Revista Ibérica de Aracnología, nº **42** (30/06/2023): 277–279.
Grupo Ibérico de Aracnología (S.E.A.). ISSN: 1576 - 9518.

Litter size of some Costa Rican scorpions (Scorpiones: Buthidae, Diplocentridae)

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Abstract: The unique and rare reproductive biology of scorpions has attracted the attention of researchers for decades, owing to their sophisticated behavior. However, the post-birth natural history of most Costa Rican species remains unclear. In response, we aimed to expand our knowledge of this topic by reporting the litter size of some Costa Rican scorpions. Here, we report this aspect for nine of the 15 species in the country. These aspects were similar to those previously reported for six of the species. For the other three species, these are the first details of their clutch size. Moreover, we confirmed that *T. jaimei* females store spermatozoa, as previously reported for Panamanian populations.
Keywords: Scorpiones, *Ananteris*, *Centruroides*, *Didymocentrus*, *Tityus*, Reproductive biology, Sperm storage.

Tamaño de las camadas de algunos escorpiones costarricenses (Scorpiones: Buthidae, Diplocentridae)
Resumen: La única y extraña biología reproductiva de los escorpiones ha atraído la atención de investigadores por décadas debido a sus comportamientos sofisticados. Sin embargo, la historia natural posparto de la mayoría de las especies de Costa Rica aún es poco conocida. Por esa razón, nuestro objetivo es ampliar el conocimiento sobre este tema generando información sobre el tamaño de camada de algunos escorpiones costarricenses. Aquí reportamos este aspecto para nueve de las 15 especies del país. Para seis de las especies, estos aspectos fueron similares a los reportados previamente. Para las tres especies restantes estos son los primeros detalles que se conocen sobre el tamaño de sus camadas. Asimismo, confirmamos que las hembras de *T. jaimei* almacenan esperma, como se reportó anteriormente para poblaciones de Panamá.
Palabras clave: Scorpiones, *Ananteris*, *Centruroides*, *Didymocentrus*, *Tityus*, Biología reproductiva, Almacenamiento de esperma

Scorpions are well known for their sophisticated reproductive biology (Polis & Sissom, 1990; Víquez, 1999). For example, behaviors performed after parturition, such as parental care, have gained special attention from researchers because of their uniqueness and complexity (Trumbo, 2012). After birth, neonates climb to their mother's back (Fig. 1), where they settle until their first molt is complete, between 5 and 30 days, depending on the species (Lourenço, 2018; Polis & Sissom, 1990; Shaffer & Formanowicz, 1996). The number of offspring born varies between species (Polis & Sissom, 1990; Lourenço, 2007). Litter size has been proven to be directly proportional to females' size, nutritional status, age, and juvenile sizes (Francke, 1981; Bradley, 1984; Lourenço, 2002, 2007).

Currently, more information on the reproductive biology of scorpions is available (Polis & Sissom, 1990; Víquez, 1999; Lezcano *et al*., 2022). However, some aspects of the post-birth natural history of most Costa Rican species remain unclear. Therefore, we aimed to expand our knowledge of the reproductive biology of Costa Rican scorpions by reporting the litter sizes of eight buthids and one diplocentrid.

For an ongoing project focused on the venomics of Costa Rican scorpions, we collected individuals of nine species from different parts of the country (Fig. 2). The scorpions were transferred to the Instituto Clodomiro Picado in San José, Costa Rica and kept individually in plastic boxes with two pieces of paper as a substrate. The laboratory conditions were controlled by maintaining a temperature of 28 ± 2°C and a relative humidity of 65 ± 5%. Mealworms, crickets, and cockroaches were offered as prey weekly, and a soaked cotton swab was provided water *ad libitum*.

In this weekly review, we examined whether any female had given birth, and if so, once the young were down, each individual was counted (Table I) and preserved in ethanol (70%). For this information, we recorded two litters from *Centruroides bicolor* (Pocock, 1898), *Centruroides edwardsii* (Gervais, 1843)*, Didymocentrus krausi* Francke, 1978*,* and *Tityus jaimei* Miranda, Bermúdez, Flórez & Armas, 2020 (previously misidentified as *Tityus pachyurus* Pocock, 1897); three from *Ananteris platnicki* Lourenço, 1983; four from *Centruroides limbatus* (Pocock, 1898), and *Tityus championi* Pocock, 1898; five from *Tityus ocelote* Francke & Stockwell, 1987; and six from *Tityus dedoslargos* Francke & Stockwell, 1987.

A previous study by Lezcano *et al*. (2022) reported some aspects of the reproductive biology of Panamanian scorpions. When compared with these data, litter size in *A. platnicki*, *C. bicolor*, *C. limbatus, T. jaimei*, and *T. ocelote* were similar to those reported by them. Similarly, Armas *et al*. (2002) mentioned a batch of 28 nymphs collected from a female Costa Rican *T. dedoslargos*. This report coincides with the maximum number of young individuals recorded in this study. To the best of our knowledge, this is the first report of litter size in the other three species.

In particular, for *T. jaimei*, we would like to report that the same individual gave birth around the same date in two consecutive years (October 19, 2021, and October 21, 2022), indicating that this species' females store spermatozoids. The number of young individuals in the last clutch was recorded and is presented herein. It is known that Panamanian females store spermatozoids throughout several births (Lezcano *et al*., 2022). The fact that this phenomenon, which should not be confused with iteroparity (Lourenço, 2018), is present in Costa Rican females shows that it is widely distributed among different populations. In fact, the capacity of females to produce multiple broods after a single insemination is not rare in scorpions, and has been confirmed in several species, particularly the buthids *Centruroides* and *Tityus* (Lourenço, 2018). Thus, this phenomenon might also be common for other Central American species, as more studies on scorpion reproductive biology are being conducted.

Acknowledgments

We thank the Vicerrectoría de Investigación (Universidad de Costa Rica) for partially financing this project with grant 741-C2-076. The permits for scorpion research and collection are registered as SINAC-ACOPAC-D-RES-051-2021 and Biodiversity Commission Resolution #293. We also thank the Laboratorio para la Investigación de Animales Peligrosos (LIAP) from the Instituto Clodomiro Picado for the maintenance and management of animals in captivity. Cecilia Díaz for coordinating the scorpion proteomic project which makes this note possible. Andres Vega the photo of *T. dedoslargos* with neonates on its back.



Fig. 1. *Tityus dedoslargos* from Hacienda Barú performing parental care. Photo by Andrés Vega.

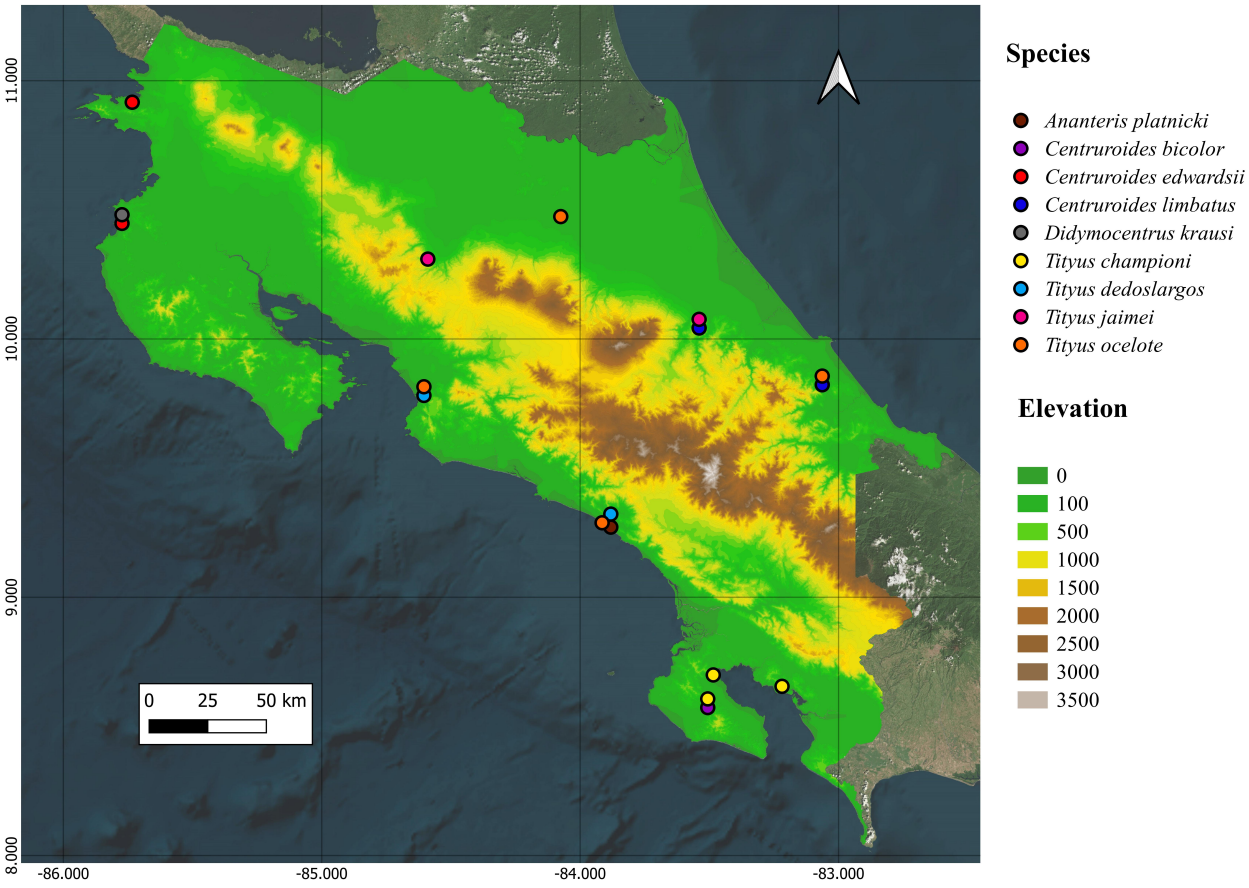


Fig. 2. Collection localities across Costa Rica by species. *Datum* used: WGS84. The elevation curve layer was obtained from the Atlas de Costa Rica (Ortiz-Malavasi, 2014).

Table I. Litter size in scorpions from Costa Rica. The number of litters sampled are denoted by n. Data are reported as both the mean value + SE and the range of values.

Species	n	Mean ± SE	Range
Ananteris platnicki	3	24 ± 3.5	20-31
Centruroides bicolor	2	40 ± 5	35-45
Centruroides edwardsii	2	66 ± 6	60-72
Centruroides limbatus	4	27.2 ± 3.9	21-38
Didymocentrus krausi	2	36 ± 4	32-40
Tityus championi	4	22.5 ± 3.5	16-30
Tityus dedoslargos	6	20.3 ± 1.9	14-28
Tityus jaimei	2	12 ± 4	8-16
Tityus ocelote	5	8.6 ± 1.2	7-13

References

ARMAS, L. F., VÍQUEZ, C., & MONTOYA, M. 2002. Complementos a la descripción de *Tityus dedoslargos* (Scorpiones: Buthidae). *Revista de Biología Tropical*, **50(1)**: 161–167.

BRADLEY, R. 1984. The influence of the quantity of food on fecundity in the desert grassland scorpion (*Paruroctonus utahensis*) (Scorpionida, Vaejovidae): An experimental test. *Journal of arid environments*, **11**: 165–172.

FRANCKE, O. F. 1981. Birth behavior and life history of *Diplocentrus spitzeri* Stahnke (Scorpiones: Diplocentridae). *The southwestern naturalist,* **25(4)**: 517–523.

LEZCANO, J. J., ARMAS, L. F., CASTILLO, L. Y., MURGAS, I. L., & MIRANDA, R. J. 2022. Some aspects of the reproductive biology of Panamanian scorpions (Scorpiones). *Revista Ibérica de Aracnología,* **40**: 47–56.*

LOURENÇO, W. R. 2002. Reproduction in scorpions, with special reference to parthenogenesis. Pp. 71-85 in Toft, S. & Scharff, N (eds.), *European Arachnology*. Aarhus University Press, Århus, 358 pp.

LOURENÇO, W. R. 2007. Litter size in micro-buthoid scorpions (Chelicerata, Scorpiones). *Boletín Sociedad Entomológica Aragonesa,* **40**: 473–477.+

LOURENÇO, W. R. 2018. Scorpions and life-history strategies: from evolutionary dynamics toward the scorpionism problem. *Journal of Venomous Animals and Toxins including Tropical Diseases,* **24**: 19.

ORTIZ-MALAVASI, E. 2014. *Atlas Digital de Costa Rica* (4 edición). Tecnológico de Costa Rica, Cartago. http://revistas.tec.ac.cr/ index.php/investiga_tec/article/view/2330

POLIS, G. A. & SISSOM, W. D. 1990. Life history. Pp 161–223, in Polis, G. A. (ed.), *The biology of scorpions*. Stanford University Press, Stanford, 587 pp.

SEITER, M. 2012. Developmental stages and reproductive biology in *Tityus confluens* Borelli, 1899 and *Tityus ocelote* (Francke & Stockwell, 1987) (Scorpiones, Buthidae). *Revista Ibérica de Aracnología,* **21**: 113–118.*

SHAFFER, L. R., & FORMANOWICZ, D. R. 1996. A cost of viviparity and parental care in scorpions: reduced sprint speed and behavioural compensation. *Animal Behaviour,* **51(5)**: 1017–1024. doi:10.1006/anbe.1996.0104

TRUMBO, S. T. 2012. Patterns of parental care in invertebrates. Pp 81–100, in Royle, N. J., Smiseth, P. T. & Kölliker, M. (eds.), *The evolution of parental care*. Oxford University Press, Oxford, 356 pp.

VÍQUEZ, C. 1999. *Escorpiones de Costa Rica*. INBio, San José, 84 pp.

* Referencia disponible en www.sea-entomologia.org