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Two new cases of metasomal duplication in scorpions, with notes on their reproductive biology (Scorpiones: Buthidae)

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Abstract: Herein we report two further cases of metasoma duplication in buthid scorpions: a second instar juvenile *Tityus obscurus* (Gervais, 1843) and an adult female *Centruroides nitidus* Thorell, 1876. Both individuals were born in captivity; the former died after its first ecdysis, but the latter reached adulthood and reproduced normally. This represents the first published record of the occurrence of such an anomaly in either species.
Key words: Scorpiones, Buthidae, anomaly, double metasoma, reproductive biology.

Dos nuevos casos de duplicación metasomal en escorpiones y notas sobre su biología reproductiva (Scorpiones: Buthidae)
Resumen: Se reportan dos casos adicionales de duplicidad del metasoma en escorpiones Buthidae: una ninfa I de *Tityus obscurus* (Gervais, 1843) y una hembra adulta de *Centruroides nitidus* Thorell, 1876. Ambos individuos nacieron en cautividad; el primero de ellos murió luego de su primera ecdisis, pero el segundo alcanzó la adultez y se reprodujo normalmente. Este representa el primer registro publicado de la ocurrencia de dicha anomalía en ambas especies.
Palabras clave: Scorpiones, Buthidae, anomalía, doble metasoma, biología reproductiva.

Introduction

The first case of symmetrical duplication of the body in scorpions (from the fourth mesosomal segment on) was recorded by Pavesi (1881) in *Euscorpius germanus* (C.L. Koch, 1837). Complete duplication of the metasoma has been widely documented in scorpion literature for many years (Brauer 1917; Berland 1913; Campos, 1918; Franganillo, 1937; Millot & Vachon, 1949; Vachon & Serfaty 1950; Vachon, 1953; Williams 1971; Armas, 1977, 1990; Matthiesen 1978; Sissom & Shelley 1995; Lourenço & Hypolite, 2010), but undoubtedly the most disparate case was that recorded by Armas *et al.* (1995a–b) in *Centruroides gracilis* (Latreille, 1804): a second instar juvenile with a total of three metasomas (most of them also secondarily divided) and six telsons. Most of these reports imply members of *Centruroides* Marx, 1890, a highly diverse Buthidae genus native to the Neotropics (Franganillo, 1937; Millot & Vachon, 1949; Briseño, 1963; Williams 1971; Armas, 1977, 1990; Armas *et al.*, 1995a–b; Sissom & Shelley 1995).

Other remarkable non-sexual morphological anomalies have also been described, such as duplication of the anterior part of the body (Matthiesen, 1979), pedipalps with extra or malformed segments (Graham, 2006; Karataş & Kürtüllü, 2006), and fusion of pectine parts (Ayrey, 2011). For an almost complete list and history of those records see Teruel (2003) and Mattoni (2005).

We describe here two additional cases of metasomal duplication: a second instar juvenile *Tityus obscurus* (Gervais, 1843) and an adult female *Centruroides nitidus* (Thorell, 1876). The latter even reached maturity and reproduce normally.

Material and methods

The scorpions were reared in plastic terraria of different sizes using standard methods. The enclosures contained a layer of soil (2 cm deep) and pieces of bark for shelter. Food consisted of small crickets (*Acheta domestica*) and fruit flies (*Drosophila melanogaster*). All individuals were fed once a week in the same intervals and kept under identical conditions of controlled temperature (26–27°C) and relative humidity (65–75%).

The individuals were studied, measured and photographed under a Wild/Leica M3Z stereomicroscope, equipped with line scale and a digital Nikon DSII Camera. Digital images were slightly processed with Adobe Photoshop® 8.0, only to optimize contrast features for exact measurements. Nomenclature and measurements follow Stahnke (1970).

Voucher specimens were preserved in 70% denatured ethanol and deposited in the collection of the Natural History Museum Wien, with accession codes NHMW-21874 (*C. nitidus*) and NHMW-21875 (*T. obscurus*).

Results and discussion

Tityus obscurus (Gervais, 1843)

Figures 1-2; table I

The prosoma, mesosoma and appendages are normal. Metasomal segment I is wider than normal but undivided, and segment II is even wider and has both lateral surfaces strongly divergent distally, suggesting an incipient division along midline. From this point on, two normal metasomas follow, each with its segments III–V and telson perfectly developed and ordinarily carinate tegument (fig. 1–2; tab. I).

The specimen was born in captivity and underwent its first ecdysis without any complications. It started feeding normally (with both metasomas being moveable in all directions and apparently functional), but the scorpion died suddenly without any visible reason. It formed part of a captive-bred stock obtained from adults collected in the Guyana-Brazil borderline (Rupununi area).

This represents the first record of double metasoma for this species, but a similar case of double metasoma from segment II on was already reported by Berland (1913).

Centruroides nitidus (Thorell, 1876)

Figures 3-4; tables I-II

The prosoma and appendages are normal. Mesosomal segments I–VI are also normal, but segment VII is wider and has both lateral surfaces strongly divergent distally, showing a partial division along midline. From this point on, two normal metasomas follow, each with its five segments and telson perfectly developed and ordinarily carinate tegument (figs. 3–4; tab. I).

The specimen was born in captivity on April 2009, in a litter that also contained a second specimen with metasoma duplication plus two individuals with tergal anomalies. All scorplings died except one of the double metasoma individuals, which started

Table I. Measurements in mm of the two anomalous specimens described herein. Abbreviations: ***C.nitidus***= *Centruroides nitidus*.NHMW 21874 ***T. obscurus***= *Tityus obscurus*. NHMW 21875 **MSs** = mesosomal segment; **MTs** = metasoma segment; **Tl ri** = telson length right; **Tl le** = telson length left. Right and left orientations correspond to dorsal view in head-up position.

	C. nitidus ♀
MSs VII:	
length	3.699
width	6.982
MTs I ri:	
length	3.048
width	2.098
MTs I le:	
length	3.127
width	2.194
MTs II ri:	
length	3.929
width	1.718
MTs II le:	
length	3.899
width	2.014
MTs III ri:	
length	4.180
width	1.846
MTs III le:	
length	4.127
width	2.322
MTs IV ri:	
length	4.881
width	2.066
MTs IV le:	
length	4.713
width	2.135
MTs V ri:	
length	5.057
width	2.297
MTs V le:	
length	5.013
width	2.584
Tl ri:	4.681
Vesicle ri	2.720
Tl le:	4.243
Vesicle le	2.490

	***T. obscurus* juv.**
MSs VII:	
length	0.830
width	1.768
MTs I:	
length	0.762
width	0.956
MTs II:	
length	1.172
width	1.084
MTs III ri:	
length	1.137
width	0.714
MTs III le:	
length	1.102
width	0.690
MTs IV ri:	
length	1.399
width	0.707
MTs IV le:	
length	1.359
width	0.685
MTs V ri:	
length	2.022
width	0.702
MTs V le:	
length	1.845
width	0.455
Tl re:	2.156
Vesicle re	1.397
Tl le:	2.068
Vesicle le	1.365

Table II. Duration in days of postembryonic development in *Centruroides nitidus* (anomalous female), including embryonic development and brood size. Abbreviations: **PE** = postembryonic development; **EP** = birth frequency; **N** = number of litter size; **n.d.** = no data available. **Notes:** *This female was born together with 16 siblings, after 142 days of embryonic development. **This duration seems too long (according to our personal observations, first instar lasts for 3-9 days in *Centruroides* spp.); we postulate that it was caused by non-optimal conditions caused by a long blackout. ***The female was mated only once and gave birth four times afterwards.

PE duration of the female with anomaly*	**date**
Instar I	29/03/2009
Instar II**	10/04/2009
Instar III	17/06/2009
Instar IV	02/08/2009
Instar V	17/10/2009
Instar VI	02/01/2010
Instar VII	11/04/2010
	378 days

EP of the female with anomaly***	**N**
December 2010	2
June 2011	12
July 2012	n.d.
March 2013	7

feeding normally (with both metasomas being moveable in all directions and functional), underwent six ecdyses without any complications, and reached sexual maturity after a complete postembryonic development of 378 days (tab. II). It formed part of a captive-bred stock obtained from adults collected in central Dominican Republic (Cibao Valley).

After this we mated the female several times with a male from the same population. The first brood was produced in December 2010 and consisted of only two offspring that died directly during birth. The second birth occurred on June 2011 and consisted of 12 successful offspring. The female gave birth again on July 2012, but all offspring died and could not be accurately counted. The fourth and last litter was delivered in March 2013 and contained seven offspring; the female was then kept single and not mated again. None of the offspring from this female showed any abnormalities. The female died in August 2013 at an age of 1,226 days.

This represents the first record of double metasoma for this species, but we are aware of at least another case that was commented on the blogosphere but never officially published. Some other adult scorpions with a double metasoma have been described (e.g., Millot & Vachon, 1949; Matthiesen, 1978; Armas, 1990), but this is the first one which is raised to maturity and confirmed as to be able to reproduce normally.

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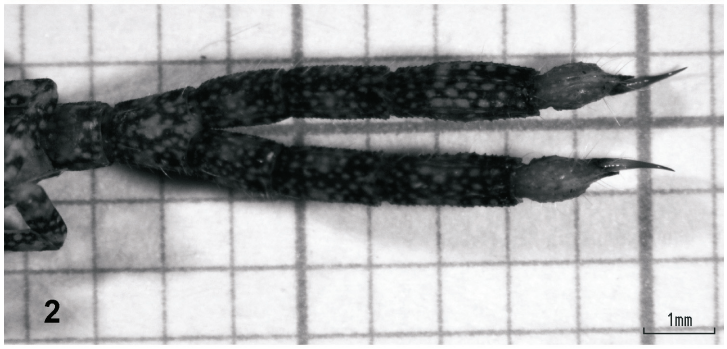
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► **Fig. 1.** Juvenile *Tityus obscurus* with double metasoma.
► **Fig. 2.** Close-up of the double metasoma of the same specimen of *Tityus obscurus*. Grid = 1mm.
► **Fig. 3.** Female *Centruroides nitidus* with a double metasoma, while mating (male left).
► **Fig. 4.** Same female *Centruroides nitidus*, with its first instar litter.









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