J., Iliffe, T.M. & Koenemann, S. (2011) Global biodiversity and phylogenetic evaluation of Remipedia (Crustacea). *PLoS ONE*, 6(5), e19627.

Schram F.R. & Lewis C.A. (1989) Functional morphology of feeding in Nectiopoda. In Felgenhauer B. E., Watling L. & Thistle A. B. (Eds), *Functional Morphology of Feeding and Grooming in Crustacea*. A.A. Balkema, Rotterdam, pp. 115–122.

Schram, F. R., Yager, J. & Emerson, M..J. (1986) Remipedia. Part I. Systematics. *Memoirs of the San Diego Society of Natural History*, 15, 1–60.

Yager, J. (1981) A new class of Crustacea from a marine cave in the Bahamas. *Journal of Crustacean Biology*, 1, 328–333.

Yager, J. (1987) *Cryptocorynetes haptodiscus*, new genus, new species, and *Speleonectes benjamini*, new species, of remipede crustaceans from anchialine caves in the Bahamas, with remarks on distribution and ecology. *Proceedings of the Biological Society of Washington*, 100, 302–320.

Yager, J. & Schram, F.R. (1986) *Lasionectes entrichoma*, n. gen., n. sp. (Crustacea, Remipedia) from anchialine caves in the Turks and Caicos, B.W.I. *Proceedings of the Biological Society of Washington*, 99, 65–70.

Yager, J. (1991) The Remipedia (Crustacea): Recent investigations of their biology and phylogeny. *Verhandlungen der Deutschen Zoologischen Gesellschaft*, 84, 261–269.

van der Ham, J.L. & Felgenhauer, B.E. (2007) The functional morphology of the putative injecting apparatus of *Speleonectes tanumekes* (Remipedia). *Journal of Crustacean Biology*, 27, 1–9.