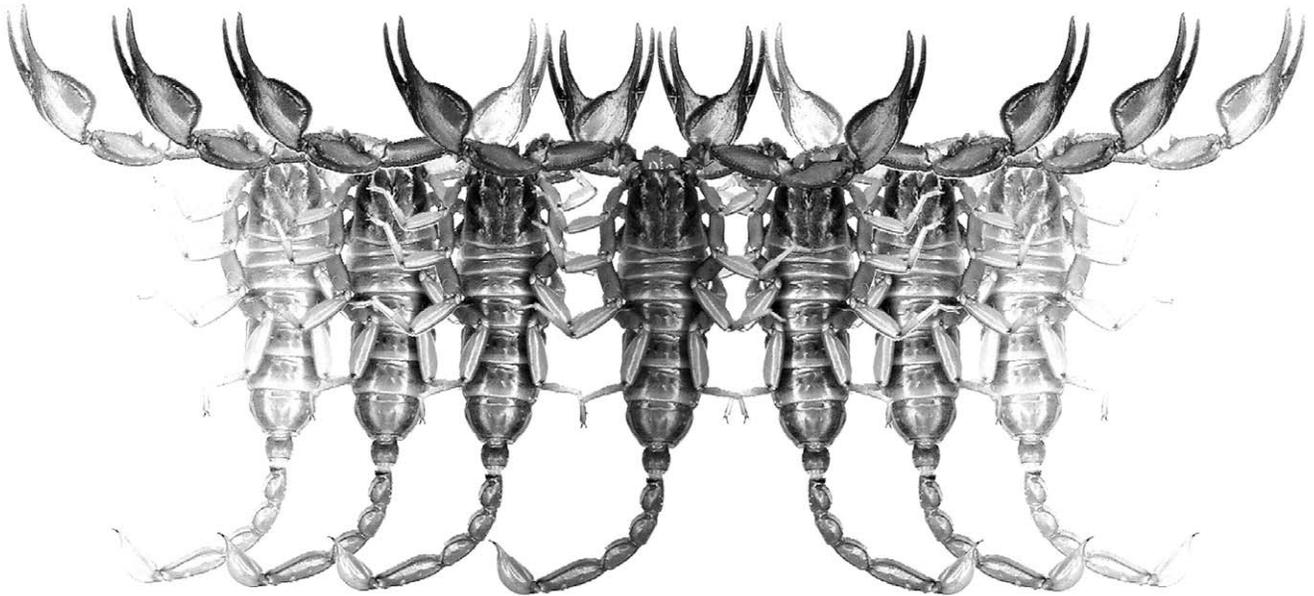


Euscorpius

Occasional Publications in Scorpiology



**The Scorpion Fauna of Mona Island, Puerto Rico
(Scorpiones: Buthidae, Scorpionidae)**

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Euscorpius

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The scorpion fauna of Mona Island, Puerto Rico (Scorpiones: Buthidae, Scorpionidae)

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<http://zoobank.org/urn:lsid:zoobank.org:pub:FA6FF328-47B3-4BD3-AD86-B3CD7D70A53B>

Summary

The scorpion fauna of the small Mona Island (= Isla de Mona), located roughly midway between Hispaniola and Puerto Rico and administratively belonging to the latter, is herein revised. Three species are confirmed to occur: the buthids *Centruroides bani* Armas et Marcano Fondeur, 1987 and *Heteroctenus abudi* (Armas et Marcano Fondeur, 1987), plus the diplocentrine scorpionid *Cazierius garridoi* Armas, 2005. The previously recorded *Heteronebo* sp. is reexamined and deemed a mislabeled specimen of *Heteronebo portoricensis* Francke, 1978 from adjacent Puerto Rico. Also, *Centruroides mariaorum* Santiago-Blay, 2009 is demonstrated to be a junior synonym of *C. bani* (implying the first demonstrable records of the latter from both Mona Island and Puerto Rico) and *Rhopalurus virkkii* Santiago-Blay, 2009 is confirmed as a junior synonym of *H. abudi*. A thorough photographic complement and supplementary ecological and distributional data are provided for every species.

Introduction

The Puerto Rican Isla de Mona (hereafter Mona Island) is a Greater Antillean islet located roughly midway between the much larger islands of Hispaniola and Puerto Rico. The island maximum size is 11 x 7 km and its general contour is kidney-shaped but angulose (Fig. 9). It is a low limestone karstic plateau with step coastal cliffs, largely covered by a xerophytic to semidesertic scrub, enriched with microphyllous semicaducifolious forest in the interior dolines and ravines (Fig. 10). Though currently unpopulated, it has been declared a Nature Reserve and every year receives researchers, students and tourists as visitors.

Its scorpion fauna has been the subject of recent interest and controversy. First, Armas (2005) recorded two undetermined species of the scorpionid genera *Cazierius* Francke, 1978 and *Heteronebo* Pocock, 1893, based exclusively on juvenile specimens. Immediately Armas (2006) examined the first adult of the former (a female) and clarified its identity as *Cazierius garridoi* Armas, 2005, described in the same previous paper allegedly from the highest mountain of mainland Puerto Rico.

Then Santiago-Blay (2009) listed three species, which he described as new: the buthids *Centruroides mariaorum* Santiago-Blay, 2009 and *Rhopalurus virkkii*

Santiago-Blay, 2009, plus the scorpionid *Cazierius tatae* Santiago-Blay, 2009. Strangely, Santiago-Blay (2009) cited the paper of Armas (2005), but did not mention the undetermined species of *Heteronebo* recorded therein and also overlooked the record of *Cazierius garridoi* by Armas (2006). Immediately afterwards, Armas (2009) synonymized *Cazierius tatae* under *Cazierius garridoi*, and suggested that the collecting data of the holotype could be wrong and it possibly originated from Mona Island.

Later, Teruel & Armas (2012) thoroughly discussed that *Rhopalurus virkkii* was most likely a junior synonym of *Rhopalurus abudi* Armas & Marcano Fondeur, 1988 from neighboring Hispaniola, but deferred making a decision because they could not study any samples from Mona Island. Similarly, Teruel, Rivera & Santos (2015) declared that *Centruroides mariaorum* was a potential junior synonym of the Hispaniolan *Centruroides bani* Armas & Marcano Fondeur, 1988, but did not introduced the formal nomenclatural change for the same reason as above.

Finally, Esposito et al. (2017) formally synonymized *Rhopalurus virkkii* under *Rhopalurus abudi* and transferred the latter to the revalidated genus *Heteroctenus* Pocock, 1893. In that paper, also *Cazierius garridoi* and *Centruroides bani* were briefly mentioned to occur in Mona Island (Esposito et al., 2017: 29), but

no voucher specimens were declared, *Centruroides mariaorum* was overlooked and no formal synonymy of the latter under *Centruroides bani* was introduced either.

Recently, as part of our continuing study of the scorpion fauna of Puerto Rico, two field trips were made to Mona Island by one of us (MJR) and some collaborators. The samples collected allowed to confirm all synonymies previously suspected or declared, and also to retrieve important data on the distribution and ecology of every species occurring in the islet. All these results are presented herein, enriched by a thorough photographic complement.

Methods & Material

Specimens were studied under a Zeiss Stemi 2000-C stereomicroscope, equipped with a line scale and a Canon PowerShot® A620 digital camera. High-resolution images were processed with Adobe Photoshop® CS5 to optimize resolution and brightness, and to remove artifacts or unnecessary details from the background.

Nomenclature and measurements follow Stahnke (1971), except for trichobothriotaxy (Vachon, 1974), metasomal carinae (Francke, 1977), pedipalp chela carinae (Acosta et al., 2008, as interpreted by Armas et al., 2011), and sternum (Soleglad & Fet, 2003). Unless otherwise noted, all morphologically diagnostic characters mentioned in the text refer to adults of both sexes. To avoid unnecessarily long references and synonymies, only the taxonomically most relevant contributions published for each species have been included, e.g., original description, redescrptions, revisions, and updates of diagnoses and distribution.

Specimens studied herein are preserved in ethanol 80% and deposited in the collections of the Instituto de Ecología y Sistemática, Havana, Cuba (IES), Universidad de Puerto Rico, Recinto Río Piedras, Puerto Rico (UPRP), and personal collection of the first author (RTO). All of them bear collecting and identification labels written in Spanish, which were translated into English here for text coherence.

Systematics

Family Buthidae C. L. Koch, 1837 Subfamily Centruroidinae Kraus, 1955

Centruroides bani Armas et Marcano Fondeur,
1987
(Figures 1–2, 8–9)

Centruroides bani Armas & Marcano Fondeur, 1987: 5–12, 14; figs. 1–2; tabs. 3–6. Teruel, 2005: 168, 170–174; figs. 8–9, 27, 29. Teruel, Armas & Kovařík,

2015a: 1, 14–16; tabs. 4–5. Teruel, Armas & Kovařík, 2015b: 20, 23–24; tab. III. Teruel, Rivera & Santos, 2015: 12. Esposito et al., 2017: 13, 29, 55.

Centruroides mariaorum Santiago-Blay, 2009: 109, 113, 120, 122; figs. 17–18, 29 [back cover]. Teruel, Rivera & Santos, 2015: 12. **New synonym.**

DIAGNOSIS (updated). Adult size medium to moderately large for the genus (55–86 mm in males, 45–65 mm in females). Coloration basically yellowish, sparsely spotted with medium to dark brown over the body and appendages; carapace predominantly pale, with irregularly defined dark interocular triangle, tergites with two irregular, narrow dark stripes; pedipalp chelae with fingers blackish. Pedipalps large, robust, and essentially bare; manus very robust, oval in male, globular in female (length/width ratio 1.48–1.66 and 1.42–1.47, respectively) with carinae weak to moderate and costate to subcostate, intercarinal spaces coriaceous with scattered irregular granules, internal surface with many scattered conical granules; fingers with eight principal rows of denticles, basal lobe/notch combination moderately strong, setation dense (male) to very dense (female). Carapace and tergites with intercarinal tegument very finely and densely granulose, with many scattered coarser granules. Pectinal tooth count 21–24 in males, 18–24 in females; female basal plate with a large, shallow, transverse central depression. Sternite V with the smooth posterior patch obsolete, coarsely punctate and setose. Metasoma moderately long and slender, distally wider and deeper in male, with 10/8/8/8/3 complete, weakly to moderately crenulate to serrate carinae; intercarinal spaces coriaceous with scattered irregular granules; segments II–IV with two pairs of ventrolateral macrosetae. Telson oval (longer and more bulbous in male), vesicle irregularly granulose, with weak to moderate laterodistal swellings in male, subaculear tubercle obsolete to small, coarsely crest-like and not too close to aculeus base.

DISTRIBUTION (Fig. 9a). This species is now known to occur all over southern half of Hispaniola (including several satellite islands such as Saona and Catalina) and the Puerto Rican Mona Island (first record).

PRIMARY MATERIAL EXAMINED (7 specimens: 3♂♂, 4♀♀). **Puerto Rico**, Mayagüez Municipality, Mona Island, Playa Sardinera, 13/July/2015, night search with UV, 0.6–2.3 m up tree trunks and foliage, also on the ground and rocks, semidesertic scrub, M. J. Rivera, A. Megill, E. Mulero, M. Vega, 2♂♂, 4♀♀ (RTO). Punta Capitán, 14/July/2015, night search with UV, inside log crack on beach sand, semidesertic scrub, M. J. Rivera, A. Megill, E. Mulero, M. Vega, 1♂ (RTO).

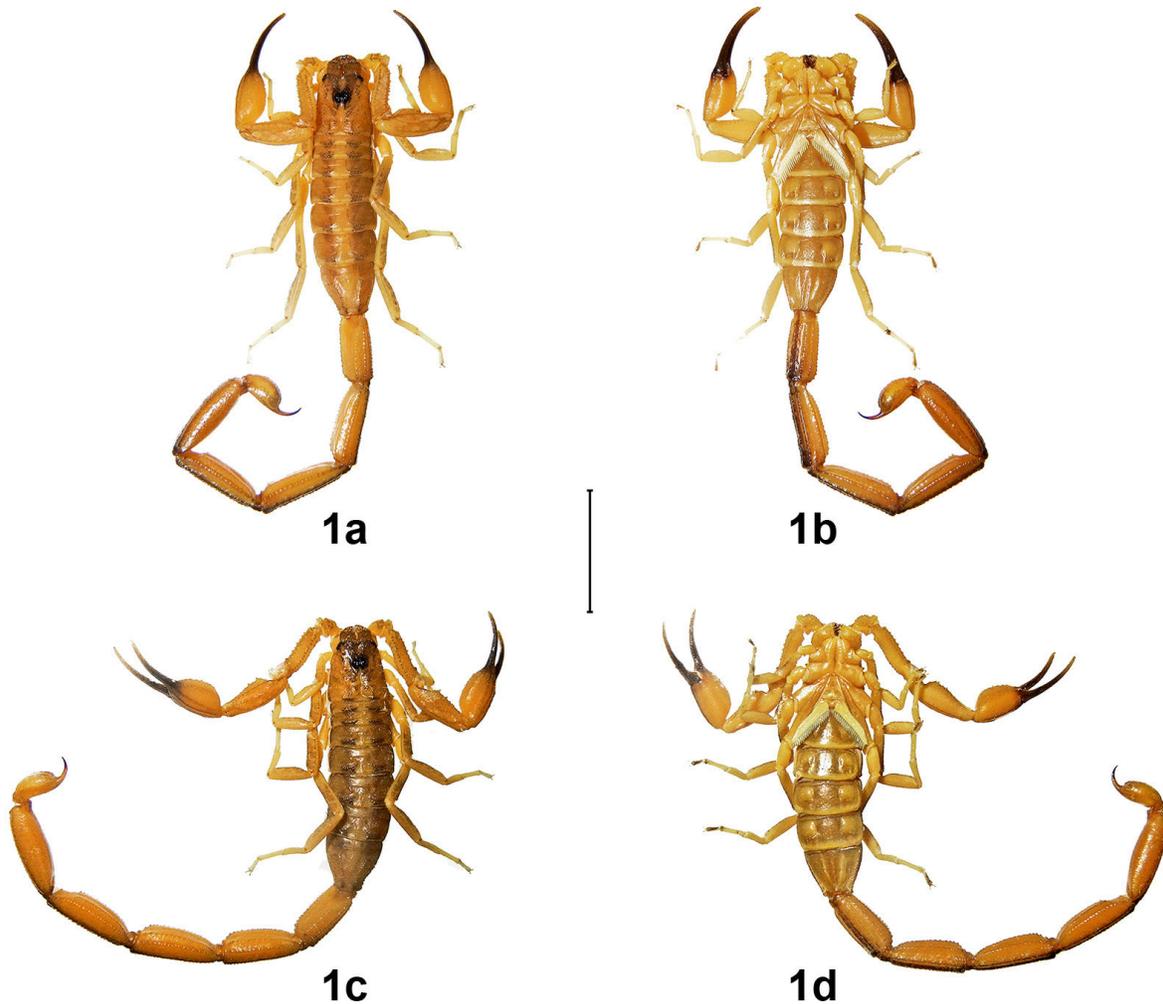


Figure 1: Adult males of *Centruroides bani*, complete dorsal (left) and ventral views: **a-b**) from Mona Island (topotype of *Centruroides mariaorum*); **c-d**) from Bani, Hispaniola (topotype). Scale bar = 10 mm.

COMPARATIVE MATERIAL EXAMINED (54 specimens: 14♂♂, 27♀♀, 13 juveniles). **Dominican Republic**, Pedernales Province, Sabana de Sansón (= km 17 of road from Oviedo to Pedernales), 123 m a.s.l., 12–14/March/2014, transition from dry semicaducifolious forest to desert scrub, R. Teruel, F. Kovařík, P. Kindl, 5♂♂, 7♀♀, 1 juvenile (RTO). Independencia Province, Sierra de Bahoruco, km 3.5 of road from Duvergé to Puerto Escondido, 184 m a.s.l., 31/January/2005, inside dead *Agave* plants and under barks, desert scrub, R. Teruel, A. Fong, D. Maceira, A. Sánchez, 2♂♂, 5♀♀ (RTO: Sco-0277). Bahoruco Province, Sierra de Neiba, Neiba, Segundo Paso, 794 m a.s.l., 9/March/2014, under barks, transition from dry semicaducifolious forest to desert scrub, R. Teruel, F. Kovařík, P. Kindl, 1♂, 3♀♀, 3 juveniles (RTO). Azua Province, El Número, 167 m a.s.l., 6–15/March/2014, inside dead *Agave* plants and under barks and rocks,

desert scrub, R. Teruel, F. Kovařík, P. Kindl, 2♀♀, 1 juvenile (RTO). Peravia Province, Bani, Sabana Buey, 20/May/1986, A. Abud, C. Marcano, E. J. Marcano, 1♀ holotype (IES: CZACC-3.2916). Bani, Las Salinas, 2/February/2005, under barks, desert sand dunes, R. Teruel, A. Fong, D. Maceira, A. Sánchez, 4♂♂, 4♀♀, 6 juveniles (RTO: Sco-0280). La Romana Province, La Cacata, 5/January/1987, under barks of fence posts, Fr. Mesa, E. J. Marcano, 1♀, 1 juvenile (IES). La Altagracia Province, Guaraguao, 4/January/1987, R. Marcano, 2♀♀, 1 juvenile (IES), 1♀ (RTO). Parque Nacional del Este, 4 km southwest of Boca de Yuma, 23 m a.s.l., 3/March/2014, under bark, coastal semicaducifolious forest, R. Teruel, F. Kovařík, P. Kindl, 1♂ (RTO). Parque Nacional del Este, La Granchorra, 500–600 m beyond ranger station, 11/February/1992, F. del Monte, K. A. Guerrero, 1♂ (RTO: Sco-0462).

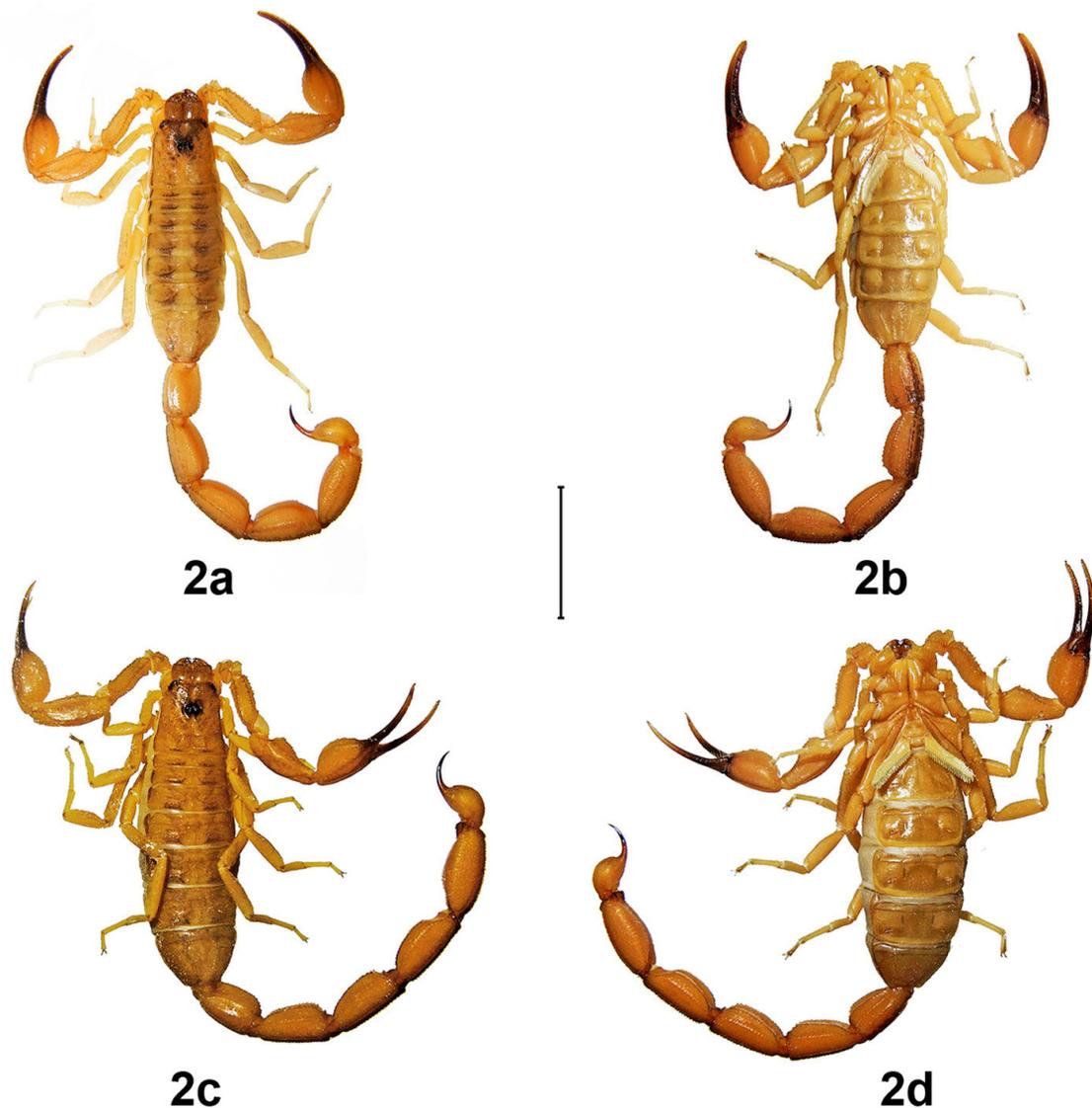


Figure 2: Adult females of *Centruroides bani*, complete dorsal (left) and ventral views: **a-b**) from Mona Island (topotype of *Centruroides mariaorum*); **c-d**) from Bani, Hispaniola (topotype). Scale bar = 10 mm.

ECOLOGICAL NOTES. According to Santiago-Blay (2009) and our personal observations (MJR), this species is widespread in Mona Island and even though not common, it is a generalist scorpion that inhabits in essentially all habitats and microhabitats available in the ground and vegetation. Such wide ecological preferences are consistent with our own observations (RT) on the Hispaniolan populations (Armas & Marcano Fondeur, 1987; Armas et al. 1999; Teruel, 2005; Teruel, Armas & Kovařík, 2015a–b).

One female collected at Playa Sardinera was found eating an unidentified cricket on a rock in the ground.

REMARKS. The validity of *Centruroides mariaorum* was recently questioned by Teruel, Rivera & Santos

(2015), who suggested that the very brief original description matched the Hispaniolan *Centruroides bani* perfectly. Also the original description of the former is poorly illustrated and entirely lacks any comparison to other described species of the genus. Nevertheless, establishing the formal synonymy was hampered by the fact that no types or additional samples of *Centruroides mariaorum* were then available for study.

On the first field trip to Mona Island, members of our team collected a representative series at Playa Sardinera, the exact type-locality of *Centruroides mariaorum*. Their direct comparison to the holotype and additional samples of *Centruroides bani* from all over Dominican Republic (including the coast facing Mona Island), confirmed that all specimens are conspecific and

morphologically identical in all characters currently used as species-diagnostic in the genus: size, coloration, pectinal tooth count, number of principal rows of denticles in pedipalp fingers, shape and attenuation degree of pedipalps and metasoma, development of subaculear tubercle and basal lobe-notch combination of pedipalp fingers, as well as sculpture, carination and setation of the body, appendages and metasoma.

Therefore, the following synonymy is formally established herein: *Centruroides bani* Armas & Marcato Fondeur, 1987 = *Centruroides mariaorum* Santiago-Blay, 2009, **new synonym**.

Very recently, Esposito et al. (2017) briefly mentioned the presence of *Centruroides bani* in Mona Island, but gave no supporting clues or evidences (i.e., voucher specimens, photographs). Thus, the present contribution represents the first demonstrable record of the presence of this species in the island and outside Hispaniola.

Heteroctenus abudi (Armas et Marcato Fondeur, 1987)
(Figures 3–4, 8–9)

Rhopalurus abudi Armas & Marcato Fondeur, 1987: 19–20; pl. II, fig. 4; tab. 10. Prendini et al., 2009: 206–224; figs. 1–2, 5a–b, 6a, 7a, 8, 11; tab. 1. Teruel & Armas, 2012a: 160, 165–167. Teruel & Armas, 2012b: 216–217; fig. 7. Teruel, Rivera & Santos, 2015: 15.

Heteroctenus abudi: Esposito et al., 2017: 2–3, 6, 10, 16–17, 19, 25, 27–32, 38, 44–46, 48–49, 51–56; figs. 1a, 2a, 4a, 13, 14a, 18a, 21a, 22a, 23a–d, 25a, 26a, 28a, 29a, 30a, 31a–d; tab. 1.

Rhopalurus virkkii Santiago-Blay, 2009: 109, 115–116, 119, 122; figs. 10, 31 [back cover]. Teruel & Armas, 2012a: 166. Teruel & Armas, 2012b: 216–217; fig. 7. Teruel, Rivera & Santos, 2015: 15.

Synonymized by Esposito et al., 2017: 29.

DIAGNOSIS (updated). Adult size medium to moderately large for the genus (male 52–70 mm, female 60–92 mm). Coloration medium to dark yellowish brown, conspicuously darker on pedipalp chelae and metasomal segments IV–V and telson; carapace and tergites symmetrically patterned with blackish brown but with margins conspicuously paler; metasoma heavily infusate ventrally and under carinae; pedipalp fingers blackish. Pedipalp chelae strongly dimorphic sexually: robust and wider than patella in male, slender and narrower than patella in female; fingers very long, with eight principal rows of denticles flanked on both sides by many supernumerary denticles (absent in earlier juvenile instars), setation dense (male) to moderate (female), basal lobe/notch combination strong in both sexes (more so in male), basal gap moderate to slight

(male) or absent (female). Carapace and tergites very densely granulose, with many scattered coarse granules. Pectines subtriangular and conspicuously wider basally; tooth count 19–24 in male, 17–22 in female; basal plate wider than long, with posterior margin deeply convex. Metasoma with 10/8/8/8/5 complete carinae, but lateral inframedians almost complete on II; segments IV–V only slightly wider distally in male, subparallel in female; telson with vesicle elongate oval, subaculear tubercle vestigial (spiniform in juvenile instars, but becoming progressively reduced along development).

DISTRIBUTION (Fig. 9a). This species is now known to occur in three disjunct insular populations, two in Hispaniola and one in Puerto Rico: **1)** Isla Saona, a large satellite island between La Romana and La Altagracia provinces, in southeastern Dominican Republic; **2)** eastern tip of mainland Dominican Republic, in southeastern La Altagracia province; **3)** Mona Island.

PRIMARY MATERIAL EXAMINED (16 specimens: 2♂♂, 7♀♀, 7 juveniles). **Puerto Rico**, Mayagüez Municipality, Mona Island, Cueva del Esqueleto, 13/July/2015, in cave wall crevice, 2 m over the floor, M. J. Rivera, A. Megill, E. Mulero, M. Vega, 1♀ (RTO). Playa Sardinera, 13/July/2015, night search with UV, on the ground and rocks, semidesertic scrub, M. J. Rivera, A. Megill, E. Mulero, M. Vega, 1♂, 2♀♀, 5 juveniles (RTO). Playa Pájaros, 11–16/June/2016, night search with UV, on rocks, semidesertic scrub, M. J. Rivera, 1♂, 4♀♀, 2 juveniles (RTO).

COMPARATIVE MATERIAL EXAMINED (63 specimens: 4♂♂, 7♀♀, 4 juveniles, 48 first instars). **Dominican Republic**, La Romana Province, Isla Saona, Catuano, 27/January/1980, E. J. Marcato, 1♀ holotype (IES: CZACC-3.2912). Isla Saona, "Pozo de la Zanja en Los Gri-Güiles" [*sic*], 14/March/1990, no more data, 1♀ with 48 first-instar litter (IES). Isla Saona, Mano Juan, June/1992, M. Gil, K. A. Guerrero, 1♂, 1♀, 3 juveniles (IES). La Altagracia Province, Parque Nacional del Este, 4 km southwest of Boca de Yuma, 23 m a.s.l., 4/March/2014, night search with UV on rock wall and piles, day search under large rocks on sandy soil, coastal semicaducifolious forest, R. Teruel, F. Kovařík, P. Kindl, 3♂♂, 2♀♀, 1 juvenile (RTO). Parque Nacional del Este, Cabo Falso, 10/March/1998, under rocks, M. Schenkel, 2♀♀ (RTO: Sco-0482).

ECOLOGICAL NOTES. This scorpion is widespread and common in Mona Island, where it inhabits exclusively the ground, mostly in rocky places. It was found once inside a garage (Santiago-Blay, 2009: 116) and one adult female was collected in a cave by our team. This habitat and microhabitat preferences are consistent with our own observations (RT) and the data

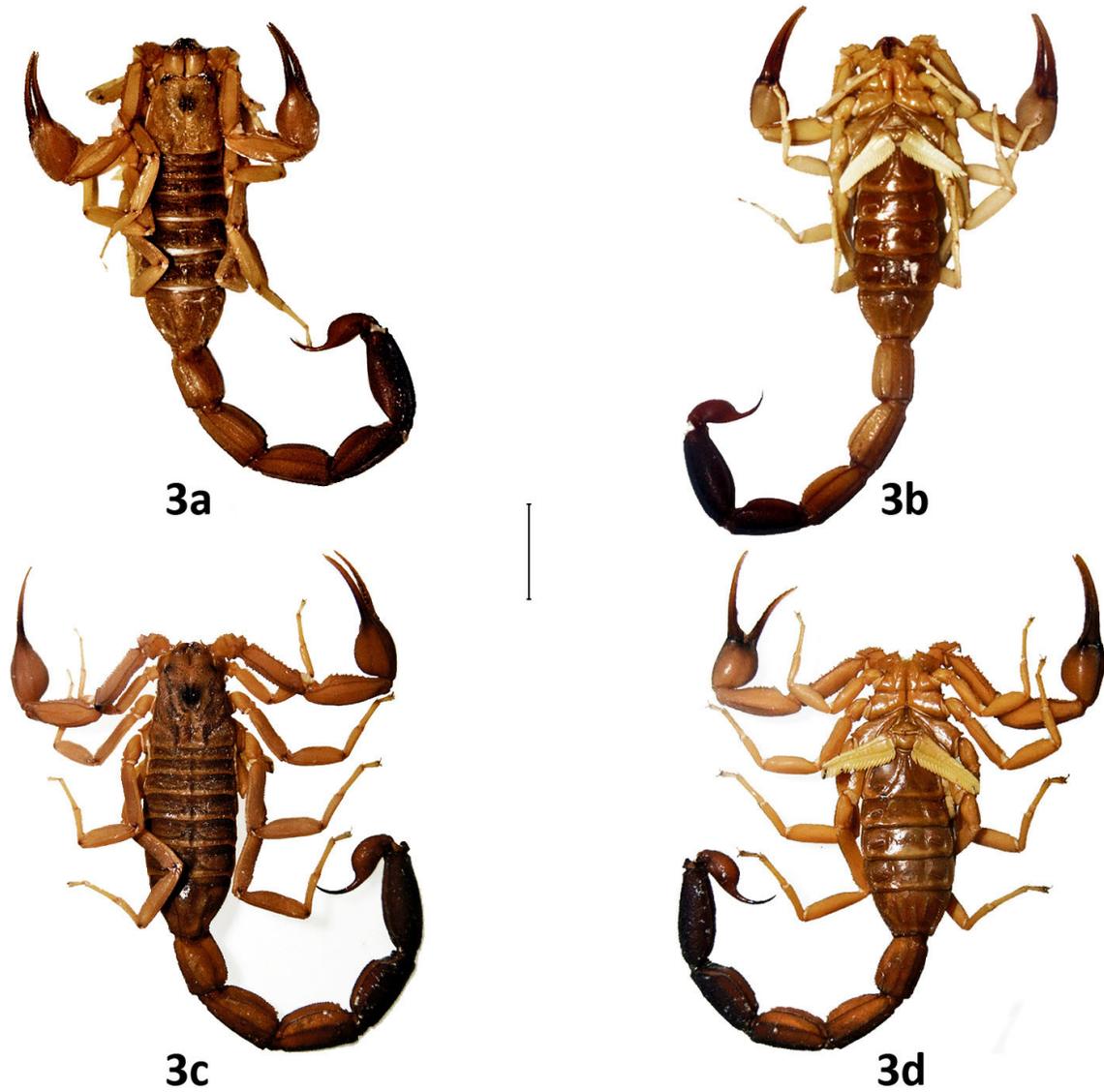


Figure 3: Adult males of *Heteroctenus abudi*, complete dorsal (left) and ventral views: **a-b**) from Mona Island (topotype of *Rhopalurus virkkii*); **c-d**) from Boca de Yuma, Hispaniola. Scale bar = 10 mm.

available in the literature for the Hispaniolan populations (Armas & Marcano Fondeur, 1987; Armas et al. 1999; Prendini et al., 2009, Esposito et al., 2017).

One of the juveniles collected at Playa Sardinera was found on a stump bark, eating an unidentified cockroach (Fig. 8d).

The first literature record of stridulation in *Heteroctenus abudi* was given by Prendini et al. (2009: 212), in specimens from Hispaniola. We also observed this behavioral display while personally collecting this species in both Mona Island and Dominican Republic.

REMARKS. The original description of *Rhopalurus virkkii* is extremely brief and poorly illustrated, it entirely lacks any comparison to other described species

of the genus and all characters argued as diagnostic match perfectly the Hispaniolan *Heteroctenus abudi*. All those problems were discussed in detail by Teruel & Armas (2012b) and later resumed by Teruel, Rivera & Santos (2015), but establishing a formal synonymy was hampered by the fact that no types or additional samples of *Rhopalurus virkkii* were then available for study. This was finally done by Esposito et al. (2017), based on morphological and molecular evidence obtained from specimens collected at Hispaniola and Mona Island.

On both field trips to Mona Island, members of our team collected a representative series in different places, including the type-locality of *Rhopalurus virkkii*. Their direct comparison to the holotype and additional samples

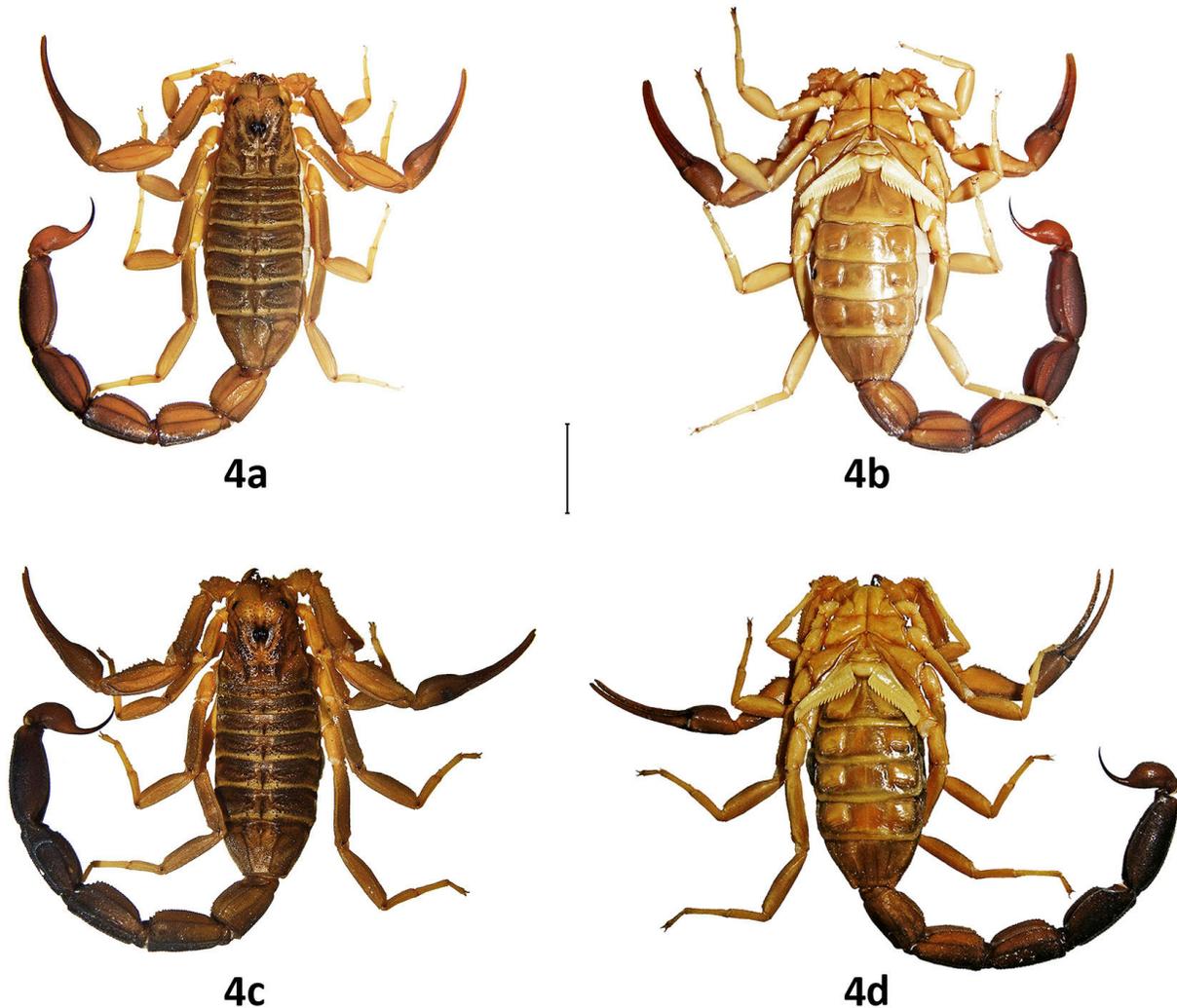


Figure 4: Adult females of *Heteroctenus abudi*, complete dorsal (left) and ventral views: **a-b**) from Mona Island (topotype of *Rhopalurus virkkii*); **c-d**) from Isla Saona, Hispaniola (topotype). Scale bar = 10 mm.

of *Heteroctenus abudi* from all its known Hispaniolan populations (including the coast facing Mona Island), revealed that all specimens are conspecific and morphologically identical in all characters currently used as species-diagnostic in the genus: size, coloration, pectinal tooth count, number of principal rows of denticles in pedipalp fingers, shape and attenuation degree of pedipalps and metasoma, development of subaculear tubercle and basal lobe-notch combination and gap of pedipalp fingers, as well as sculpture, carination and setation of the body, appendages and metasoma. Thus, the synonymy proposed by Esposito et al. (2017) is herein confirmed.

Esposito et al. (2017: 27) characterized the specimens of *Heteroctenus abudi* from Mona Island as "markedly paler" than those from Hispaniola. Nevertheless, the difference between our samples from both populations is irrelevant: some specimens from Mona Island (especially adult females) are as dark as the

darker ones from Hispaniola, and vice versa. This variability is not only genetic, i.e., a few of the paler individuals are less strongly sclerotized and underfed, which is the typical condition of recently molted individuals.

Family Scorpionidae Latreille, 1802
Subfamily Diplocentrinae Karsch, 1880

Cazierius garridoi Armas, 2005
 (Figures 5–6, 8–9)

- Cazierius garridoi* Armas, 2005: 69–72; figs. 1–8.
 Armas, 2006: 300; fig. 1; tab. I. Armas, 2009: 298.
 Teruel, Rivera & Santos, 2015: 13.
Cazierius tatae Santiago-Blay, 2009: 109–111, 120–121; figs. 13, 27 [back cover]. **Synonymized by**
 Armas, 2009: 298.
Cazierius sp.: Armas, 2005: 72; fig. 8.



Figure 5: Adult female holotype of *Cazierius garridoi*, complete dorsal (left) and ventral views, with accompanying original labels. Scale bar = 10 mm.

DIAGNOSIS. Adult size medium for the genus (19–34 mm). Coloration yellowish to olivaceous brown, with a moderately dense pattern of dark brown spots all over the body and appendages; metasomal segment V and telson similarly spotted; pedipalps with carinae and fingers conspicuously infuscate. Pedipalps with chela oval and without reticulations, globose and weakly carinate in male, slender and essentially acarinate in female. Carapace and tergites glossy but with coarse and shiny granules scattered. Pectinal tooth count 6–7 in male, 5–6 in female. Legs short, essentially acarinate and smooth; pedal spurs small; telotarsal spiniform setae formula 4/4 : 5/5 : 6/6 : 6/6. Metasoma moderately hirsute, with segments I–III wider than long, IV–V longer than wide; essentially all carinae obsolete to very weak and smooth to subgranulose, except variably crenulate

ventral laterals and ventral submedians on I–IV, irregularly dentate ventral laterals and ventral transverse on V, the latter perfectly arched; intercarinal spaces glossy, with few vestigial granules scattered. Telson with vesicle oval and glossy, essentially smooth; subcucular tubercle vestigially granulose.

DISTRIBUTION (Fig. 9c). If valid (see below), this species is confirmed to occur only in Mona Island, from which it is most likely endemic.

PRIMARY MATERIAL EXAMINED (13 specimens: 2♀♀, 11 juveniles). **Puerto Rico**, Cordillera Central, border between Ponce and Jayuya Municipalities, Cerro de Punta, 1,330 m a.s.l. [likely wrong locality, see below under *Heteronebo portoricensis*], September/



Figure 6: Subadult male of *Cazierius garridoi* from Mona Island (paratype of *C. tatae*), complete dorsal (left) and ventral views. Scale bar = 10 mm.

2000, under rock, O. H. Garrido, A. Silva, A. Pérez-Asso, 1♀ holotype (IES: CZACC-3.3146). Mayagüez Municipality, Mona Island, September/2000, under rocks, J. L. Fontenla, A. R. Pérez-Asso, 1♀, 3 juveniles (IES: CZACC-3.3150). Bajura de los Cerezos, 20/August/1982, M. Rivera, 1 juvenile (paratype of *Cazierius tatae*, UPRP). Same locality, 15/July/2015, under rocks, microphyllous semicaducifolious forest, M.

J. Rivera, A. Megill, E. Mulero, M. Vega, 4 juveniles (RTO). Los Corrales de los Indios, 11–16/June/2016, under rocks at base of trees, microphyllous semicaducifolious forest, M. J. Rivera, 3 juveniles (RTO).

COMPARATIVE MATERIAL EXAMINED (*Cazierius cicero*: 24 specimens: 9♂♂, 10♀♀, 5 juveniles). **Dominican Republic**, San Pedro de Macorís Province,

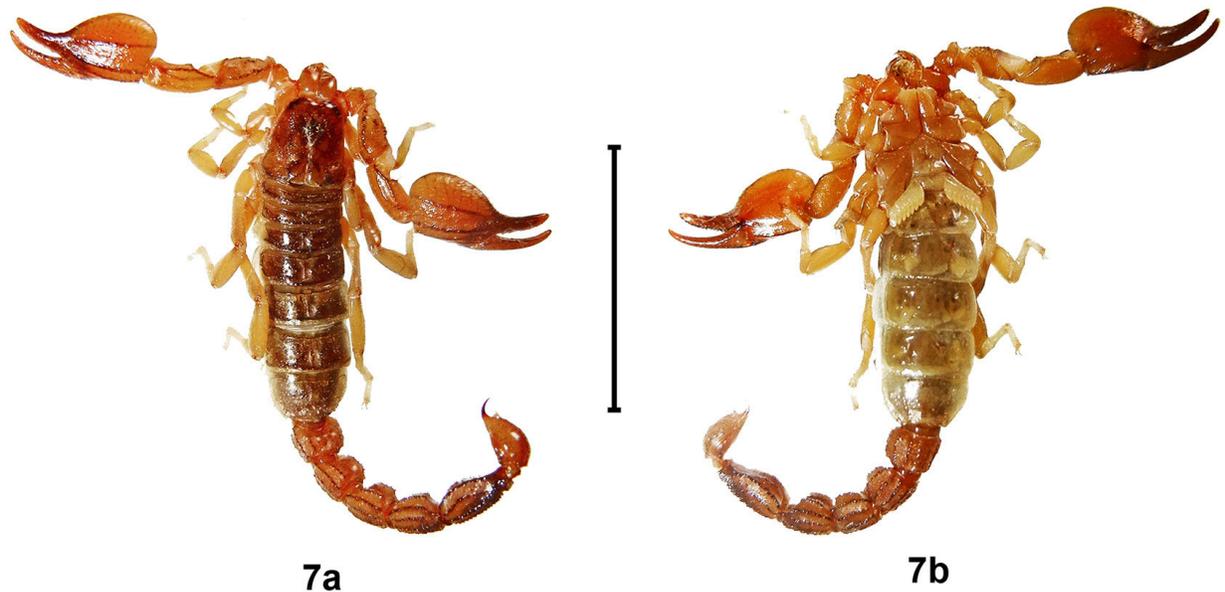


Figure 7: Subadult male of *Heteronebo portoricensis* allegedly from Mona Island, complete dorsal (left) and ventral views. Scale bar = 10 mm.

Guayacanes, Los Conucos, 6/April/1986, under rocks, A. Abud, E. J. Marcano, 1♂ holotype (IES: CZACC-3.2913). Bridge over Cumayasa river, border with La Romana Province, 39 m a.s.l., 1/March/2014, under rocks, semicaducifolious forest, R. Teruel, F. Kovařík, P. Kindl, 2♂♂, 3♀♀, 1 juvenile (RTO). La Altagracia Province, 4 km north of Bayahibe, 48 m a.s.l., 1/March/2014; under rocks, dry semicaducifolious forest; R. Teruel, F. Kovařík, P. Kindl, 1♀, 1 juvenile (RTO). 1 km south of Bayahibe, 6 m a.s.l., 1/March/2014; under rock and inside rotten palmetto trunk, dry semicaducifolious forest; R. Teruel, F. Kovařík, P. Kindl, 2♀♀, 1 juvenile (RTO). Parque Nacional del Este, Guaraguao, 4/September/1987, under rocks, L. F. de Armas, A. Abud, 1♀, 1 juvenile (IES). Parque Nacional del Este, 4 km southwest of Boca de Yuma, 23 m a.s.l., 3/March/2014, night search with UV on ground and rock wall, day search under rocks, coastal semicaducifolious forest, R. Teruel, F. Kovařík, P. Kindl, 6♂♂, 3♀♀, 1 juvenile (RTO).

ECOLOGICAL NOTES. According to our personal observations, plus the data extracted from the literature available (Armas, 2005, 2006, 2009; Santiago-Blay, 2009), this species is widespread but rare all over Isla de Mona, and inhabits exclusively under rocks in the ground of shady places with leaf litter.

REMARKS. Immediately after its original description, *Cazierius tatae* was synonymized under *Cazierius garridoi* by Armas (2009), based upon his study of four additional specimens of the former and the holotype of

the latter. For the present revision, we examined a few paratypes of *Cazierius tatae* from the UPRP collection and all specimens from IES collection identified as *Cazierius garridoi* by Armas (2005, 2006, 2009), including the holotype. Moreover, on both field trips to Mona Island, members of our team collected a representative series in different places, including the type-locality of *Cazierius tatae*. The direct comparison of all these samples confirmed that the synonymy proposed by Armas (2009) is correct.

As partially stated in its original description (Armas, 2005), *Cazierius garridoi* is most closely related on morphological grounds to *Cazierius cicero* (Armas et Marcano Fondeur, 1987), which is endemic from southeastern Hispaniola (including the coast facing Mona Island). Nevertheless, their mutual taxonomic distinction is far from being as clear as stated in that paper: our present revision revealed that both taxa are actually identical in all characters traditionally used as species-diagnostic for Diplocentrinae, including those originally used by Armas (2005: 71): size, coloration, pectinal tooth counts, telotarsal spiniform setal formula, and carination, granulation and setation of the body and appendages. The single exception is the development of the dorsal lateral carinae of metasoma, which are essentially smooth in *Cazierius garridoi* but variably granulose in *Cazierius cicero*.

This character alone is not enough for a reliable species distinction, especially because it has already been found to vary in other species of this genus (Teruel & Cala, 2006: 308; R. Teruel, unpublished data). For this reason, we suspect that populations from Mona

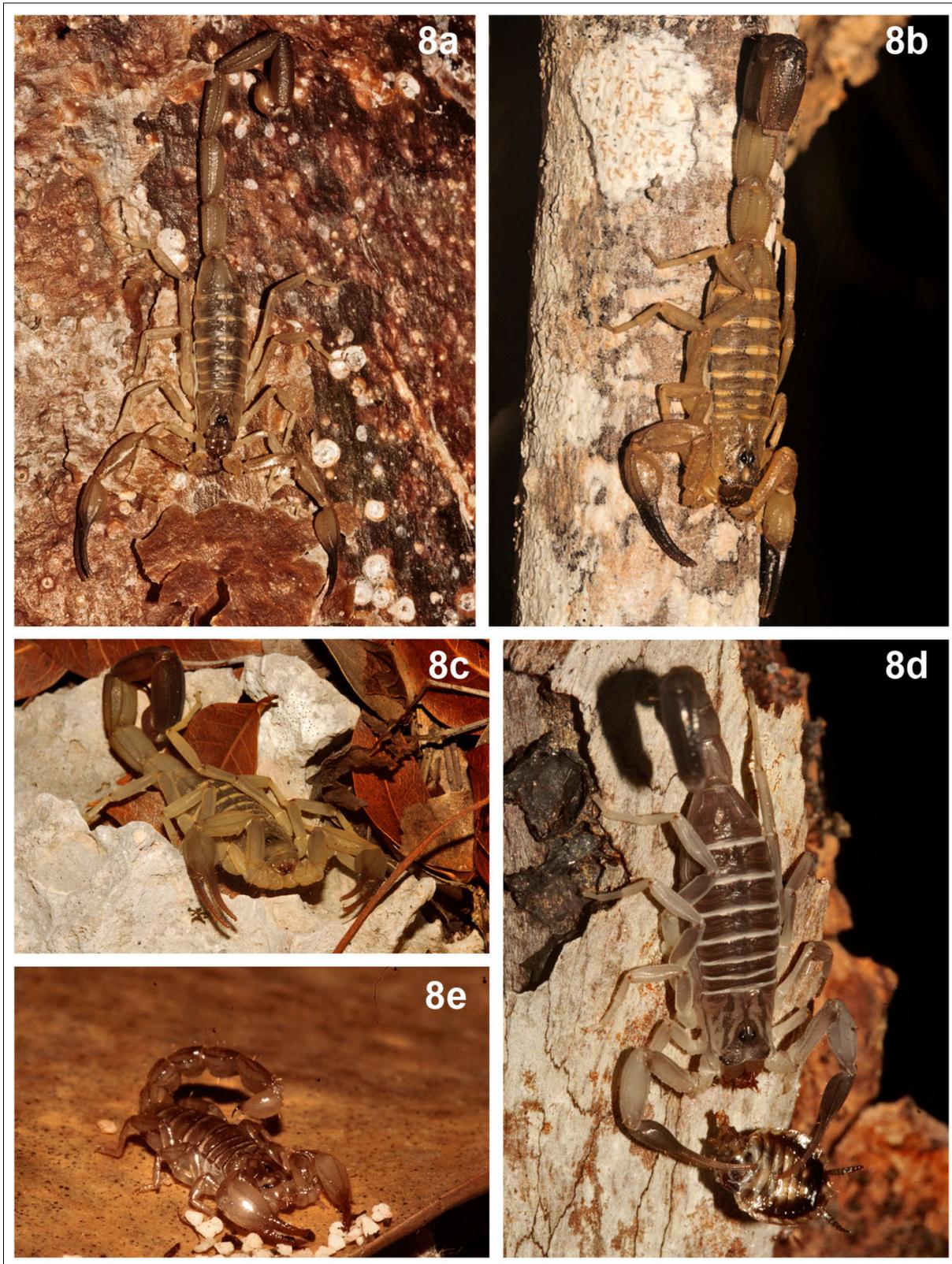


Figure 8: Scorpions from Mona Island, photographed alive in their natural habitat during nocturnal activity: **a)** *Centruroides bani*, adult male, sit-and-wait hunting on tree trunk; **b)** *Centruroides bani*, adult female, sit-and-wait hunting on tree trunk; **c)** *Heteroctenus abudi*, adult male, sit-and-wait hunting on rocky ground; **d)** *Heteroctenus abudi*, juvenile female, eating a cockroach on tree stump; **e)** *Cazierius garridoi*, juvenile female, walking on leaf litter.

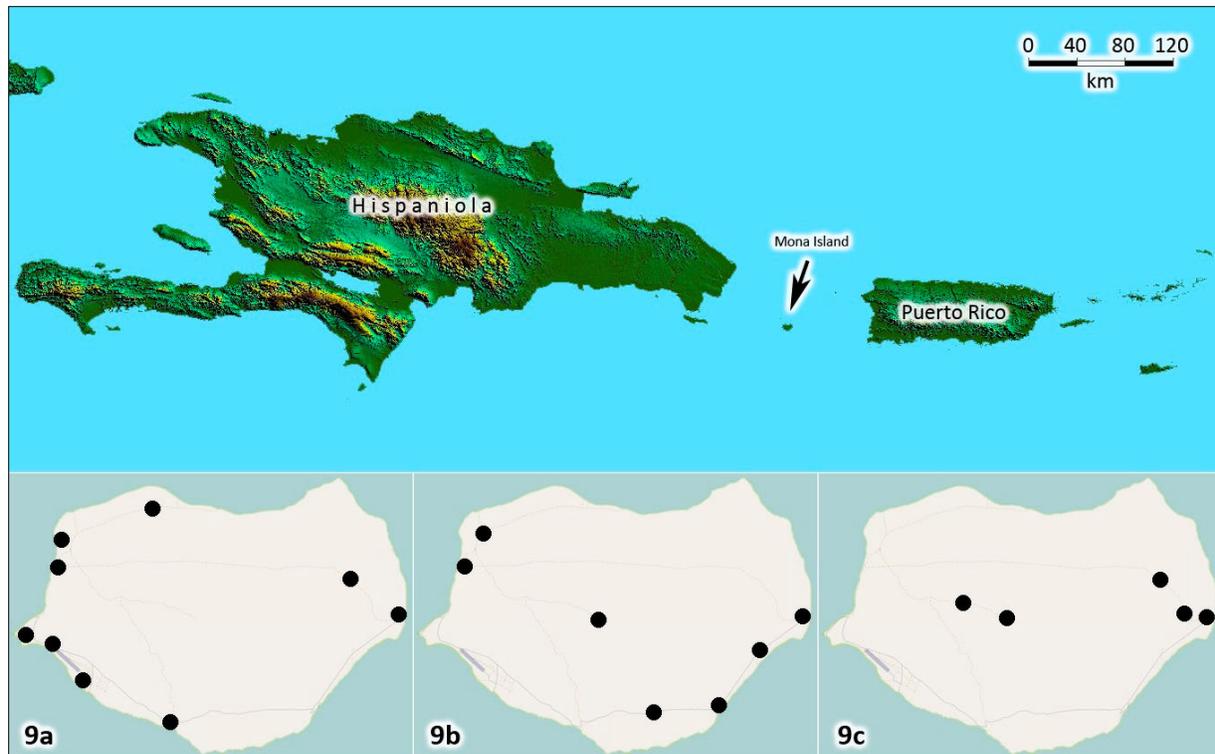


Figure 9: Geographical location of Mona Island (top) and updated local distribution of: **a)** *Centruroides bani*; **b)** *Heteroctenus abudi*; **c)** *Cazierius garridoi*. In all bottom close-ups, frame size represents 11 x 7 km.

Island and Hispaniola are actually conspecific, as already confirmed herein for *Centruroides bani* and *Heteroctenus abudi* (both of which coincidentally occur in the same geographical area). Nevertheless, we remain cautious and prefer not to introduce the formal synonymy until more representative material from Mona Island becomes available, especially adult males.

Heteronebo portoricensis Francke, 1978
(Figure 7)

Heteronebo sp.: Armas, 2005: 73; fig. 8. Teruel et al., 2015: 13.

DISTRIBUTION. This species is confirmed to occur only in Puerto Rico and immediately offshore satellite islets such as Magueyes and Caja de Muertos. The single known specimen allegedly from Mona Island was most likely collected in mainland Puerto Rico and inadvertently mislabeled (see below in Remarks section).

PRIMARY MATERIAL EXAMINED (1 specimen). **Puerto Rico**, Mayagüez Municipality, Mona Island [likely wrong locality, see below in Remarks section], September/2000, under rock, J. L. Fontenla, 1 juvenile ♂ (IES).

COMPARATIVE MATERIAL EXAMINED (37 specimens: 5♂♂, 24♀♀, 7 juveniles, 1 first-instar). **Puerto Rico**, Sabana Grande Municipality, Susúa, 200 m a.s.l., 3/October/2000, O. H. Garrido, J. A. Genaro, A. Pérez-Asso, 2♀♀, 1 juvenile (IES). 10/July/2005, under rocks, humid montane forest, A. Sánchez, 2♀♀ (RTO: Sco-0377). Yauco Municipality, Guayanilla, Punta Verraco, 10 m a.s.l., December/1999, J. A. Genaro, 1♀, 1 juvenile (IES). 16/July/2010, under rocks, dry subcoastal forest, L. F. de Armas, A. Pérez-Asso, 1♂, 1♀ (RTO: Sco-0479). Guánica Municipality, Guánica, 75 m a.s.l., 22/August/1995, G. Alayón, 1♂, 1♀, 1 juvenile (IES). 26/February/2001, under rocks, dry coastal forest, A. Sánchez, 2♀♀ (RTO: Sco-0020). November/2002, under rock, dry coastal forest, A. Sánchez, 1♂ (RTO: Sco-0216). 13/October/2003, under rock, dry coastal forest, A. Sánchez, 1♀ (RTO: Sco-0239). 25/March/2004, under rock, dry subcoastal forest, A. Sánchez, 1♀ (RTO: Sco-0238). 31/July/2004, under rocks, dry subcoastal forest, A. Sánchez, 1♂, 2♀♀, 2 juveniles, 1 first-instar (RTO: Sco-0261). 18/February/2012, under rocks, dry subcoastal forest, A. Sánchez, 6♀♀ (RTO: Sco-0540). Ponce Municipality, Real Arriba, 22/August/1995, under rocks, A. Ruiz-Baliú, 1♀, 1 juvenile (RTO: Sco-0021). Caja de Muertos Island, 24/July/2010, under rocks and fallen log, xerophytic scrub, L. F. de Armas, A. Pérez-Asso,



Figure 10: Four sites of Mona Island, showing the typical vegetation and ground where the scorpions inhabit: **a)** south-eastern coast; **b)** central-western part; **c)** central part; **d)** Bajura de los Cerezos.

2♀♀, 1 juvenile (IES). 10/February/2012, A. Sánchez, under rocks, xerophytic scrub, 1♂, 2♀♀ (RTO: Sco-0541).

REMARKS. Armas (2005: 73) regarded the single specimen from Mona Island as an immature male of an undetermined species similar to *Heteronebo portoricensis*, and cited the lack of punctations from sternites and telson as a diagnostic character. Ten years later, Teruel et al. (2015: 13) examined the same specimen and concurred with Armas (2005). Nevertheless, the detailed study of additional specimens of *Heteronebo portoricensis* revealed that this difference is due to immaturity: two same-sized juvenile males (apparently subadults) from Guánica and Ponce also lack punctations in the same cuticular surfaces.

On the other hand, we strongly suspect that this specimen of *Heteronebo portoricensis* and the holotype of *Cazierius garridoi* were accidentally swapped during the sorting or mailing process and thus, that the correct origins are Cerro de Punta for the former and Mona Island for the latter. According to their original label

data (see above) and supplementary information provided by Luis F. de Armas (personal communication to RT), both specimens were collected during a field trip conducted by the same team to both islands, and later given to him in separate batches. Additional evidences give overwhelming support to the mislabeling hypothesis:

First, *Cazierius garridoi* is the only diplocentrine confirmed to occur in Mona Island and has been repeatedly found by multiple, independent collectors including our team. As opposite, no other specimens of the genus *Cazierius* have been found in mainland Puerto Rico, despite long-term and intensive searches for many years (including continued searches by our team at Cerro de Punta and nearby areas).

Conversely, no other specimens of the genus *Heteronebo* have been found in Mona Island, despite recurrent and intensive searches by our team and other collectors. But *Heteronebo portoricensis* is widespread across mainland Puerto Rico (where it has been repeatedly found by multiple, independent collectors including our team), and was already recorded from

Adjuntas (Francke, 1978: 45), a mountainous locality near to Cerro de Punta.

Last, the present study revealed that the scorpion fauna of Mona Island is a detached, impoverished fragment of that of easternmost Hispaniola, i.e., essentially all species are shared between both territories (*Centruroides bani*, *Heteroctenus abudi* and possibly also *Cazierius cicero*). And again, the genus *Heteronebo* is conspicuously absent from eastern half of Hispaniola (Armas, 1988, 1999, 2001; Teruel, 2005; Teruel, Armas & Kovařík, 2015b).

General Remarks

The present revision sets the scorpion species confirmed to occur at Mona Island to three: two buthids of the closely-related genera *Centruroides* and *Heteroctenus* and one diplocentrine scorpionid of the genus *Cazierius*. This is the standard composition for coastal localities of the Greater Antilles (R. Teruel, unpublished), but rather poor due to the apparent absence of other buthid genera such as *Microtityus* and *Tityus*, both of which occur in similar landscapes of both coasts directly facing Mona Island (easternmost Hispaniola and westernmost Puerto Rico). In comparison with these adjacent areas, also at least a second species of *Centruroides* and maybe a troglobite could still be discovered in this island because it cannot be regarded yet as satisfactorily sampled, especially its extensive cave systems.

This contribution does not alter the number of species compiled in the most recent catalogue of the Puerto Rican scorpion fauna (Teruel, Rivera & Santos, 2015), but clarifies the identity of those occurring in Mona Island. Nevertheless, an important update has been made: the endemism (excluding the Virgin Islands) has now decreased from 82% to less than 74% and is expected to drop even more, if the suspected synonymies of *Cazierius garridoi* and two other species of *Centruroides* are confirmed (Teruel, Rivera & Santos (2015: 12)).

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References

- ACOSTA, L. E., D. M. CANDIDO, E. H. BUCKUP & A. D. BRESCOVIT. 2008. Description of *Zabius gaucho* (Scorpiones, Buthidae), a new species from southern Brazil, with an update about the generic diagnosis. *The Journal of Arachnology*, 36: 491–501.
- ARMAS, L. F. DE. 1988. *Sinopsis de los escorpiones antillanos*. Editorial Científico-Técnica, Havana, 102 pp.
- ARMAS, L. F. DE. 1999. Quince nuevos alacranes de La Española y Navassa, Antillas Mayores (Arachnida: Scorpiones). *Avicennia*, 10–11: 101–136.
- ARMAS, L. F. DE. 2001. Scorpions of the Greater Antilles, with the description of a new troglobitic species (Scorpiones: Diplocentridae). Pp. 245–253 in Fet, V. & P. A. Selden (eds.). *Scorpions 2001. In Memoriam Gary A. Polis*. Bucks: British Arachnological Society, xi + 690 pp.
- ARMAS, L. F. DE. 2005. Alacranes Diplocentrinae de Puerto Rico (Scorpiones: Scorpionidae). *Revista Ibérica de Aracnología*, 11: 69–73.
- ARMAS, L. F. DE. 2006. Presencia de *Cazierius garridoi* Armas, 2005 (Scorpiones: Scorpionidae) en Isla Mona, Puerto Rico. *Boletín de la Sociedad Entomológica Aragonesa*, 38: 300.
- ARMAS, L. F. DE. 2009. Acerca de algunos alacranes (Scorpiones: Buthidae, Scorpionidae) recientemente descritos o registrados de Puerto Rico e Isla Mona, Antillas Mayores. *Boletín de la Sociedad Entomológica Aragonesa*, 45: 298.
- ARMAS, L. F. DE & E. J. MARCANO FONDEUR. 1987. Nuevos escorpiones (Arachnida: Scorpiones) de República Dominicana. *Poeyana*, 356: 1–24.
- ARMAS, L. F. DE & E. J. MARCANO FONDEUR. 1987. Nuevos escorpiones (Arachnida: Scorpiones) de República Dominicana. *Poeyana*, 356: 1–24.
- ARMAS, L. F. DE, J. A. OTTENWALDER & K. A. GUERRERO. 1999. Escorpiones de las islas Saona,

- Beata y Catalina, República Dominicana (Arachnida: Scorpiones). *Cocuyo*, 8: 30–32.
- ESPOSITO, L. A., H. Y. YAMAGUTI, C. A. SOUZA, R. PINTO-DA-ROCHA & L. PRENDINI. 2017. Systematic revision of the Neotropical club-tailed scorpions, *Physoctonus*, *Rhopalurus*, and *Troglo-rhopalurus*, revalidation of *Heteroctenus*, and descriptions of two new genera and three new species (Buthidae: Rhopalurusinae). *Bulletin of the American Museum of Natural History*, 415: 1–134.
- FRANCKE, O. F. 1977. Scorpions of the genus *Diplocentrus* Peters from Oaxaca, Mexico. *The Journal of Arachnology*, 4: 145–200.
- FRANCKE, O. F. 1978. Systematic revision of diplocentrid scorpions (Diplocentridae) from Circum-Caribbean lands. *Special Publications The Museum Texas Tech University*, 14: 1–92.
- PRENDINI, L., L. A. ESPOSITO, J. C. HUFF & E. S. VOLSCHENK. 2009. Redescription of *Rhopalurus abudi* (Scorpiones: Buthidae), with first description of the male and first record from mainland Hispaniola. *The Journal of Arachnology*, 37: 206–224.
- SANTIAGO-BLAY, J. A. 2009. Systematics and some aspects of the biology of the scorpions (Arachnida) of the Greater Puerto Rico Region: a biosystematic synopsis. *Entomological News*, 120(1): 109–124.
- SOLEGLAD, M. E. & V. FET. 2003. The scorpion sternum: structure and phylogeny (Scorpiones: Orthosterni). *Euscorpius*, 5: 1–34.
- STAHNKE, H. L. 1971. Scorpion nomenclature and mensuration. *Entomological News*, 81: 297–316.
- TERUEL, R. 2005. Nuevos datos sobre la taxonomía, distribución geográfica y ecología de los escorpiones de la República Dominicana (Scorpiones: Liochelidae, Scorpionidae, Buthidae). *Boletín de la Sociedad Entomológica Aragonesa*, 36: 165–176.
- TERUEL, R. & L. F. DE ARMAS. 2012a. Redescrición de *Rhopalurus junceus* (Herbst 1800) (Scorpiones: Buthidae). *Boletín de la Sociedad Entomológica Aragonesa*, 50: 153–174.
- TERUEL, R. & L. F. DE ARMAS. 2012b. Nueva especie de *Rhopalurus* Thorell 1876 de Cuba oriental, con algunas consideraciones sobre sus congéneres antillanos (Scorpiones: Buthidae). *Boletín de la Sociedad Entomológica Aragonesa*, 50: 209–217.
- TERUEL, R., L. F. DE ARMAS & F. KOVAŘÍK. 2015a. A new species of *Centruroides* Marx, 1890 (Scorpiones: Buthidae) from southern Hispaniola, Greater Antilles. *Euscorpius*, 198: 1–18.
- TERUEL, R., L. F. DE ARMAS & F. KOVAŘÍK. 2015b. Two new species of scorpions (Scorpiones: Buthidae, Scorpionidae) from Dominican Republic, Greater Antilles. *Revista Ibérica de Aracnología*, 27: 13–33.
- TERUEL, R. & F. CALA. 2006. La subfamilia Diplocentrinae (Scorpiones: Scorpionidae) en Cuba. Cuarta parte: redescrpciones de *Cazierius gundlachii* (Karsch 1880) y *Cazierius parvus* Armas 1984 y descripción del macho adulto de *Cazierius asper* Teruel 2006. *Boletín de la Sociedad Entomológica Aragonesa*, 39: 305–317.
- TERUEL, R., M. J. RIVERA & C. J. SANTOS. 2015. Two new scorpions from the Puerto Rican island of Vieques, Greater Antilles (Scorpiones: Buthidae). *Euscorpius*, 208: 1–15.
- VACHON, M. 1974. Études des caractères utilisés pour classer les familles et les genres des scorpions (Arachnides). 1. La trichobothriotaxie en arachnologie. Sigles trichobothriax et types de trichobothriotaxie chez les Scorpions. *Bulletin du Muséum national d'Histoire naturelle*, 3e série, 140 (Zoologie, 104): 857–958.