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On the highest altitudinal occurrences of scorpions in Cuba (Arachnida: Scorpiones)

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Abstract: All findings of scorpions above 800 m altitude in Cuba are herein revised; this contour is seen to be exceeded only by four members of Buthidae: *Centruroides anchorellus* Armas, 1976, *Centruroides baracoae* Armas, 1976, *Centruroides stockwelli* Teruel, 2000, and *Rhopalurus junceus* (Herbst, 1800). Some of the previous records from the literature are corrected and the upper limit is found to correspond to *C. baracoae* in eastern Cuba (1,600 m at the source of Palma Mocha River). Also, the occurrence of *C. stockwelli* is documented at the highest mountain of central Cuba (1,140 m at Pico San Juan, Cienfuegos), as well as new upper records for *C. anchorellus* (1,362 m on the southern slope of Pico Martí) and *R. junceus* (1,231 m at Pico El Toldo).
Key words: Scorpiones, Buthidae, *Centruroides*, *Rhopalurus*, altitude, Cuba.

Sobre los hallazgos de mayor altitud de escorpiones en Cuba (Arachnida: Scorpiones)
Resumen: Se revisan todas las capturas de escorpiones por encima de los 800 m de altitud en Cuba y se constata que dicha cota es superada sólo por cuatro especies de Buthidae: *Centruroides anchorellus* Armas 1976, *Centruroides baracoae* Armas 1976, *Centruroides stockwelli* Teruel 2000 y *Rhopalurus junceus* (Herbst 1800). Se rectifican varios de los registros publicados previamente y se esclarece que el máximo límite corresponde a *C. baracoae* en Cuba oriental (cabezadas del río Palma Mocha, 1 600 m). Además, se reporta la presencia de *C. stockwelli* en la mayor elevación de Cuba central (Pico San Juan, 1 140 m), así como nuevos registros máximos para *C. anchorellus* (ladera sur de Pico Martí, 1 362 m) y *R. junceus* (Pico El Toldo, 1 231 m).
Palabras clave: Scorpiones, Buthidae, *Centruroides*, *Rhopalurus*, altitud, Cuba.

The topography of the Cuban Archipelago is very complex and characterized by extensive lowland plains that alternate with undulating hills and steep mountains. There are four main mountain ranges (fig. 1), which are isolated in the three physiographical regions traditionally recognized for the country, and their highest altitudes increase along a northwest-southeast gradient:

● **Western region:** the Guaniguanico Range with a maximum altitude of 699 m at Pan de Guajaibón (Artemisa province).

● **Central region:** the Guamuhaya Massif with 1,140 m at Pico San Juan (Cienfuegos province).

● **Eastern region:** the Sagua-Baracoa Massif with 1,241 m at Pico Cristal (border of Santiago de Cuba and Holguín provinces), and the Sierra Maestra Range with 1,972 m at Pico Real del Turquino (Santiago de Cuba province).

The altitudinal gradient in climatic and edaphic conditions on these mountains both function as limiting factors for the distribution of most of their associated biota, which is particularly reflected in the vegetation physiognomy. Borhidi (1991) stated that this gradient of temperature and relative humidity translates into approximately 0.5°C and 1.8% per 100 m, respectively, and commented on the importance of these factors in the occurrence of zonal vegetation. The vertical gradient of temperature drops significantly in the condensation belt (800–1,600 m), whose lower end matches the transition zone from submontane forests such as seasonal evergreen forest and submontane rainforest, through the typical high mountain vegetation like montane rainforest (Borhidi, 1991; Reyes, 2012).

Scorpions are highly diverse and widespread all over the Cuban Archipelago, with two families, 10 genera and 55 species currently recognized as valid for the country (Teruel & Kovařík, 2012; Teruel, 2013). Nevertheless, and consistently with the altitudinal gradient in bioclimatic conditions mentioned above, Cuban scorpions seldom occur above the lower end of the condensation belt (800 m): so far, only three of them have been found at these altitudes (Armas, 1984, 1988; Teruel, 2000, 2003) and they all belong to the family Buthidae (table I): *Centruroides anchorellus* Armas, 1976, *Centruroides baracoae* Armas, 1976, and *Rhopalurus junceus* (Herbst, 1800).

This paucity of high-montane scorpions is in sharp contrast with other Greater Antillean and mainland American territories, and still awaits a satisfactory explanation. For example, in the neighboring island of Hispaniola a total of three families, six genera and 20 species have been confirmed to occur above 1,000 m, including the highest possible altitude of 3,187 m at Pico Duarte (Armas, 1988, 1999, 2005; Teruel, 2005; Armas & Teruel, 2012; Teruel & Kovařík, unpublished data).

On the other hand, the high altitudinal data mentioned in the Cuban scorpiologic literature are often wrong or misleading, because of a couple of problems that prevailed until recently: official data were classified for military use only and personal GPS devices were not authorized in the country, thus, authors had to gather their data exclusively from outdated or unreliable maps. For example, the maximum record published for Cuban scorpions is given as 1,214 m for La Gran Piedra (Teruel, 2000), but another locality mentioned in the same paper that is actually the highest (source of Palma Mocha river, at 1,600 m), simply went unnoticed because this data was then unavailable to the author.

Nowadays these handicaps are fortunately over, and herein we proceed to update the list of the highest montane findings of scorpions in Cuba. Altitudes are expressed in meters above sea level and all values have been extracted from current topographic maps (scale 1: 25,000) or actually measured *in situ* with a calibrated GPS device (Garmin E-Trex). All specimens are preserved in ethanol 80% and deposited in the personal collections of the authors (RTO, TMR), and that of Centro Oriental de Ecosistemas y Biodiversidad (BIOECO).

● ***Centruroides anchorellus* Armas, 1976.** SANTIAGO DE CUBA province: GUAMÁ municipality: El Turquino Range: Alto de Cardero (19°58'15.3"N - 76°50'23.4"W; 1,306 m); June, 2004; L. Viña; 1♀ (RTO). El Turquino Range: southern slope of Pico Martí (20°00'

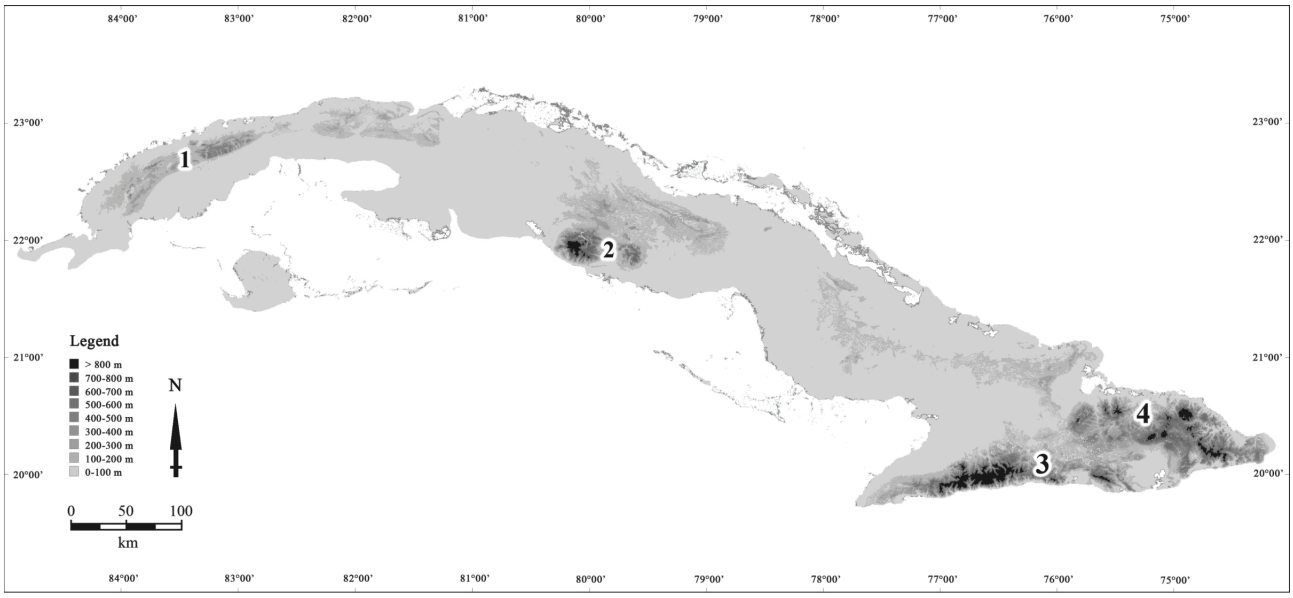

Fig. 1. Map of Cuba showing the four main mountain ranges: Guaniguanico Range (**1**); Guamuhaya Massif (**2**);Sierra Maestra Range (**3**); Sagua-Baracoa Massif (**4**).

Table I. Cuban localities with confirmed scorpion occurrences above 800 m altitude. New records are shaded in gray. Values corrected herein for data that were either wrongly or not stated in the original sources are marked with an asterisk. Abbreviations for provinces: Cienfuegos (CF), Granma (GR), Holguín (HG), Santiago de Cuba (SC).

Species	Altitude	Locality	Source
C. anchorellus	1,362 m	Southern slope of Pico Martí, SC	This paper
	*1,306 m	Alto de Cardero, SC	Armas (1988)
	1,214 m	La Gran Piedra, SC	Armas (1988), Teruel (2000)
	*1,130 m	La Isabelica, SC	Teruel (2000)
	1,100 m	Road La Gran Piedra, km 13.5, SC	Teruel (2000)
	800 m	El Olimpo, SC	This paper
C. baracoae	*1,600 m	Source of Palma Mocha river, SC	Teruel (2000)
	1,100 m	Northern slope of Pico Caracas, GR	This paper
	*1,241 m	Pico Cristal, SC	Teruel (2000)
	1,175 m	Pico El Toldo, HG	This paper
	*987 m	Loma de La Mensura, HG	Teruel (2000)
	900 m	La Platica, SC	This paper
	*800 m	El Toldo High Plateau, HG	Teruel (2000)
C. stockwelli	1,140 m	Pico San Juan, CF	This paper
R. junceus	1,175 m	Pico El Toldo, HG	This paper
	1,130 m	Pico Mogote, SC	Teruel (2003)
	*987 m	Loma de La Mensura, HG	Teruel & Armas (2012)
	900 m	Pinares de Mayarí, HG	Teruel & Armas (2012)
	*800 m	El Toldo High Plateau, HG	Teruel & Armas (2012)

34”N 20°00’34”N - 76°33’57”W; 1,362 m); October 27, 1999; R. Teruel; 1♂, 1♀ (RTO). SANTIAGO DE CUBA municipality: La Gran Piedra Range: La Gran Piedra (20°00’39.5”N - 75°37’38.2”W; 1,214 m); July 21, 1990; R. Teruel, 2♀♀ (RTO). March 31, 1991; R. Teruel; 1♂ (RTO). October 10, 1992; R. Teruel, L. Velazco; 1♂ (RTO). February 26, 1994; R. Teruel, Y. Pupo; 9♂♂, 7♀♀, 4 juveniles (RTO). June 9, 1995; R. Teruel; 1♀ (RTO). La Gran Piedra Range: La Isabelica (20°00’18.0”N - 75°37’08.1”W; 1,130 m); March 6, 1994; R. Teruel, Y. Pupo, A. Álvarez; 1♂ (RTO). La Gran Piedra Range: km 13.5 of road from Las Guásimas to La Gran Piedra (20°00’39.0”N - 75°38’06.5”W; 1,100 m); November 22, 1991; R. Teruel, W. Morando; 1♂, 1♀ (RTO). March 21, 1993; R. Teruel, Y. Pupo; 1♂ (RTO). La Gran Piedra Range: El Olimpo (20°00’55”N - 75°39’43”W; 800 m); February 6, 2000; A. Sánchez; 2♂♂, 2♀♀, 1 juvenil (RTO).

● ***Centruroides baracoae*** **Armas, 1976.** GRANMA province: BARTOLOMÉ MASÓ municipality: El Turquino Range: northern slope of Pico Caracas (19°58’13.4”N - 77°00’30.2”W; 1,100 m); March 5–10, 2013; R. Teruel, J. Costa, L. O. Melián; 1♂, 23♀♀, 16 juveniles (RTO). SANTIAGO DE CUBA province: GUAMÁ municipality: El Turquino Range: source of Palma Mocha River (20°00’28”N - 76°50’07”W; 1,600 m); April 15, 1985; B. Cortés; 1♂, 1 juvenile (RTO). El Turquino Range: La Platica (20°00’41.8”N - 76°53’27.3”W; 900 m); March 28–30, 2012; R. Teruel; 15♀♀, 4 juveniles (RTO). SEGUNDO FRENTE municipality: El Cristal Range: Pico Cristal (20°32’30.3”N - 75°28’36.3”W; 1,241 m); August 22, 1975; J. Fernández; 1♀ (RTO). HOLGUÍN province: MAYARÍ municipality: Sagua-Baracoa Massif: Nipe High Plateau: Loma de la Mensura (20°29’22.0”N - 75°48’27.7”W; 987 m); October 21, 1996; N. Navarro, C. Peña; 1♂, 1♀, 3 juveniles (RTO). May 4, 1997; A. Sánchez; 1♀ (BIOECO). MOA municipality: Sagua-Baracoa Massif: Pico El Toldo (20°30’25.2”N - 74°54’42.6”W; 1,175 m); April 1–15, 2004; J. L. Delgado, N. Viña; 5♂♂, 7♀♀, 1 juvenile (RTO). El Toldo High Plateau (20°30’51.0”N - 74°55’18.0”W; 800 m); October, 1997; A. Fong, L. F. de Armas; 1♂, 1♀, 3 juveniles (BIOECO, RTO).

● ***Centruroides stockwelli*** **Teruel, 2000.** CIENFUEGOS province: CUMANAYAGUA municipality: Guamuhaya Massif: Pico San Juan (21°59’20.6”N - 80°08’51.0”W; 1,140 m); October 4–6, 2013; T. M. Rodríguez-Cabrera, R. Marrero, J. León; 2♂♂, 3♀♀, 2 juveniles (RTO); November 8–15, 2013; T. M. Rodríguez-Cabrera, R. Marrero, R. López-Silvero; 2♂♂ (TMR); February 21–28, 2014; T. M. Rodríguez-Cabrera, C. Martínez; 1♂ (RTO).

Fig. 2. *Centruroides stockwelli* at Pico San Juan: **a)** male; **b)** female; **c)** female with first instar litter; **d)** female with second instar litter. Individuals a–b photographed during ordinary nocturnal activity (16.7°C).

Fig. 3. *Centruroides baracoae* photographed during ordinary nocturnal activity (5°C): **a)** female from Pico Caracas; **b)** female with first instar litter from La Platica.

●***Rhopalurus junceus* (Herbst, 1800).** HOLGUÍN province: MAYARÍ municipality: Nipe High Plateau: Loma de la Mensura (20°29'22.0"N - 75°48'27.7"W; 987 m); May 4, 1997; A. Sánchez; 2♀♀ (BIOECO). Nipe High Plateau: Pinares de Mayarí (20°28'44.2"N - 75°49'06.5"W; 900 m); May 4, 1997; A. Sánchez; 1♀ (BIOECO). MOA municipality: Sagua-Baracoa Massif: Pico El Toldo (20°30'25.2"N - 74°54'42.6"W; 1,175 m); September 10, 1997; A. Fong; 1♀. July 19, 2004; J. L. Delgado; 2 juveniles (RTO). Sagua-Baracoa Massif: El Toldo High Plateau (20°30'51.0"N - 74°55'18.0"W; 800 m); October, 1996; A. Fong, N. Viña, N. Viña, L. O. Melián; 1 juvenile (BIOECO). September 10, 1997; A. Fong, N. Viña, F. Rodríguez; 1♀, 1 juvenile (BIOECO). June 1–15, 2004; N. Viña, J. L. Delgado; 1♂, 2♀♀ (RTO). SANTIAGO DE CUBA province: SANTIAGO DE CUBA municipality: La Gran Piedra Range: Pico Mogote (19°58'58.7"N - 75°34'21.6"W; 1,130 m); September 20–25, 2002; A. Fong, D. Maceira, J. Jiménez; 1♀, 5 juveniles (RTO).

Most of the samples listed above were collected by us during night searches with ultra-violet light, and this allowed making important observations on the ecology of these high-altitude populations. In all of them, scorpions became active just after sunset and remained as such until late evening. Despite the low temperature and high relative humidity (4–17°C and >85%, respectively), scorpions behaved quite normally: wandering around, hunting, mating, giving birth, carrying young and molting (fig. 2–3). Chilling winds plus crescent to full moon at all localities, and even slight rain during one night at La Platica, did not produce any detectable changes in the activity patterns. The same behavior was already recorded in the montane populations of the closely related *Centruroides nitidus* (Thorell, 1876), at the Central Range of Hispaniola (Teruel, 2005; Armas *in* Teruel, 2005).

In all those altitudinal localities, scorpions were found predominantly in human buildings and their surroundings (e.g., concrete or wooden houses, huts, and ruins), where they lurk inside cracks and crevices of old walls, roof, floor and furniture, in lumber or junk rooms, inside boxes, closets and wardrobes. The scorpion numbers in the primary vegetation were much smaller, and specimens were found under rocks and barks, as well as inside epiphytic bromeliads and hollow stems of tree ferns. We regard this as an opportunistic trait: the scorpions are obviously taking advantage of the much more suitable conditions offered by those manufactured structures as opposite to the wild, i.e., denser populations of prey, greater diversity of shelters, and protection against extreme fluctuations of climatic variables such as temperature and humidity.

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