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THE PREYS OF CUBAN SCORPIONS (SCORPIONES: BUTHIDAE, DIPLOCENTRIDAE): AN APPRAISAL

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Abstract: There are data on the prey of only 21 (35.0%) of the 61 species of Cuban scorpions, with scorpions (including conspecific ones), beetles and cockroaches the most frequent victims. As a whole, almost 435 predation events have been recorded for the Cuban scorpions, of which more than 320 correspond to cannibalism, mainly on the widespread Cuban endemic *Heteroctenus junceus* (Herbst, 1800). This species has the highest number of recorded prey items and of field observations; its list includes spiders, amblypygids, scorpions, insects (mainly cockroaches and crickets), centipedes, frogs and lizards. Most of the prey were identified to species (30) or genus (12), whereas 19 morphospecies were only identified to the suprageneric level. For the genus *Cryptoiclus* (Diplocentridae) data are lacking, whereas *Heteronebo* (Diplocentridae) and *Microtityus* (Buthidae) have one single known prey species each.
Key words: Scorpiones, Buthidae, Diplocentridae, natural history, predation, cannibalism, West Indies.

Las presas de los escorpiones cubanos (Scorpiones: Buthidae, Diplocentridae): Evaluación
Resumen: Existen datos sobre las presas de solo 21 (35.0%) de las 61 especies de escorpiones cubanos, siendo los propios escorpiones (incluidos los conespecíficos), coleópteros y cucarachas los más frecuentemente depredados. En total se han reportado casi 435 eventos de depredación a cargo de escorpiones cubanos, de los cuales más de 320 corresponden a canibalismo, mayormente en *Heteroctenus junceus* (Herbst, 1800), especie endémica de este país y de amplia distribución. Esta es, además, la especie que cuenta con mayor cantidad de observaciones en el campo; su lista de presas incluye arañas, amblipígidos, escorpiones, insectos (principalmente cucarachas y grillos), ciempiés, ranas y lagartos. Sobre el género *Cryptoiclus* (Diplocentridae) no existen datos, mientras que en *Heteronebo* (Diplocentridae) y *Microtityus* (Buthidae) solo consta una especie para cada uno.
Palabras clave: Scorpiones, Buthidae, Diplocentridae, historia natural, depredación, canibalismo, Antillas.

Introduction

Information on predator-prey interactions is a valuable source that helps to a best understanding of the ecological niche range and food webs of the species (Van den Burg, 2020). Nevertheless, those data on the natural history are mostly obtained incidentally and, if published or subject of a thesis or other professional document, are disperse in several journals or institutions.

Dealing with the Cuban scorpions, a recent paper summarizes available data on their predators (Rodríguez-Cabrera *et al*., 2020b), but a similar comprehensive contribution on their preys is lacking. On this subject, the list published by Toscano-Gadea & Costa (2006) deals with buthid species only, it excluded cannibalism and inter-specific predation, whereas most data on the Cuban scorpions were taken from Teruel (1997).

Under laboratory conditions, consumption by *Centruroides* spp. of dried dead invertebrates (a centipede, termites, and cockroaches) was mentioned by Armas (1975). Nevertheless, field observations on the diet of the Cuban scorpions were unnoticed until last decades of the 20th century (Armas, 1976, 1984, 1988; Teruel, 1996a, b, 1997). The last work is an unpublished B. Sci. dissertation, but most of the data that it contains have been published (Teruel, 2001; Teruel in Teruel & Cala (2006); Teruel in Toscano-Gadea & Costa, 2006).

In the present contribution, the list of the confirmed preys of the Cuban scorpions is revised and new records are presented.

Materials & methods

Published articles (102), books (three) and seven unpublished B. Sc. Dissertations on Cuban scorpions were revised searching for data on preys of those species. Preference has been given to published data; lacking the pertinent consent, the unpublished information has not been herein included. Unverified preys mentioned by Teruel & Kovařík (2012), as well as records on the basis of photos that were not exactly determined if taken in the laboratory or the field, are excluded. Some preys recorded for *Centruroides gracilis* by Armas (1988: 11) were based on personal observations of the author in San Antonio de los Baños, Artemisa Province, Cuba, but this fact was not explicitly stated; such omission is herein amended and the correct data are incorporated in Table I. The events recorded as Teruel in Toscano-Gadea & Costa (2006) and Teruel in Cala (2006) have as original source to Teruel (1997). Data are considered actualized until November 30, 2020. Table I includes first record only (not posterior references). Geographic coordinates have been taken from Google Earth.

Results

As a whole, almost 435 events of predation have been recorded for the Cuban scorpions, of which more than 320 correspond to cannibalism, mainly on *Heteroctenus junceus* (Table I).

For 21 (35.0%) of the 61 Cuban species of scorpions belonging to the families Buthidae (16) and Diplocentridae (5) at least one prey has been recorded (Table I), being the scorpions (including conspecific), beetles and cockroaches the most frequently eaten. The species having most recorded preys and more field observations is the widespread Cuban endemic *Heteroctenus junceus*; its list includes spiders, amblypygids, scorpions, insects (mainly cockroaches and crickets), centipedes, frogs and lizards (Table I).



Fig. 1-2. Predation of cockroaches by *Centruroides gracilis* in the wall of a residential backyard in San Antonio de los Baños, Artemisa Province, Cuba. **1**, *Blaberus cranifer*; **2**, *Pycnoscellus surinamensis*. Photographs by the author.



Fig. 3. Adult female *Centruroides gracilis* with anomalous right pedipalp chela (from a residential backyard in San Antonio de los Baños, Artemisa Province, Cuba). Photograph by the author.

Most of the preys were identified to species (31) or genus (12), whereas 19 morphospecies were only identified to suprageneric level. The list of the preys identified to species or genus includes scorpions (11, largely involved in cannibalistic incidents), cockroaches (7), centipedes (3), lizards (3), ants (3), crickets (2), whip spiders (2), and also opilions, spiders, beetles, bees, bugs, silverfishes and frogs (one species each).

In addition to the events of cannibalism in *H. junceus*, other prey having a high frequency was the ant *Odontomachus* sp., implicated in at least 43 predation events by *Cazierius gundlachii* (Table I).

New records

Centruroides gracilis. The following observations were made by the author on the wall of a backyard (22°53'39.64"N, 82°30'31.47"W; 76 m a.s.l.), San Antonio de los Baños town, Artemisa Province. (1) On December 17, 2017, 1.6 m above the soil, an adult female was detected at the 21:40 hr that had been gripped an adult *Blaberus cranifer* (Dictyoptera: Blaberidae), which it was eating for the head (Fig. 1). (2) On August 30, 2014, at 1.80 m above the soil, a one-handed juvenile (Fig. 2) was observed at the 21:00 hr eating a juvenile *Pycnoscellus surinamensis* (Dictyoptera: Blaberidae). This specimen had the left pedipalp without the segments beyond the femur, feasibly as consequence of an accident or problems during the ecdysis [on April 18, 2015, in the same urban home, other adult female with a similar malformation (right pedipalp chela with only the basal portion of the hand) was observed (Fig. 3)].

Heteroctenus aridicola. On the type locality, on October 6, 1973, approximately at 21:00 hr, on columnar cactus,

Table I. Confirmed preys of the Cuban scorpions. *Symbols*: *: not Cuban endemic.

Predator / Prey	Source	Comments
FAMILY DIPLOCENTRIDAE		
***Cazierius asper* Teruel, 2006**		
INSECTA: Coleoptera: unidentified beetles. DIPLOPODA: unidentified millipedes.	Teruel (2006).	DIPLOPODA: cited by Teruel & Kovařík (2012: 156) as "small millipedes".
***Cazierius gundlachii* (Karsch, 1880)**		
INSECTA: Coleoptera: unidentified beetles. Hymenoptera: *Odontomachus* sp.	Coleoptera: Teruel in Teruel & Cala (2006). Hymenoptera: Teruel & Díaz [Cedeño] (2002), Teruel & Cala (2006).	Hymenoptera: At least 43 observed events.
***Didymocentrus sanfelipensis* Armas, 1976**		
INSECTA: Hymenoptera: *Solenopsis geminata*. Coleoptera: unidentified Tenebrionidae	Hymenoptera: Armas (1976). Coleoptera: This paper (pers. obs.).	Hymenoptera: A winged female predated by a juvenile.
***Didymocentrus trinitarius* (Franganillo, 1930)**		
INSECTA: Coleoptera: unidentified beetles. DIPLOPODA: unidentified millipedes	Coleoptera: Teruel & Rodríguez (2008). DIPLOPODA: Rodríguez-Cabrera (2016).	Coleoptera: Elytrous of beetles, likely predated by an immature specimen, were found in the scorpion refuge. Diplopoda: On the basis of remains found in the immediate vicinity of burrow entrances, it was suggested that millipedes constitute one of the most frequent preys of this scorpion.
***Heteronebo nibujon* Armas, 1984**		
INSECTA: Coleoptera: unidentified beetles. DIPLOPODA: (unidentified millipedes.	Teruel & Díaz [Cedeño] (2004).	The same data appear in Díaz Cedeño (2002).
FAMILY BUTHIDAE		
***Alayotityus delacruzi* Armas, 1973**		
ARACHNIDA: Scorpiones: *A. delacruzi*. INSECTA: Dictyoptera: unidentified Blattidae. Thysanura: *Cubacubana decui*. Coleoptera: larvae of Tenebrionidae.	Scorpiones: Teruel (2001). Coleoptera & Dictyoptera: Teruel (2001). Thysanura: Teruel in Toscano-Gadea & Costa (2006).	Thysanura: Teruel (2001) identified it as Nicoletidae, only.
***Alayotityus juraguaensis* Armas, 1973**		
INSECTA: Heteroptera: *Rhytidoporus identatus*.	Teruel in Toscano-Gadea & Costa (2006).	
***Alayotityus nanus* Armas, 1973**		
ARACHNIDA: Scorpiones: *Microtityus* cf. *trinitensis*. Insecta: Hymenoptera: *Odontomachus* sp. CHILOPODA: Geophilomorpha: unidentified centipedes. DIPLOPODA: unidentified millipedes. CRUSTACEA: Isopoda: unidentified Oniscidea	Scorpiones: Teruel (1996a). Hymenoptera: Teruel (1996b). CHILOPODA: Teruel in Toscano-Gadea & Costa (2006). DIPLOPODA: Teruel (1996b). CRUSTACEA: Isopoda: Armas (1984).	DIPLOPODA: Two observations. Isopoda: under stone, in subcoastal microphilous semideciduos forest.
***Alayotityus sierramaestrae* Armas, 1973**		
ARACHNIDA: Amblypygi: *Phrynus damonidaensis*. INSECTA: Dictyoptera: *Pycnoscellus surinamensis*.	Amblypygi: Armas *et al*. (2013). Dictyoptera: Teruel in Toscano-Gadea & Costa (2006).	
***Centruroides anchorellus* Armas, 1976**		
ARACHNIDA: Scorpiones: *C. anchorellus*. INSECTA: Hymenoptera: (1) *Apis mellifera*. (2) *Camponotus* cf. *ramulorum*. Lepidoptera: unidentified moths.	Scorpiones: Rodríguez-Cabrera *et al*. (2020b). Hymenoptera: (1) Teruel in Toscano-Gadea & Costa (2006); (2) Teruel (2019). Lepidoptera: Teruel & Kovařík (2012).	Scorpiones: Two instances of cannibalism.
***Centruroides arctimanus* Armas, 1976**		
ARACHNIDA: Scorpiones: *C. arctimanus*. INSECTA: Dictyoptera: unidentified Blattidae. Orthoptera: *Achaeta assimilis*.	Scorpiones: Teruel & Kovařík (2012). Dictyoptera: Teruel (1996b). Orthoptera: Pérez [Pérez] & Teruel (2004).	Orthoptera: The same data appear in Pérez Pérez (2003).
***Centruroides baracoae* Armas, 1976**		
ARACHNIDA: Scorpiones: *C. baracoae*. Hymenoptera: *Apis mellifera*. Lepidoptera: unidentified moths.	Scorpiones: Teruel (1996a). Hymenoptera: Teruel in Toscano-Gadea & Costa (2006). Lepidoptera: Teruel & Kovařík (2012).	Scorpiones: Misidentified as *C. anchorellus* by Teruel (1996a) (see Teruel, 2000: 11); the same error appears in Toscano-Gadea & Costa (2006).
Centruroides gracilis* (Latreille, 1804)		
ARACHNIDA: Scorpiones: *C. gracilis*. INSECTA: Dictyoptera: (1) *Blaberus cranifer*, *Pycnoscellus surinamensis*, and *Periplaneta americana*. (2) *Periplaneta australasiae*. Coleoptera: *Phyllophaga* sp. Orthoptera: unidentified crickets. CHILOPODA: Scolopendromorpha: (1) *Scolopendra* sp. (2) *Rhysida* sp., and *Scolopocryptops* sp. REPTILIA: Squamata: *Anolis porcatus*.	Scorpiones: Armas (2003), Rodríguez-Cabrera *et al*. (2020b). Dictyoptera: (1) Armas (2003, this paper); (2) Teruel in Toscano-Gadea & Costa (2006). Coleoptera: Armas (1988). Orthoptera: (1) Armas (1988). Scolopendromorpha: (1) Armas (1988), Teruel in Toscano-Gadea & Costa (2006), Teruel in Rodríguez-Cabrera *et al*. (2015). (2) Teruel in Rodríguez-Cabrera *et al*. (2015). Squamata: N. Morales in Armas (2001).	Scorpiones: At least five observed cases. Data by Rodríguez-Cabrera *et al*. (2020b) included those of Teruel (1997). Dictyoptera: Several observed cases for each prey.
Centruroides guanensis* Franganillo, 1930		
INSECTA: Hymenoptera: *Apis mellifera*.	Teruel & Kovařík (2012), cited as "honeybees".	For additional preys see Forcelledo Barranco (2016).
***Heteroctenus aridicola* Teruel & Armas, 2012**		
INSECTA: Dictyoptera: *Eurycotis* sp.	This paper (pers. obs.).	
***Heteroctenus garridoi* (Armas, 1974)**		
INSECTA: Dictyoptera: *Byrsotria* sp.	Teruel & Díaz (2002).	

Predator / Prey	Source	Comments
***Heteroctenus junceus* (Herbst, 1800)**		
ARACHNIDA: Amblypygi: *Phrynus pinarensis*. Araneae: (1) *Lycosa* sp. (2) *Heteropoda venatoria*. (3) unidentified mygalomorph spider. Scorpiones: (1) *Cazierius gundlachii*, (2) *Didymocentrus sanfelipensis*, *Centruroides guanensis*, *Centruroides stockwelli*, (3) *H. junceus*. INSECTA: Dictyoptera: (1) *Byrsotria* sp. (2) *Periplaneta australasiae* and *Eurycotis taurus.* Orthoptera: (1) *Achaeta assimilis*. (2) *Amphiacusta* sp. CHILOPODA: Scolopendromorpha: (1) *Scolopendra alternans*. (2) *Scolopocryptops ferrugineus.* AMPHIBIA: Anura: (1) *Eleutherodactylus* sp. REPTILIA: Squamata: (1) *Sphaerodactylus torrei*. (2) *Sphaerodactylus elegans.* (3) *Anolis sagrei.*	Amblypygi: Teruel & Toledo (2014). Araneae: (1) Teruel & Armas (2012a). (2) Teruel in Toscano-Gadea & Costa (2006). (3) Teruel (1996b). Scorpiones: (1) Teruel in Teruel & Cala (2006), Teruel & Armas (2012a), Rodríguez-Cabrera *et al*. (2020b). (2) Rodríguez-Cabrera *et al*. (2020b). (3) Armas in Teruel (1997), Teruel & Armas (2012a), Rodríguez-Cabrera *et al*., 2020b). Dictyoptera: (1) Teruel in Toscano-Gadea & Costa 2006), Teruel & Armas (2012a). (2) Teruel & Armas (2012a). Orthoptera: (1) Pérez [Pérez] & Teruel (2004), Teruel & Armas (2012a). (2) Teruel & Armas (2012a). Scolopendromorpha: (1) Barro & Cherva (2013). (2) Rodríguez-Cabrera *et al*. (2015). Anura: (1) Rodríguez-Cabrera *et al*. (2020a). Squamata: (1) Teruel & Armas (2012a). (2) R. Regalado in Armas (2001). Teruel *et al.* (2020)	Before 2018, *H. junceus* appears cited as *Rhopalurus junceus.* Scorpiones: (2) The events of cannibalism (*H. junceus*) and intra-guild predation (*C. guanensis*) observed in Canasí, Mayabeque Province (Rodriguez-Cabrera *et al*., 2020b: 1, figs. 1 a, c) are the same recorded by Forcelledo Barranco (2016: 25, Anexe 1 A, D). During a long-term survey (11 years) in a central Cuban population, more than 300 instances of cannibalism were observed (Rodriguez-Cabrera *et al*., 2020b). Orthoptera: (1) The same data appear in Pérez Pérez (2003).
Isometrus maculatus* (De Geer, 1778)		
INSECTA: Thysanura: unidentified.	Teruel (2009).	A large silverfish predated by an adult male at night in Sabana (20°16'57"N, 74°16'00"W), Maisí, Guantanamo Province (Teruel, 2009: 177).
***Microtityus farleyi* Teruel, 2002**		
ARACHNIDA: Araneae: unidentified Lycosidae	Teruel & Kovařík (2012: fig. 213).	
***Tityopsis inexpectata* (Moreno, 1940)**		
ARACHNIDA: Opiliones: *Neoscotolemon* sp.	Hernández-Borroto & Alegre (2020)	
***Tityopsis* sp.**		
CRUSTACEA: Isopoda: unidentified Oniscidea	This paper (pers. obs.).	Specific identity of this population of *Tityopsis* is pending of further studies.

two adult females were eating a *Eurycotis* sp. each (Dictyoptera: Blattidae), approximately 2 m over the soil. For details on the habitat see Teruel & Armas (2012b).

Tityopsis sp. In an orange grove belonging to the "Plan Citrícola Victoria de Girón", in Torriente (22°35'20.12"N, 81°14'34.84W; 08 m a.s.l.), Jagüey Grande municipality, Matanzas Province, on January 14, 1984, at 11:00 hr, was found under a stone a juvenile, which was eating an unidentified isopod (Oniscidea).

Didymocentrus sanfelipensis. On January 15, 1971, in the type locality, remains of tenebrionid beetles (Coleoptera: Tenebrionidae) were found in the refuge of a juvenile. For details on the habitat, see Armas (1976) and Teruel & Rodríguez (2008).

Discussion

The present revision clearly demonstrated the limited attention devoted to the study and observation of the diet of the Cuban scorpions in their natural environment. For only 35.0% of those species some of their preys have been documented. The most studied species, *Heteroctenus junceus* and *Centruroides gracilis*, are the largest and most widespread Cuban scorpions, being also the last a very common synanthropic scorpion, a circumstance that obviously contributed to that result. For comparison: other Cuban species widely distributed but smaller in size, as *Centruroides guanensis* and *C. anchorellus*, have not more than five recorded preys (Table I).

On the other hand, the five species of vertebrates recorded as preys of the Cuban scorpions involved two species only: *H. junceus* (one frog and three lizards) and *C. gracilis* (one lizard) (Table I).

For species belonging to the genus *Cryptoiclus* (Diplocentridae) data on their preys are lacking; whereas *Heteronebo* (Diplocentridae) and *Microtityus* (Buthidae) have a single species each with available information on this subject. On the other hand, for 14 of the 21 scorpion species listed in Table I, not more than two preys have been recorded, mostly identified to class or order, only.

In addition to the preys listed in Table I, a small amount of additional reports can be found in some of the unpublished B. Sc. dissertations, but was not possible to obtain the pertinent permission for utilizes such information in the present contribution.

As observed in two adult females of the common synanthropic *C. gracilis*, serious damages in one of the pedipalps (Figs. 2–3) is not an impediment for catching a prey. Nevertheless, it is expected that predation success decreases in such specimens.

Despite data included in the present contribution and those in Rodríguez-Cabrera *et al*. (2020b) and the unpublished B. Sc. dissertations, our knowledge on the preys and predators of the Cuban scorpions is lean. Definitely, most complete studies on those important aspects of the natural history are needed.

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