

Iteroparity following single insemination and largest size litter in *Rhopalurus junceus* (Herbst, 1800) (Scorpiones: Buthidae)

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Abstract: The occurrence of iteroparity following a single insemination is recorded herein for first time in both the Buthidae genus *Rhopalurus* Thorell, 1876, and *R. junceus* (Herbst, 1800). Also, we document the largest litter observed in this species, composed of 72 pulli.

Key words: Scorpiones, Buthidae, *Rhopalurus*, reproductive biology, Cuba.

Partos múltiples a partir de una única inseminación y tamaño máximo de camada en *Rhopalurus junceus* (Herbst, 1800) (Scorpiones: Buthidae).

Resumen: Se reporta por primera vez la ocurrencia de partos múltiples a partir de una única inseminación en el género de Buthidae *Rhopalurus* Thorell, 1876 y en *R. junceus* (Herbst, 1800). También se registra aquí la mayor camada observada en esta especie, formada por 72 preinifas.

Palabras clave: Scorpiones, Buthidae, *Rhopalurus*, biología reproductiva, Cuba.

Introduction

Iteroparity (multiple parturition by the same female, despite sexual or asexual reproduction) has been widely documented as the rule for most scorpion genera (see a compendium in Polis & Sissom, 1990). Nevertheless, there is a special type of iteroparity in which the female gives birth multiple times after a single initial mating, without need of further inseminations. This special type has been also repeatedly recorded in scorpion literature for a few genera (tab. I), but so far no official term has been coined to define it; moreover, in those species that undergo this special reproductive strategy, females also mate readily between parturitions if given the chance, as we have observed many times while captive-rearing many species of the genera *Centruroides* Marx, 1890, *Isometrus* Ehremberg, 1828, *Lychas* C. L. Koch, 1845, and *Tityus* C. L. Koch, 1836 (R. Teruel & T. M. Rodríguez-Cabrera, pers. obs.).

Rhopalurus junceus (Herbst, 1800) has been recorded to obligatorily require another mating to produce a new litter by any post-partum female, like other species of the genus (Armas, 1986, 1987a; Teruel & Armas, 2012). About the litter size for this species, the most recent contribution (Teruel & Armas, 2012) recorded a range of 6–55 pulli in 95 cases, with the most commonly found around 20–30.

Herein we present two findings that bring new light on the reproductive biology of *R. junceus*. First, we observed a female that produced two broods after a single insemination, and second we recorded a remarkably higher litter size of 72 pulli in another specimen.

Material and methods

The scorpions were collected by day under rocks between the small towns called San Antón and Pepito Tey (22°08'N - 80°21'W, altitude 30 m a.s.l.), in Cienfuegos province. The area is a karstic zone covered by secondary vegetation. In captivity, each individual was kept in a 90 x 180 mm plastic container with a 35 mm deep cement substrate, and fed once a week on cockroaches (Blattodea: Blaberidae: *Pycnoscelus surinamensis*); water was offered *ad libitum* in a small plastic cap. The room was maintained under a light/darkness cycle of 9/15 hours and air temperature varied from 27–32°C.

Once sacrificed, the specimens were measured with a Vernier Caliper (0.05 mm accuracy) and weighted to the nearest 0.01 g with

a Gram Precision® BH-1200 electronic scale. Both females herein mentioned are preserved in 85% ethanol and deposited in the personal collection of the second author (RTO).

When referring to iteroparity, we strongly recommend other authors to specify always whether it follows a single initial mating or not, e.g., "*iteroparity following single insemination*" or "*iteroparity following multiple inseminations*". This will provide crucial information on the reproductive strategy of the studied species, which otherwise will regrettably be lost. Note that this applies to sexual reproduction only, i.e., consecutive litters produced by parthenogenesis do not require male mating, at least in scorpions.

Results and discussion

Iteroparity

On 2 April 2014, a gravid female *R. junceus* (# 1 in tab. II) was collected and brought alive to the laboratory. It started giving birth at noon May 8 (36 days after capture) and finished at dusk after delivering 30 pulli. The whole litter molted into nymph I on May 14, after a six-day first instar. Two days later, they started to disperse by themselves and were finally moved to individual containers.

After the female recovered by feeding normally, repeated attempts to mate it to different males were unsuccessful: she always rejected them all aggressively, without ever engaging in courtship. However, at noon August 23 (107 days after first parturition), she unexpectedly gave birth again to 55 pulli. The litter made the first molt in August 28 (a five-day first instar) and started to disperse three days later.

After a similar recovery, the female accepted a male and mated normally in September 19 (27 days after second parturition), but showed no obvious signs of being pregnant until she was sacrificed and preserved two months later. It is interesting to note here also that this second litter was 25 young larger than the first one, something opposite to the most commonly observed occurrence (Teruel & Armas, 2012).

This represents the first observation of the occurrence of *iteroparity following single insemination* in the genus *Rhopalurus*, as opposite to what has been reported in literature (Armas, 1986, 1987a; Teruel & Armas, 2012). Nevertheless, we remain cautious

Table I. Scorpion genera that have been recorded to undergo iteroparity following single insemination. For those genera which have been repeatedly recorded in literature (e.g., *Centruroides*, *Tityus*), we present a selection of the most representative sources only.

| FAMILY / Genus | Source |
|--|---|
| BUTHIDAE C. L. Koch, 1837 | |
| • <i>Centruroides</i> Marx, 1890 | Williams (1969), Armas & Hernández Contreras (1981), Kovoor <i>et al.</i> (1987), this paper. |
| • <i>Isometrus</i> Ehrenberg, 1828 | Probst (1972), Dupré (1999), Teruel (2009), this paper. |
| • <i>Lychas</i> C. L. Koch, 1845 | This paper. |
| • <i>Rhopalurus</i> Thorell, 1876 | This paper. |
| • <i>Tityus</i> C. L. Koch, 1836 | Bücherl (1956), Matthiesen (1968, 1969, 1971), Lourenço (1979a–b), this paper. |
| SCORPIONIDAE Latreille, 1802 | |
| • <i>Didymocentrus</i> Kraepelin, 1905 | Kovoor <i>et al.</i> (1987), Dupré (1992). |

Table II. Measurements (mm) and mass (g) after parturition of the two females *Rhopalurus junceus* discussed herein. Abbreviations: length (L), posterior width (W), before parturition (BP), after parturition (AP), not measured (NM).

| Character | Female # 1 | Female # 2 |
|--------------------------------------|-------------|-------------|
| Total (L) | 91.3 | 87.5 |
| Carapace (L/W) | 10.3 / 11.2 | 10.0 / 10.9 |
| Mesosoma (L) | 26.6 | 25.3 |
| Metasoma (L) / Segment V (L) | 54.4 / 12.6 | 52.2 / 11.4 |
| Chela (L) | 18.3 | 17.4 |
| Mass (BP/AP - 1 st birth) | 6.70 / 4.18 | NM |
| Mass (BP/AP - 2 nd birth) | 4.90 / 3.70 | NM / 3.7 |

because there is an alternate possibility that must be taken into consideration: a case of facultative or casual parthenogenesis. This reproductive trait has also been repeatedly documented in other buthids, even in phylogenetically closely-related genera such as *Centruroides*, e.g., at least two cases of facultative parthenogenesis "hidden" inside normally sexual-reproducing populations of *Centruroides gracilis* Latreille, 1805, were recorded by Teruel (2004). Additional observations are required to corroborate iteroparity or parthenogenesis in *R. junceus* and to elucidate the potential triggering factors.

Maximum litter size

On 15 May 2014, another gravid female *R. junceus* (# 2 in tab. II) was collected and brought to the laboratory. She started giving birth at 09:00 hours of June 13 (29 days after collection), and finished parturition at 11:25 hours, after delivering a litter of 72 pulli; the relative clutch mass was 0.624 g. The entire litter molted into nymph I on June 18 (a five-day first instar), and started to get off in June 19 (1 day after first ecdysis).

In June 25 (6 days after the young got off) the female accepted a male and mated without problems. During the night from September 25 to 26, 2014 (92 days after last copulation), the female gave birth to 26 pulli; relative clutch mass was 0.308 g. This new litter made their first molt five days later, in October 1, and commenced to disperse in October 5 (4 day after first ecdysis).

With a maximum total length of 107 mm and body mass up to 8 g, *R. junceus* is a large buthid, among the largest species of its genus (Teruel & Kovařík, 2012; T. M. Rodríguez-Cabrera, pers. obs.). However, litters reported for this species are comparatively much smaller than those of other buthids of equivalent size (Armas, 1987b). This sharp contrast could be due to differences in reproductive investment between *R. junceus* and, e.g., *Centruroides gracilis* (Latreille, 1804): the later tends to produce larger litters (up to 91 offspring) but composed of smaller pulli (Lucas, 1890; Francke & Jones, 1982; Armas, 1987b).

Teruel & Armas (2012) mentioned that the offspring-number-to-mother-size direct correlation found in other Neotropical buthids such as *Centruroides*, does not occur in *R. junceus*. For example, Teruel & Armas (2012) highlighted that the largest litter known to them (55 pulli) was delivered by one of the smaller females (67 mm), whereas one of the smaller litters (18 young) came from one of the biggest females (100 mm). These authors commented as well that this phenomenon could be related to some physiological causes such as feeding condition and/or reproductive depletion: the older a female becomes, the smaller the litters it produces. This was ob-

served by us in the two consecutive litters produced by the above-mentioned female, which is relatively large for the species (tab. II).

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References

- ARMAS, L. F. DE 1986. Biología y morfometría de *Rhopalurus garridoi* Armas (Scorpiones: Buthidae). *Poeyana*, **333**: 1-27.
- ARMAS, L. F. DE 1987a. Cópula múltiple en escorpiones (Arachnida: Scorpiones). *Miscelánea Zoológica*, La Habana, **30**: 1-2.
- ARMAS, L. F. DE 1987b. Cantidad de hijos por parto en escorpiones cubanos (Scorpiones: Buthidae, Diplocentridae). *Ciencias Biológicas*, **18**: 119-122.
- ARMAS, L. F. DE & N. HERNÁNDEZ CONTRERAS 1981. Gestación y desarrollo postembrionario en algunos *Centruroides* (Scorpionida: Buthidae) de Cuba. *Poeyana*, **217**: 1-10.
- BÜCHERL, W. 1956. Escorpiões e escorpionismo no Brasil. V. Observações sobre o aparelho reprodutor masculino e o acasalamento de *Tityus trivittatus* e *Tityus bahiensis*. *Memorias do Instituto de Butantan*, **27**: 121-155.
- DUPRE, G. 1992. Observations de parturitions séquentielles chez *Didymocentrus lesueurii* (Gervais, 1844) (Scorpionida, Diplocentridae). *Arachnides*, **13**: 2-5.
- DUPRE, G. 1999. Note sur l'iteroparite d'*Isometrus maculatus* (De Geer, 1778) (Scorpiones, Buthidae). *Arachnides*, **40**: 12-13.
- FRANCKE, O. F. & S. K. JONES 1982. The life history of *Centruroides gracilis* (Scorpiones: Buthidae). *The Journal of Arachnology*, **10**: 223-239.
- KOVOOR, J., W. R. LOURENÇO & A. MUÑOZ-CUEVAS 1987. Conservation des spermatozoïdes dans les voies génitales des femelles et biologie de la reproduction des Scorpions (Chélicérates). *Comptes Rendus de l'Académie des Sciences de Paris*, **304**(10): 259-264.
- LOURENÇO, W. R. 1979a. La biologie sexuelle et le développement post embryonnaire du scorpion Buthidae: *Tityus trivittatus fasciolatus*, Pessoa 1935. *Revista Nordestina de Biologia*, **2**(1-2): 49-96.
- LOURENÇO, W. R. 1979b. Le scorpion Buthidae: *Tityus mattogrossensis* Borelli, 1901 (Morphologie, écologie, biologie et développement post embryonnaire). *Bulletin du Muséum National d'Histoire Naturelle de Paris*, 4^{ème} série, **1A**, **1**: 95-117.
- LUCAS, M. H. 1890. Sur la fécondité du genre du scorpion. *Bulletin de la Société Entomologique de France*, 6^{ème} série, **10**: 46.

- MATTHIESEN, F. A. 1968. On the sexual behavior of some Brazilian scorpions. *Revista Brasileira de Pesquisas Médicas e Biológicas*, **1**(2): 93-96.
- MATTHIESEN, F. A. 1969. Le développement post-embryonnaire du scorpion Buthidae, *Tityus bahiensis* (Perty, 1834). *Bulletin du Muséum National d' Histoire Naturelle*, 2^{ème} série, **41**(6): 1367-1370.
- MATTHIESEN, F. A. 1971. Observations on four species of Brazilian scorpions in captivity. *Revista Brasileira de Pesquisas Médicas e Biológicas*, **4**(4-5): 301-302.
- POLIS, G. A. & D. SISSOM 1990. Life History. Pp. 81-111, in "*The biology of scorpions*" (G. A. Polis, ed.). Stanford University Press, Stanford, California, 587 pp.
- PROBST, P. J. 1972. Zur fortpflanzungsbiologie und zur entwicklung der giftdrüsen bei scorpion *Isometrus maculatus* (DeGeer, 1778) (Scorpiones: Buthidae). *Acta Tropica*, **29**(1): 1-87.
- TERUEL, R. 2004. Primer registro de partenogénesis en *Centruroides gracilis* (Latreille, 1804) (Scorpiones: Buthidae). *Revista Ibérica de Aracnología*, **9**: 141-142. <http://www.sea-entomologia.org/Publicaciones/RevistaIbericaAracnologia/RIA09/R09-016-141.pdf>
- TERUEL, R. 2009. Morfología, ecología y distribución de *Isometrus maculatus* (DeGeer, 1778) en Cuba (Scorpiones: Buthidae). *Boletín de la Sociedad Entomológica Aragonesa*, **45**: 173-179. http://www.sea-entomologia.org/Publicaciones/PDF/BOLN45/173_179BSEA45Isometrus.pdf
- TERUEL, R. & L. F. DE ARMAS. 2012. Redescipción de *Rhopalurus junceus* (Herbst, 1800) (Scorpiones: Buthidae). *Boletín de la Sociedad Entomológica Aragonesa*, **50**: 153-174. http://www.sea-entomologia.org/Publicaciones/PDF/BOLN_50/153174BSEA50Rhopalurusjunceus.pdf
- TERUEL, R. & F. KOVÁŘÍK. 2012. *Scorpions of Cuba*. Clairon Production, Prague, 232 pp.
- WILLIAMS, S. C. 1969. Birth activities of some North American scorpions. *Proceedings of the California Academy of Sciences*, **37**: 1-24.