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A Preliminary Survey of the Harvestmen (Arachnida: Opiliones) of Tobago, West Indies

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ABSTRACT

Eleven species of harvestmen were collected from along the trail connecting the Speyside overlook to Pigeon Peak on Tobago, including representatives of the families Agoristenidae, Cosmetidae, Cranidae, Manaosbiidae, Sclerosomatidae, and Stygnidae. The most abundant species were *Cynortula granulata* Roewer 1912 (Cosmetidae), *Paecilaemainglei* Goodnight and Goodnight 1947 (Cosmetidae), *Rhopalocranaus albilineatus* Roewer 1932 (Manaosbiidae) and *Phareicranaus calcariferus* (Simon 1879) (Cranidae). We also captured adults of *Prionostemma vittatum* Roewer 1910, *Avima intermedia* (Goodnight and Goodnight 1947) and *Stygnoplus biguttatus* Pinto-da-Rocha 1997. With the exception of *P. calcariferus*, each of these collections represent a new record for Tobago. In this paper, we also provide descriptions of the male reproductive anatomy for each species as well as notes on natural history, including the association of cyanobacteria with a sclerosomatid harvestman and stridulation by *C. granulata*.

Key words: biogeography, Caribbean, Laniatores, Neotropical, taxonomy, faunistics.

INTRODUCTION

Harvestmen (also known as daddy longlegs or harvest spiders) belong to the Opiliones, the third largest order of arachnids (approximately 6,500 species: Kury 2011). Since 2003, we have engaged in field and laboratory-based studies of harvestmen from Trinidad (Townsend *et al.* 2008a). These investigations have provided new insights into the biology of these arachnids, especially with respect to habitat use (Burns *et al.* 2007; Proud *et al.* 2011; Townsend *et al.* 2011a), behavioral ecology (Hunter *et al.* 2007; Proud and Townsend 2008), interactions with parasitic and phoretic mites (Townsend *et al.* 2008b), and developmental morphology (Townsend *et al.* 2009). In addition to a key to families, Townsend *et al.* (2008a) provided the first records for the Kimulidae in Trinidad. Since the publication of this paper, we have confirmed the identity of these species that we had previously listed as unidentified including *Cynortula granulata* Roewer 1912 (*Cynortula* sp. 1), *C. undulata* Roewer 1947 (*Cynortula* sp. 2), *Paecilaema paucipustulatum* Roewer 1947 (*Paecilaema* sp. 2), and *Avima intermedia* (Goodnight and Goodnight 1947) (*Trinella* sp.).

In comparison to the harvestmen fauna of Trinidad, very little is known about the natural history, diversity or distribution of harvestmen from Tobago. Cokendolpher and Camilo-Rivera (1989) provided a single combined

species list for Trinidad and Tobago. Similarly, Kury (2003) did not distinguish between the faunas of these islands, and listed the only confirmed record for Tobago (Pinto-da-Rocha and Kury 2003) as being the cranid harvestman *Phareicranaus calcariferus* Roewer 1932.

The primary objective of our study was to examine the diversity of harvestmen in Tobago. In the field, we also made natural history observations concerning microhabitat selection, diurnal and nocturnal activity, parental care, and anti-predatory behaviors. In efforts to identify undescribed species and confirm the distribution of known taxa, we also dissected and compared the reproductive anatomy of adult males for species from Tobago and Trinidad.

METHODS

Harvestmen were collected by hand from vegetation and beneath logs and palm fronds from 10-14 August, 2010. All specimens were encountered along the trail connecting the Speyside overlook to Pigeon Peak, and within hiking distance of our base camp (11N 17.845 60W 32.934 at 1331 ft. elevation). Primary habitat in this area is lower montane rainforest.

Sampling occurred along trails during morning, afternoon and evening hours. Prior to collection, several individuals were observed haphazardly for brief periods

(5-10 min.) of time. Voucher specimens of adults were preserved in 70% ethanol.

In the laboratory, specimens were photographed with a Leica EZD4 digital stereomicroscope. Genitalia of adult males were dissected and prepared for examination with scanning electron microscopy (SEM). We also dissected penises from harvestmen collected from Trinidad (Townsend *et al.* 2008a) as well as from select museum specimens from the American Museum of Natural History, New York, U.S.A. (AMNH). Penises were dehydrated in a graded ethanol series, dried with hexamethyldisilazane, sputter-coated with gold, and photographed with a Hitachi S-3000N SEM in the Microscopy Center at the University of Louisiana at Lafayette, USA. Voucher specimens will be deposited in the AMNH collection.

RESULTS AND DISCUSSION

We collected 11 species of harvestmen including representatives of 6 families (Table 1). However, we did not capture any individuals for the families Kimulidae, Samoidae, Stygnommatidae and Zalmoxidae, taxa that occur in forested habitats in Trinidad (Table 1). Individuals of these families predominantly occur in the leaf litter microhabitat (Townsend *et al.* 2008a). The visual survey method that we employed in Tobago is biased against the collection of small, secretive species that occur primarily in the leaf litter. Thus, it is possible that representatives of these families may occur in Tobago and that we simply failed to find them.

In Tobago, our field observations indicate that the most common species of harvestmen are *Cynortula granulata* (Cosmetidae), *Paecilaema inglei* Goodnight and Goodnight 1947 (Cosmetidae), *Prionostemma* sp. 6 (Sclerosomatidae), *Prionostemma* sp. 7, *Rhopalocranus albilineatus* Roewer 1932 (Manaosbiidae), and *Phareicranus calcariferus* (Simon 1879) (Cranidae). These species occurred in most habitats and were locally abundant in several locations. In contrast, we found relatively few individuals of *Cranellus* sp. (Manaosbiidae), *Stygnoplus biguttatus* Pinto-da-Rocha 1997 (Stygnidae), *Avima* spp. (Agoristenidae), and *Prionostemma vittatum* (Sclerosomatidae). Our comparative study of reproductive anatomy revealed that there are several species of harvestmen that may be endemic to Tobago. These taxa include *Cranellus* sp. (Figs. 2E-F, 6A-B), *Prionostemma* spp. (Figs. 4A-D, 6G-J), and *Avima* sp. (Figs. 1A, 5A-B). The following is a detailed summary of our observations of species for each family. In addition, we provide a description of penis morphology for each species.

Agoristenidae

Trinella, the largest genus in the subfamily Leiosteninae, was recently found to be a junior synonym of *Avima*

(Villarreal and Kury 2009). The agoristenid species that occur in Trinidad and Tobago are members of this genus. Male *Avima* have relatively large chelicerae (Fig. 1A) in comparison to females (Fig. 1B). Leg I of these harvestmen is filiform and much narrower than legs II-IV (Figs. 1A-B). The two species from Tobago are easily distinguished by their dorsal coloration. In contrast to *A. albiornata* from Trinidad which has white spots on the third free tergite and anal operculum, *Avima* sp. from Tobago has large white spots on the lateral margins of the dorsal scutum (Figs. 1A-B). Adult *A. intermedia* lack these spots and have a relatively uniform brown dorsum, with a darker central region on the opisthosoma (Fig. 1C). The penises of these harvestmen (Figs. 5A-E) have a truncus with an apical ventral plate and a stylus with dorsal longitudinal crest (Pinto-da-Rocha and Kury 2007). As with the penises of other *Avima* spp. (Pinto-da-Rocha 1996), the trunci of the Trinidad and Tobago species have 3 lateral pairs of bifid setae with a single glans. In *Avima* spp. from Tobago (Figs. 5A-D), there were no single setae above the bifid setae on the truncus and the most variable characters between species were the relative length and shape of the stylus. We also observed interspecific variation (Figs. 5A-C) in the shape of the ventral plate.

We collected *Avima* spp. from leaf litter, palm fronds and a shaded cove-like area adjacent to a trail. Most individuals were adults ($n = 6$ for *Avima* sp., $n = 4$ for *A. intermedia*), but we did capture one late nymph.

Cosmetidae

We collected two species for this family: *Cynortula granulata* (Figs. 1E-F) and *Paecilaema inglei* (Figs. 1D). These species are easily distinguished on the basis of relative body size, dorsal armature, tarsal formula and coloration. *Paecilaema* is larger with respect to scutal length (2-3 mm) and has larger paired, spiniform tubercles on the dorsum. The dorsum of adult *P. inglei* is covered in small, scattered white spots (Fig. 1D). Males of *Paecilaema* have enlarged chelicerae in comparison to females, whereas the chelicerae of male and female *C. granulata* are very similar in size. In males of both species, the basal tarsal segments of leg I are enlarged. In *Paecilaema*, there are seven tarsomeres on leg I, whereas in *Cynortula*, there are only six. The penises of these harvestmen (Figs. 5F-L) have a relatively long truncus, with a distal end consisting of a ventral plate and a dorsal stylus with a crest (Kury and Pinto-da-Rocha 2007). There are 2-3 distolateral curved setae and 2 basal straight setae on the lateral border of the ventral plate. We observed interspecific variation (Figs. 5F-L) in the shape of the distal border of the ventral plate, the relative size of the glans, and the number of distolateral curved setae on the ventral plate. However, comparisons with multiple (3-5) speci-

Table 1. The harvestmen fauna of Trinidad and Tobago. All species records from Tobago are new, with the exception of *P. calcariferus* (Kury 2003; Pinto-da-Rocha and Kury 2003). X* denotes taxa confirmed by Townsend *et al.* (2008a).

Taxa	Tobago	Trinidad	Venezuela
Agoristenidae			
<i>Avima albiornata</i> (Goodnight and Goodnight 1947)		X	
<i>Avima intermedia</i> Goodnight and Goodnight 1947	X	X*	
<i>Avima leiobuniformis</i> (Šilhavý 1973)		X*	
<i>Avima</i> sp.	X		
Cosmetidae			
<i>Cynortula granulata</i> Roewer 1912	X	X*	
<i>Cynortula modesta</i> (Sørensen 1932)		X	
<i>Cynortula undulata</i> Roewer 1947		X*	
<i>Libitiosoma granulatum</i> Roewer 1947		X	
<i>Paecilaema adspersum</i> Roewer 1947		X	
<i>Paecilaema inglei</i> Goodnight and Goodnight 1947	X	X*	X
<i>Paecilaema paucipustulatum</i> Roewer 1947		X*	
<i>Vonones testaceus</i> Roewer 1947		X	
Cranidae			
<i>Phareicranaus calcariferus</i> (Simon 1879)	X	X*	X
Kimulidae			
sp. 1		X*	
sp. 2		X*	
sp. 3		X*	
Manaosbiidae			
<i>Cranellus montgomeryi</i> Goodnight and Goodnight 1947		X*	
<i>Cranellus</i> sp.	X		
<i>Rhopalocranaus albilineatus</i> Roewer 1932	X	X*	X
Samoidae			
<i>Maracaynatum trinidadense</i> Šilhavý 1979		X*	
<i>Pellobunus longipalpus</i> Goodnight and Goodnight 1947		X*	
sp. 3		X*	
Sclerosomatidae			
<i>Holcobunus aureopunctata</i> Roewer 1953		X	
<i>Prionostemma fuliginosum</i> Roewer 1953		X	
<i>Prionostemma insulare</i> Roewer 1953		X*	X
<i>Prionostemma referens</i> Roewer 1953		X	
<i>Prionostemma vittatum</i> Roewer 1910	X	X*	X
<i>Prionostemma</i> sp. 5		X*	
<i>Prionostemma</i> sp. 6	X		
<i>Prionostemma</i> sp. 7	X		
Stygnidae			
<i>Stygnoplus clavotibialis</i> (Goodnight and Goodnight 1947)		X*	X
<i>Stygnoplus biguttatus</i> Pinto-da-Rocha 1997	X		
Stygnommatidae			
<i>Stygnomma</i> sp.		X*	
Zalmoxidae			
<i>Ethobunus tuberculata</i> (Goodnight and Goodnight 1947)		X	X

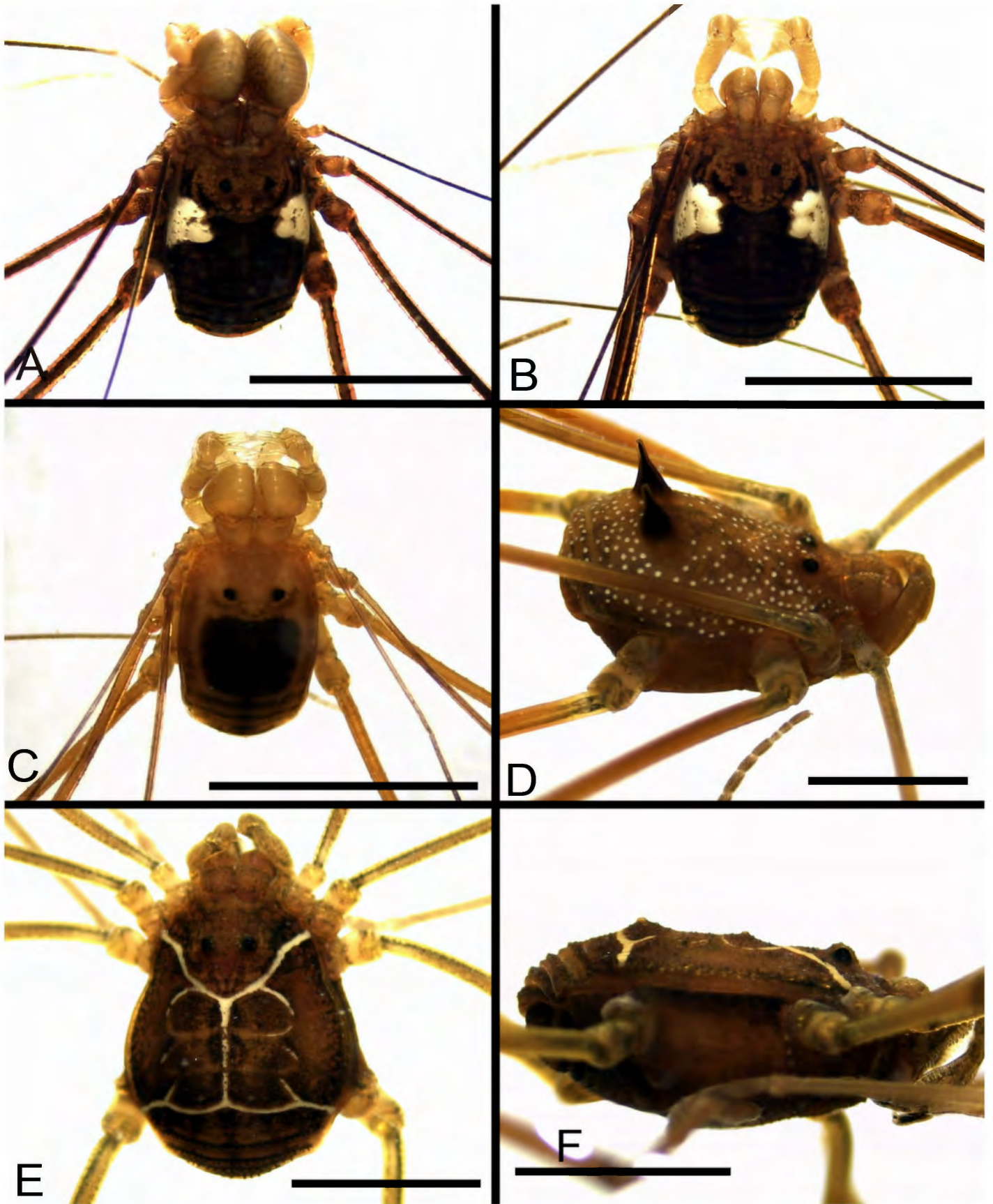


Fig. 1. Photographs of harvestmen from the families Agoristenidae and Cosmetidae. A. Dorsal view of a male *Avima* sp. (Agoristenidae). B. Dorsal view of a female *Avima* sp. C. Dorsal view of *A. intermedia*. D. Lateral view of *Paecilaema inglei* (Cosmetidae). E. Dorsal view of a male *Cynortula granulata* (Cosmetidae). F. Lateral view of a female *C. granulata*. Scale bars = 3 mm.

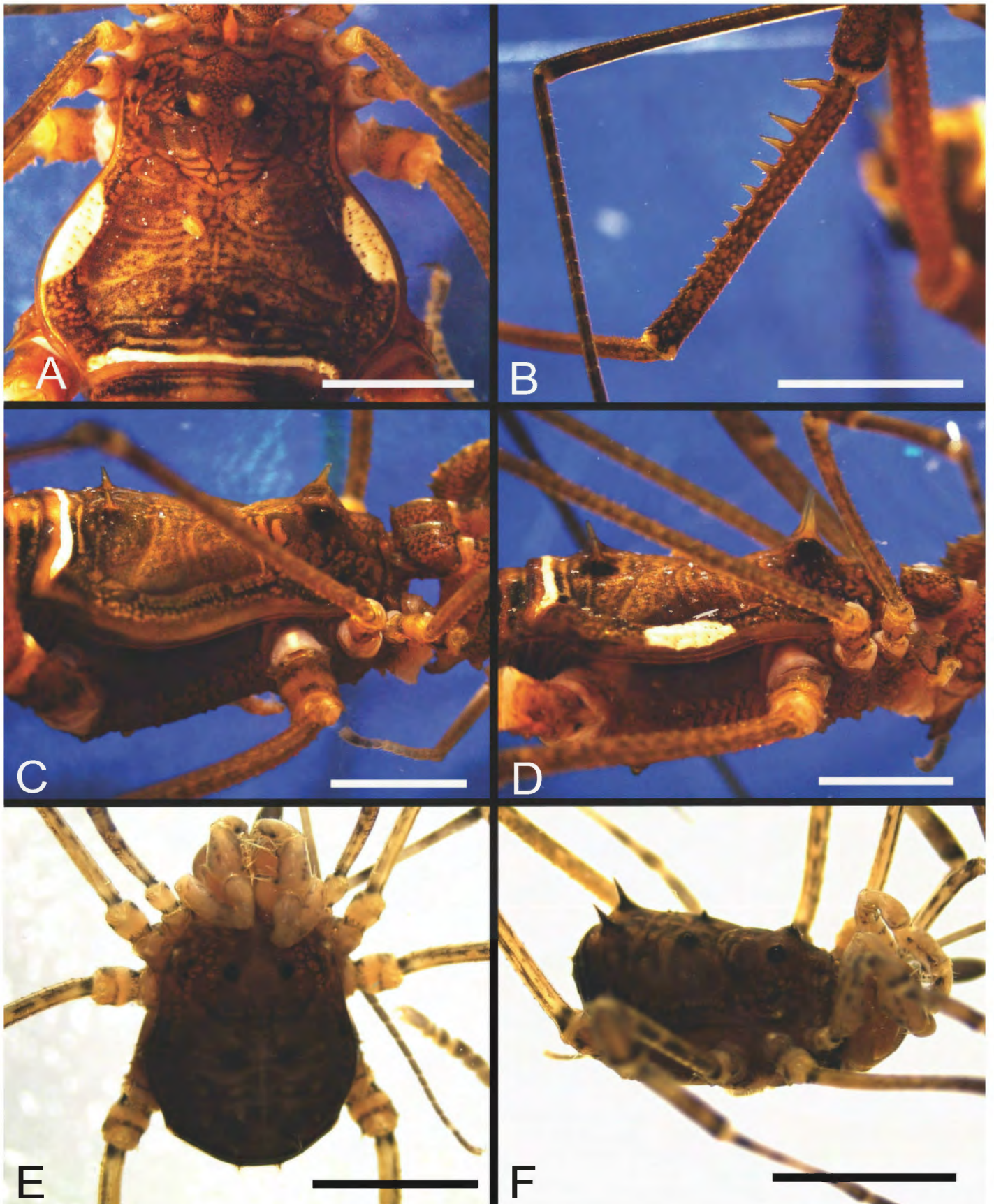


Fig. 2. Photographs of the harvestmen *Phareicranaus calcariferus* (Cranidae) and *Cranellus* sp. (Manaosbiidae). A. Dorsal view of male *P. calcariferus*. B. Lateral view of left tibia IV of male *P. calcariferus*. C. Lateral view of male *P. calcariferus*. D. Lateral view of male *P. calcariferus*. E. Dorsal view of male *Cranellus* sp. F. Lateral view of male *Cranellus* sp. Scale bars = 3 mm.

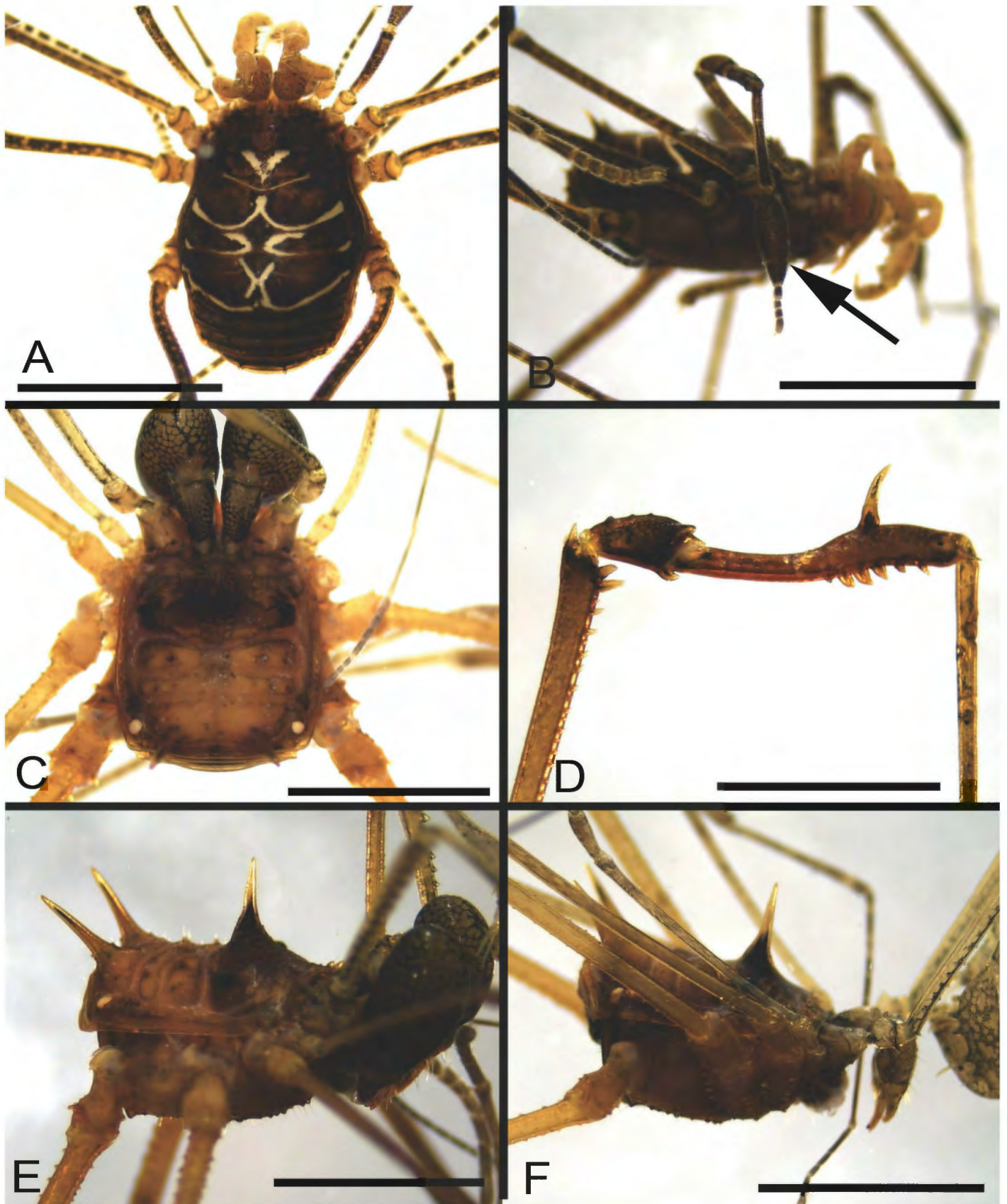


Fig. 3. Photographs of the harvestmen *Rhopalocranaus albilineatus* (Manaosbiidae) and *Stygnoplus biguttatus* (Stygnidae). **A.** Dorsal view of female *R. albilineatus*. **B.** Lateral view of male *R. albilineatus*, arrow indicates enlarged basitarsal segments on leg I. **C.** Dorsal view of male *S. biguttatus*. **D.** Lateral view of femur, patella and tibia IV of male *S. biguttatus*. **E.** Lateral view of male *S. biguttatus*. **F.** Lateral view of female *S. biguttatus*. Scale bars = 3 mm.

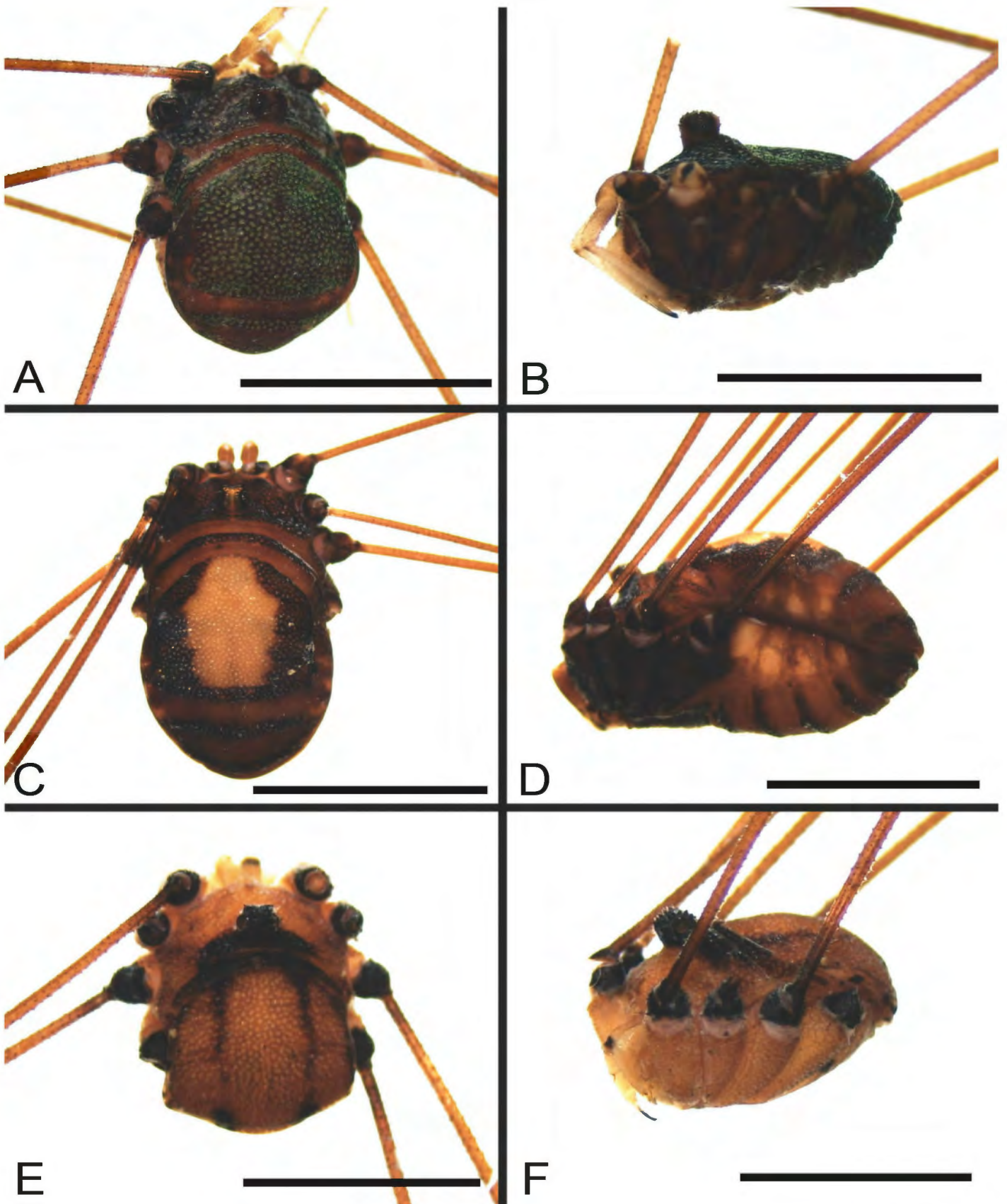


Fig. 4. Photographs of harvestmen from the family Sclerosomatidae. **A.** Dorsal view of a female *Prionostemma* sp. 6. **B.** Lateral view of a male *Prionostemma* sp. 6. **C.** Dorsal view of a female *Prionostemma* sp. 7. **D.** Lateral view of a female *Prionostemma* sp. 7. **E.** Dorsal view of a male *Prionostemma vittatum*. **F.** Dorsal view of a male *Prionostemma vittatum*. Scale bars = 3 mm.

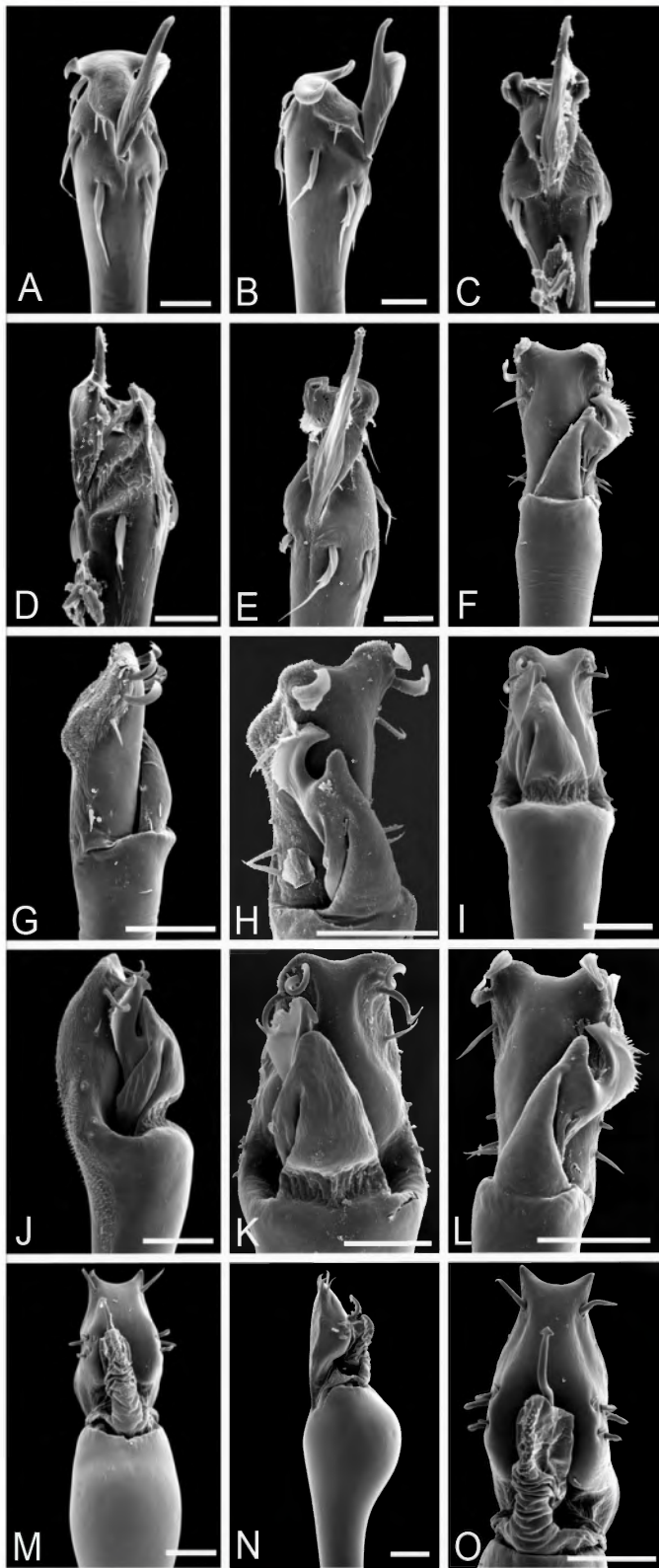


Fig. 5. SEM micrographs of the distal tip of the penis of select species of harvestmen. **A.** *Avima* sp. 1 (Agoristenidae) from Tobago, dorsal view. **B.** *Avima* sp. 1 (Agoristenidae) from Tobago, lateral view. **C.** *A. intermedia* from Tobago, dorsal view. **D.** *A. intermedia* from Tobago, lateral view. **E.** *A. leiobuniformis* from Trinidad, dorsal view. **F.** *Cynortula granulata* (Cosmetidae) from Tobago, dorsal view. **G.** *C. granulata* (Cosmetidae) from Tobago, lateral view. **H.** *C. granulata* from Trinidad, dorsal view. **I.** *Paecilaemainglei* (Cosmetidae) from Tobago, dorsal view. **J.** *P.inglei* (Cosmetidae) from Tobago, lateral view. **K.** *P.inglei* from Trinidad, dorsal view. **L.** *P. paucipustulatum* from Trinidad, dorsal view. **M.** *Phareicranaus calcariferus* (Cranaiidae) from Tobago, dorsal view. **N.** *P. calcariferus* (Cranaiidae) from Tobago, lateral view. **O.** *P. calcariferus* from Trinidad, dorsal view. Scale bars = 50 μ m for A-E; 100 μ m for F-O.

mens from each species that were collected from Trinidad revealed little or no intraspecific variation in penis morphology (Figs. 5F-L).

With respect to natural history, we collected individuals of both species from beneath palm fronds and logs ($n = 114$ for *C. granulata*, $n = 22$ for *P.inglei*). Several individuals of *C. granulata* stridulated in response to being held. The functional significance of this behavior is unclear, although it may be useful in defense as a means for startling a potential predator (Gnaspini and Hara 2007). We also observed that several adults retracted their legs and remained motionless for many seconds when disturbed. Prior studies have interpreted this behavior as thanatosis or death feigning (Chelini *et al.* 2009). We collected several, relatively late nymphs ($n = 5$) of *P.inglei*. In contrast to adults, nymphs possess elongate, pointed (rather than flattened) pedipalps.

Cranaiidae

Recently, Pinto-da-Rocha and Bonaldo (2011) synonymized the two known species of cranaid harvestmen from Trinidad. The sexually dimorphic characters that had been used to distinguish between males were reinterpreted as differences between two male morphotypes, alpha and beta. Adult male *Phareicranaus calcariferus* vary in total body length from 9.4-11.2 mm (Townsend *et al.* 2009) and are the largest species of harvestman on Trinidad (Townsend *et al.* 2008a). On Tobago, we collected adults (Figs. 2A-D) and nymphs. Adult males are easily recognized on the basis of their enlarged chelicerae and the armature of femur-tibia IV (Fig. 2B). The distal end of the penis of *P. calcariferus* has a ventral plate with a slightly concave margin, and an arrow-like stylus with a folded glans (Figs. 5M-O). We compared the genitalia of 3-5 adults from each island, but did not observe intraspecific variation in penis morphology between individuals collected from Trinidad and Tobago (Figs. 5M-O). However, we observed variation in the dorsal coloration of adult males on Tobago. Adults from Trinidad and most individuals from Tobago generally have large yellow or white spots on the lateral margins of the dorsal scutum (Fig. 2D). However, a few adult males from Tobago lacked these spots (Fig. 2C).

In the field, we found cranaiids ($n = 35$ adults) generally inactive during the day. They were most commonly observed occupying spaces beneath logs or within palm

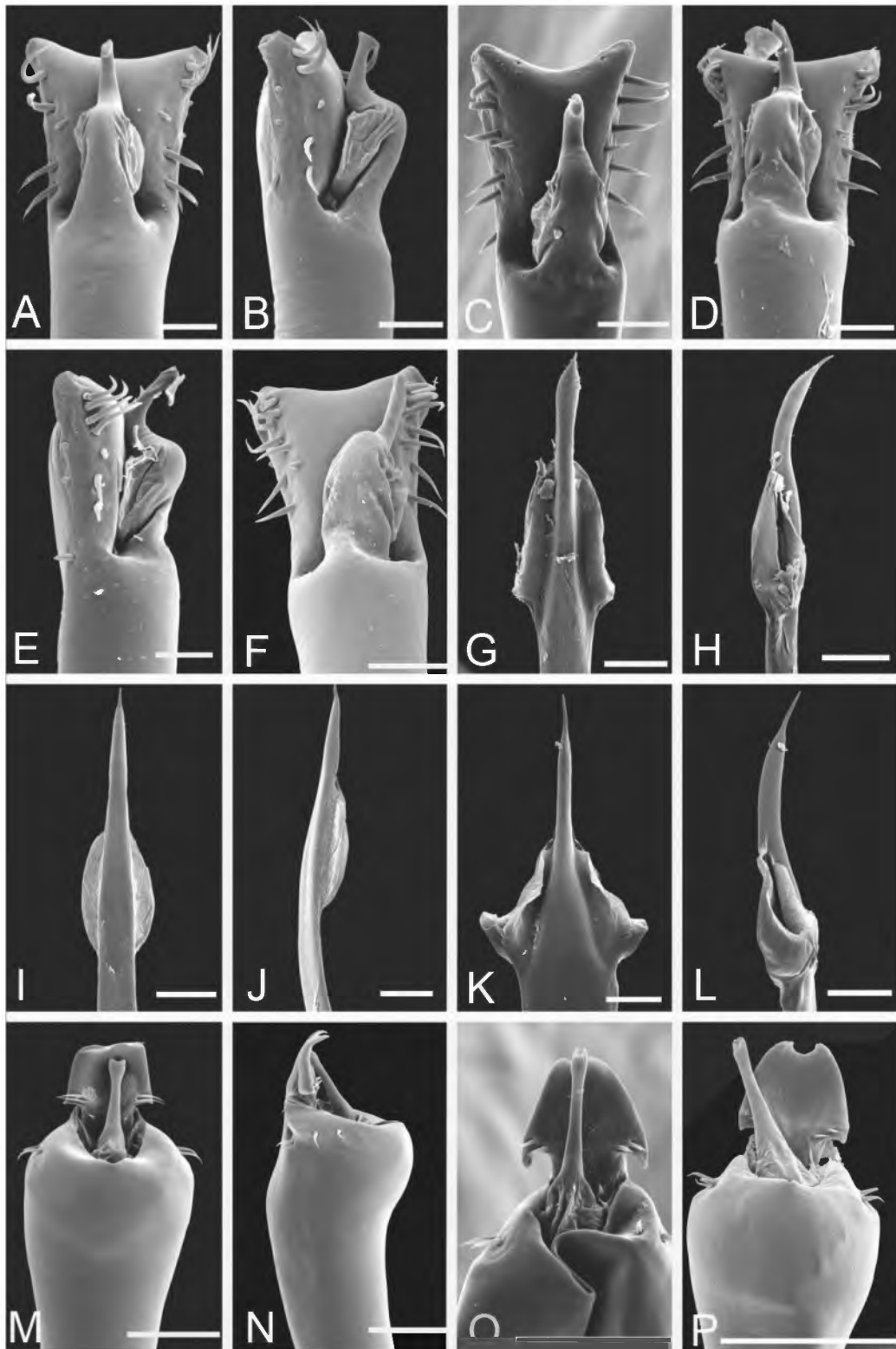


Fig. 6. SEM micrographs of the distal tip of the penis of select species of harvestmen. **A.** *Cranellus* sp. (Manaosbiidae) from Tobago, dorsal view. **B.** *Cranellus* sp. (Manaosbiidae) from Tobago, lateral view. **C.** *C. montgomeryi* from Trinidad, dorsal view. **D.** *Rhopalocranaus albilineatus* (Manaosbiidae) from Tobago, dorsal view. **E.** *R. albilineatus* (Manaosbiidae) from Tobago, lateral view. **F.** *R. albilineatus* from Trinidad, dorsal view. **G.** *Prionostemma* sp. 6 (Sclerosomatidae) from Tobago, dorsal view. **H.** *Prionostemma* sp. 6 (Sclerosomatidae) from Tobago, lateral view. **I.** *Prionostemma* sp. 7 from Tobago, dorsal view. **J.** *Prionostemma* sp. 7 from Tobago, lateral view. **K.** *P. vittatum* from Tobago, dorsal view. **L.** *P. vittatum* from Tobago, lateral view. **M.** *Stygnoplus biguttatus* (Stygnidae) from Tobago, dorsal view. **N.** *S. biguttatus* (Stygnidae) from Tobago, lateral view. **O.** *S. clavotibialis* from Trinidad, dorsal view. **P.** *S. tuberculatus* from Dominica, dorsal view. Scale bars = 50 μ m for A-F; 150 μ m for G-L; 100 μ m for M-P.

frond sheaths. At night, however, we frequently discovered adults climbing the vegetation. With the exception of *Prionostemma* spp., *P. calcariferus* is probably the most arboreal harvestmen on Tobago. We also observed multiple instances of adults in close proximity to early and late nymphs ($n = 40$), presumably the adults actively defend eggs, larvae and nymphs (Machado and Warfel 2006; Hunter *et al.* 2007; Townsend *et al.* 2009; Townsend *et al.* 2011a).

Manaosbiidae

The males of *Cranellus* and *Rhopalocranaus* possess enlarged and fused basitarsi on leg I (Fig. 3A), features not exhibited by females. This dimorphism is common to most, but not all, taxa in the family (Kury 1997; Townsend *et al.* 2011b). These species differ markedly with respect to coloration. *Cranellus* sp. has a dark brown dorsum with lighter brown-yellow appendages (Figs. 2E-F). In contrast, *Rhopalocranaus albilineatus* has white or yellow lines on its dark brown dorsum and its dark brown legs are similar in color to the dorsum (Figs. 3A-B). The *Cranellus* sp. from Tobago differs from *C. montgomeryi* from the Northern Range in Trinidad in several respects, including leg coloration and dorsal armature. In general, the legs of *Cranellus* sp. are darker and have a more distinct pattern of darker mottling than those of *C. montgomeryi*. This species also has fewer small, granular tubercles on its dorsum. The penis of this species has one less marginal spine on each side of the ventral plate as well as a slightly more concave distal margin (Fig. 6A-B) than that of *C. montgomeryi* (Fig. 6C). Based upon an examination of multiple (3-5) individuals, we did not find any intraspecific variation in penis morphology between populations of *R. albilineatus* from Trinidad and Tobago (Figs. 6D-F).

Our field collections indicate that *R. albilineatus* is generally more abundant ($n = 122$ adults) than *Cranellus* sp. ($n = 9$) on Tobago. We also collected several late nymphs of *R. albilineatus* ($n = 28$) and *Cranellus* sp. ($n = 5$), indicating that both species were reproductively active prior to our sampling period. Individuals were most frequently captured from beneath logs, palm fronds and the leaf litter.

Sclerosomatidae

We collected three species of harvestmen from this family, including *Prionostemma vittatum*, and two unidentified *Prionostemma* spp. (species 6 and 7; these species differ from three unidentified species from Trinidad (Townsend *et al.* 2008a)). *Prionostemma vittatum* (Figs. 4E-F) differs from other species in having lightly colored coxae, with a dark eye mound, and two black lines on its dorsum. In Trinidad (Townsend *et al.* 2008a), it is one of

the most common harvestmen, however, on Tobago, we only collected two adults.

Prionostemma sp. 6 is generally very dark (Figs. 4A-B). In the living condition, individuals of both sexes are bluish green. In ethanol, much of this coloration fades, however, if a specimen is allowed to air dry, small spots of blue or green become readily visible. To further investigate this unusual coloration, we examined an in-

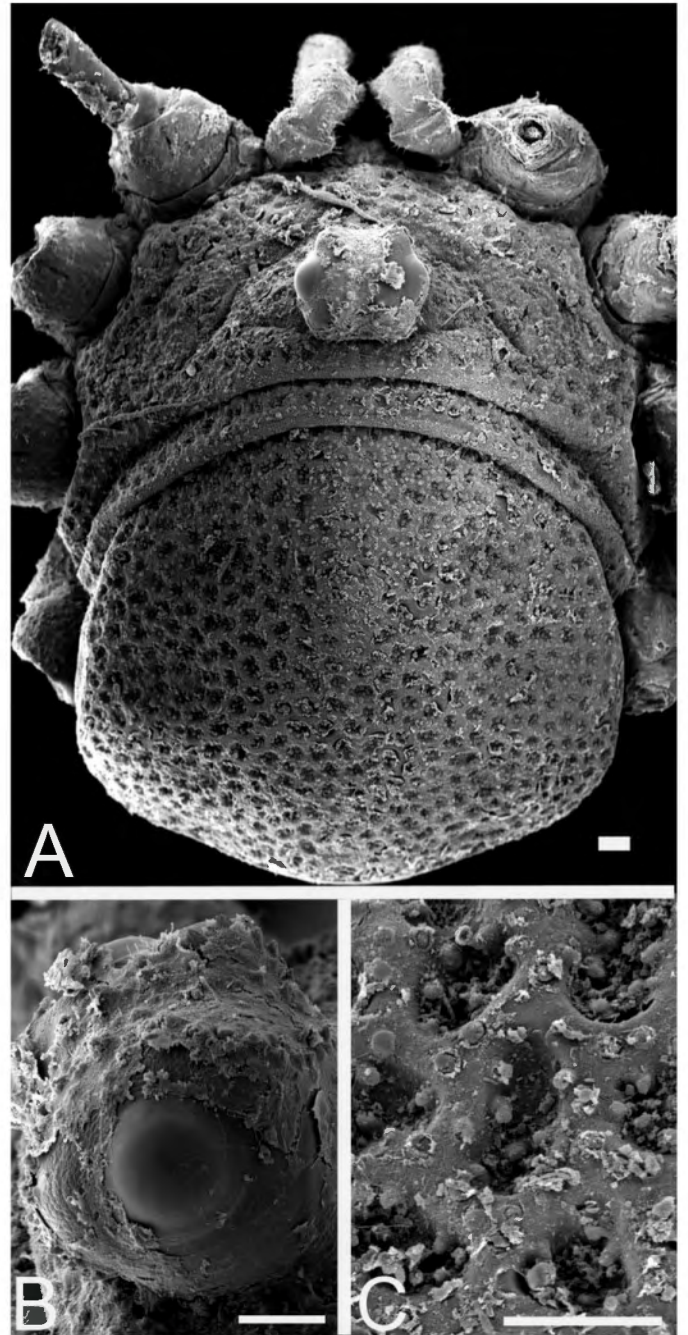


Fig. 7. SEM micrographs of the dorsal surfaces of an adult male *Prionostemma* sp. 6 revealing the distribution of an epizoic organism, presumably cyanobacteria. **A.** Dorsal habitus. **B.** Lateral view of eye mound. **C.** Pits on dorsal surface of opisthosoma. Scale bars = 100 μ m.

dividual with SEM (Fig. 7). The dorsal surface of this specimen had a highly pitted morphology (Fig. 7A, C). The prosoma, opisthosoma, ocularium (Fig. 7B) and coxae were covered in a thin, irregular film that had a scattered distribution of small, rounded cellular structures. Removal of this film from several individuals and examination by light microscopy revealed that these cells were similar in size and shape to those of cyanobacteria, but were not distinctive. Machado and Vital (2001) identified epizoic cyanobacteria and liverworts from multiple specimens of Neotropical harvestmen in Brazil. Given the color and general morphology of the film present on this specimen, we hypothesize that these harvestmen host either cyanobacteria or an epizoic fungus. We collected 55 individuals of this species, every specimen was bluish green.

The second unidentified species (Figs. 4C-D) was also relatively common ($n = 40$ adults). This species had a dark patch on the lateral margins and posterior third of the dorsum, a dark prosoma and coxae, and a lighter ventral surface of the opisthosoma. With respect to reproductive morphology, the penises of sclerosomatid harvestmen feature a truncus with a terminal stylus (Tourinho 2007). Neotropical species in this family also often possess an alate portion with winglets (Figs. 6G-L). We observed interspecific variation in the relative size and shape of the winglets and the relative length of the stylus at the tip of the glans.

Sclerosomatid harvestmen are generally inactive during the day, occupying perches on leafy vegetation and on tree trunks and buttresses. After dark, they become more active and wander in the leaf litter, presumably in search of food and mates (Grether and Donaldson 2007; Donaldson and Grether 2007; Wade *et al.* 2011). We rarely captured individuals from beneath cover objects. We captured 12 early and late nymphs, but were unable to identify them to species.

Stygnidae

We collected multiple adult *Stygnoplus biguttatus* Pinto-da-Rocha 1997 ($n = 9$). Males possess relatively large chelicerae (Fig. 3C, E) in comparison to females (Fig. 3F). Femur-tibia IV of the male is also armed with large spines (Fig. 3D) that are absent on the female. Males from Tobago appear to possess relatively larger spines on leg IV in comparison with those from populations in Venezuela (Pinto-da-Rocha 1997). In *Stygnoplus*, the dorsum is also adorned with a single large spine between the separate eye mounds and there are paired, large spini-form tubercles on the posterior region of the opisthosoma (Figs. 3E-F). In *Stygnoplus biguttatus*, the relative size of the spine between the eyes is also sexually dimorphic

(Figs. 3E-F). Penis morphology (Fig. 6M-P) consists of a truncus with a distal tip divided into a ventral plate and dorsal glans bearing the stylus (Pinto-da-Rocha 1997). In comparison to *S. clavotibialis* from Trinidad (Fig. 6O) and *S. tuberculatus* from Dominica (Fig. 6P), the ventral plate of the penis in this species (Fig. 6M) differs in shape with respect to both the distal margin and the proximal, lateral margins. In addition, the relative shape and size of the stylus exhibits interspecific variation.

With respect to natural history, individuals were collected from logs and the surfaces of tree buttresses, but were not found in the leaf litter. We rarely captured more than two individuals from the same area and did not observe any nymphs.

SUMMARY

Our field study provides the first insights into the biology of harvestmen from Tobago and further contributes to the study of their diversity and biogeography in the West Indies. Our data collectively increase the diversity of harvestmen occurring on Tobago from one to 11 species (Kury 2003). Owing to the limitations of our sampling method with respect to small leaf litter taxa and our limited number of sample sites, we were only able to confirm the occurrence of six families on Tobago (Table 1). A more thorough sampling approach involving pitfall traps and litter sifting is needed to determine if harvestmen from the families Kimulidae, Samoidae, Stygnomatidae and Zalmoxidae also occur on the island.

Our natural history observations for the harvestmen of Tobago are similar to those previously reported for species from Trinidad during the wet season (Townsend *et al.* 2008a). In general, our field observations indicate that most species are nocturnal and active in the leaf litter in forested habitats. In addition, the collection of nymphs indicates that several species are reproductively active during the later months of the dry season or the early portion of the wet season. As with populations of *Phareicranaus calcariferus* in Trinidad (Hunter *et al.* 2007; Townsend *et al.* 2009; Townsend *et al.* 2011a), we found adult *P. calcariferus* in close proximity to nymphs of several instars in Tobago. With the exception of this species, little is known about the behavior or reproductive biology of harvestmen from either Trinidad or Tobago. Future studies that investigate natural history and behavior as well as interactions between harvestmen and their predators, prey and parasites are needed for both wet and dry seasons.

With respect to reproductive anatomy, our study provides the first descriptions or SEM micrographs of penis morphology for several species of harvestmen from Tobago and Trinidad, especially for taxa described prior

to the 1970s. Over the past several decades, characters based upon penis morphology have become critical elements in taxonomic studies (Acosta *et al.* 2007). Comparative studies of reproductive anatomy are also useful in examining intraspecific and interspecific variation among populations from different islands. In our study, we were able to confirm the presence of *Cynortula granulata*, *Paecilaema inglei* and *Rhopalocranaus albilineatus* on Tobago.

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