

First report of arm-span competition in buthid scorpions: male-male contest in *Tityus cf. rosenbergi* Pocock, 1898

Authors: Wyman, Jules Thornton, Wright-Ueda, Julien, Agnew, Quinn, Castellano, Ismael, and Simone, Yuri

Source: The Journal of Arachnology, 52(3) : 210-213

Published By: American Arachnological Society

URL: <https://doi.org/10.1636/JoA-S-23-009>

The BioOne Digital Library (<https://bioone.org/>) provides worldwide distribution for more than 580 journals and eBooks from BioOne's community of over 150 nonprofit societies, research institutions, and university presses in the biological, ecological, and environmental sciences. The BioOne Digital Library encompasses the flagship aggregation BioOne Complete (<https://bioone.org/subscribe>), the BioOne Complete Archive (<https://bioone.org/archive>), and the BioOne eBooks program offerings ESA eBook Collection (<https://bioone.org/esa-ebooks>) and CSIRO Publishing BioSelect Collection (<https://bioone.org/csiro-ebooks>).

Your use of this PDF, the BioOne Digital Library, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Digital Library content is strictly limited to personal, educational, and non-commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne is an innovative nonprofit that sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

SHORT COMMUNICATION

First report of arm-span competition in buthid scorpions: male-male contest in *Tityus* cf. *rosenbergi* Pocock, 1898

Jules Thornton Wyman¹, Julien Wright-Ueda¹, Quinn Agnew², Ismael Castellano³ and Yuri Simone^{4,5}: ¹Department of Biology, Stanford University, 371 Serra Mall, Stanford, CA 94305, USA; ²Department of Ecology, Evolution, and Environmental Biology, Columbia University, 1200 Amsterdam Avenue, New York, NY 10027, USA; ³Fundación de Conservación Jocotoco, Valladolid N24-414 y Luis Cordero, Quito, Ecuador; ⁴CIBIO, Centro de Investigação em Biodiversidade e Recursos Genéticos, InBIO Laboratório Associado, Campus de Vairão, Universidade do Porto, 4485-661 Vairão, Portugal; E-mail: Yurisimone1@gmail.com; ⁵BIOPOLIS Program in Genomics, Biodiversity and Land Planning, CIBIO, Campus de Vairão, 4485-661 Vairão, Portugal.

Abstract. Although courtship and mating behaviors have been described for nearly all scorpion lineages, intrasexual interactions in scorpions remain understudied. Recently, a novel ritualized behavioral unit, termed “arm-span competition,” in which individuals face off and extend their pedipalps laterally, was described from analyses of male-male contests in several scorpionid species. Here, we present the first documented observation of arm-span competition in a buthid scorpion, *Tityus* cf. *rosenbergi* Pocock, 1898. Interestingly, both *T. cf. rosenbergi* and most scorpionid species known to engage in arm-span competition exhibit a similar sexual dimorphism: males have markedly longer and more slender pedipalps than females. We suggest that the elongated pedipalps in males of these species might be the result of selective pressure related to ritualized arm-span competition. We also highlight the potential for citizen science to contribute rare observations to scientific literature.

Resumen. Aunque se han descrito comportamientos de apareamiento para casi todos los linajes de escorpiones, las interacciones intrasexuales siguen poco estudiadas. Recientemente, a partir del análisis de luchas macho-macho en algunos escorpiónidos, se describió una nueva unidad de comportamiento ritualizado denominada “competencia por extensión de pedipalpos” en que los individuos se enfrentan extendiendo sus pedipalpos lateralmente. En este trabajo, presentamos la primera observación documentada de este comportamiento en un búpido, *Tityus* cf. *rosenbergi* Pocock, 1898. Tanto *T. cf. rosenbergi* como la mayoría de las especies de escorpiónidos en que se describió este comportamiento, exhiben un dimorfismo sexual similar: los machos tienen pedipalpos notablemente más elongados y delgados que las hembras. Con esta observación, sugerimos que los pedipalpos de los machos en estas especies sean el resultado de la presión selectiva relacionada con la competencia ritualizada por extensión de pedipalpos. Además, enfatizamos el potencial de la ciencia ciudadana para contribuir con observaciones raras a la literatura científica.

Keywords: Agonistic behavior, Citizen science, Intrasexual combat, Neotropical scorpions, Sexual selection
<https://doi.org/10.1636/JoA-S-23-009>

Scorpions (Order: Scorpiones; Koch, 1837) comprise over 2,700 species (Rein 2017). They range across six continents and have successfully colonized most biomes, from arid deserts to humid rainforests, because of their high capability to adapt to even the most extreme environments (Polis 1990). Scorpions are generally abundant and frequently encountered, especially in tropical and sub-tropical areas (Polis & Yamashita 1991; Lighton et al. 2001; Stockmann 2013); nevertheless, much about their natural history remains poorly understood. In particular, some sex-linked behaviors are remarkably understudied. While courtship and mating have been described in nearly all scorpion families (Polis 1990; Lourenço 2002), accounts of intrasexual aggression are scarce in the current literature. Benton (1992) reported a high frequency of intrasexual aggression in a population of *Tetratrachobothrius flavicaudis* (De Geer, 1778) (Euscorpidae), but did not provide further behavioral details. Tallarovic (2000) provided the first detailed descriptions of intrasexual aggression in scorpions based on the observation of multiple contests involving both male-male and female-female pairs of captive *Hadrurus arizonensis* Ewing, 1928 (Hadruridae). In these interactions, scorpions grabbed each other with their pedipalps and occasionally grasped their opponent’s metasoma or attempted to flip their opponent. The author observed no stinging, suggesting that this combat may be ritualized.

While *H. arizonensis* presents only very subtle sexual dimorphism (Fox et al. 2015), many other scorpion species can be remarkably dimorphic. The most common sexually dimorphic traits include stinger, metasoma, pectines, body size, and pedipalps (McLean 2018; Simone & van der Meijden 2021). In particular, pedipalps and their pincer-like ends (chela) may present different degrees of sexual dimorphism in scorpions. Possibly, as observed in many other arthropods (Rico-Guevara & Hurme 2019), the shape of these sexually dimorphic traits could be the result of specialized fighting styles used in male-male contests.

Recently, Tang (2023) described a distinct form of apparently ritualized combat between captive males of several species of Heterometrinae (Scorpionidae) scorpions. In most of the species analyzed, males tend to have narrower, longer pedipalps than females. In the new proposed behavioral unit, termed “arm-span competition,” both contenders faced off and with their pedipalps extended laterally. The author suggested that this type of sexual dimorphism may be related to this particular form of intrasexual contest.

Interestingly, several distantly related scorpion lineages can present similar sexual dimorphism. The Neotropical buthid genus *Tityus* CL Koch, 1836 is taxonomically complex, comprising over 200 species (Brito & Borges 2015). Almost all of the *Tityus* species within the subgenus *Atreus* present extreme sexual dimorphism,



Figure 1.—Two *Tityus cf. rosenbergi* males engaged in arm-span competition. At this stage, both scorpions were mostly motionless.

especially in the pedipalps (Lourenço 2011). As in some Heterometrinae and other scorpionids (e.g., *Opisthophthalmus* CL Koch, 1837 (Scorpionidae); Visser & Geerts 2021), as well as members of at least one other scorpion family (i.e., Chactidae; González-Gómez et al. 2020), males of *Tityus* (*Atreus*) *rosenbergi* Pocock, 1898 have significantly more elongated and slender pedipalps than females (Lourenço & Flórez 2018). Here, based on an observation of wild individuals, we describe the first recorded instance of intrasexual contest in *Tityus cf. rosenbergi*, and the first instance of arm-span competition in a buthid scorpion. The documentation of such a rare event in the field by a group of non-arachnologists, and its subsequent dissemination through social media platforms, provides a remarkable example of the power of citizen science to shed light on infrequent yet important ecological processes.

On 17 August 2022 at 2124h (UTC-5), we observed two *Tityus* individuals, identified as *T. cf. rosenbergi* based on the authors' photographic material and a recent re-classification of trans-Andean *Atreus* (Lourenço & Ythier 2017; Lourenço & Flórez 2018), in combat in Canandé Reserve, an 8,500-hectare reserve within the Chocó lowland forest in Esmeraldas, Ecuador (0.52540° N, 79.21030° W; WGS84; 323m asl). At the time of our observation, local air temperature was approximately 21°C and relative humidity was near 100%. The two *T. cf. rosenbergi* individuals were of approximately the same size and were found on an *Inga* sp. trunk (diameter approximately 15 cm) in a secondary forest patch with over 20 years of regeneration. We identified both scorpions as males based on their slender and elongated pedipalps (Lourenço & Flórez 2018). They were facing each other with their metasomas held vertically and pedipalps extended laterally (Fig. 1; Supplemental Videos S1–S3, online at <https://doi.org/10.1636/JoA-S-23-009.s1> through <https://doi.org/10.1636/JoA-S-23-009.s3>). They periodically engaged in intense clashes. During these clashes, they mirrored each other's movements, rapidly knocking together their metasomas (with telsons tucked), sometimes gently grasping each other's chelae, and

jockeying for position (Fig. 2; Video S2, online at <https://doi.org/10.1636/JoA-S-23-009.s2>). They traveled up and down the trunk while maintaining close contact and switched positions at least once. Throughout the interaction, both scorpions maintained their pedipalps laterally extended. They sometimes made prolonged contact with their chelicerae, both during and between periods of activity (Video S3, <https://doi.org/10.1636/JoA-S-23-009.s3>). Although not recorded, we observed both scorpions rapidly shaking their bodies (i.e., “juddering”; Alexander 1957) multiple times. We took many photographs and videos, and as far as we could tell, the scorpions were undisturbed by our presence. There was no clear winner after approximately twenty minutes of observation, and we did not witness the conclusion of the contest.

This observation represents the first recorded instance of intrasexual contest in *Tityus cf. rosenbergi* and the first evidence of the “arm-span competition” behavior in buthids. The interaction was more similar to that described by Tang (2023) for male *Srilankametrus yaleensis* (Kovářík et al., 2019) and other Heterometrinae scorpions than that described by Tallarovic (2000) for both sexes of *Hadrurus arizonensis*. As described for *S. yaleensis* and relatives, we noted that the *T. cf. rosenbergi* engaged in “arm-span competition” throughout much of the contest, and grasped each other's chelae only lightly, in marked contrast to the grappling and periodic head-to-tail alignment described for *H. arizonensis* as well as for other species of buthids by Tang (2023). Other similarities included cheliceral and metasomal contact (only the latter was observed in *Hadrurus* intrasexual combat), although the reasons for these behaviors remain unknown. It is worth noting that the absence of intentional stinging between males is shared across other observations of arm-span competition (Tang 2023), further suggesting the ritualized nature of the contests. With the present report, we suggest that the elongation of the male pedipalps of some scorpion species might be related to their “arm span competition” behavior. The length of the pedipalp is used in males to size



Figure 2.—Two *Tityus cf. rosenbergi* males engaged in arm-span competition. At this stage, both scorpions were pushing toward one another, while rapidly knocking together their metasomas and periodically gently grasping each other's chelae.

each other up by means of the lateral extension of the pedipalps. Validating this hypothesis requires additional data. First, it must be proven that this behavior is primarily performed by sexually dimorphic species in which males bear narrower and more elongated pedipalps than females. To further suggest that this behavior has evolved independently in multiple scorpion lineages, it would be necessary to document the occurrence of arm-span competition in other families of scorpions which present similar sexual dimorphism in the pedipalps.

Our observation also highlights the importance of scientific observations of rare species or behaviors contributed through

citizen science. Citizen science has already produced terrestrial invertebrate datasets of great spatial and temporal scale, allowing for the discovery of unknown behaviors and species (Campbell & Engelbrecht 2018; Gardiner & Roy 2022). The present observations were made serendipitously by co-authors WJT, W-UJ, AQ and CI, who recorded the unusual behavior during a herpetological field trip. The videos, posted on Instagram by WJT, were seen by YS and served as the basis for this note. We urge citizen scientists to document observations of interesting behaviors and/or species and make these observations publicly available for scientific studies and potential conservation efforts.

ACKNOWLEDGMENTS

Work supported by the European Union's Horizon 2020 Research and Innovation Programme under the Grant Agreement Number 857251. YS was funded by a PhD scholarship by Fundação para Ciência e Tecnologia (SFRH/BD/136934/2018). Fieldwork was supported by the Fundación de Conservación Jocotoco, and we thank Martin Schaefer and Chiara Correa in particular for their support. We thank Daniel Carhuff and Andrew Connoy for their field assistance, and Daniel Carhuff for providing his photographs and video for our use. We would like to thank Javier Blasco-Aróstegui for alerting us to taxonomic changes within the *Tityus asthenes* group and Eric Ythier for providing us with the article describing *Tityus rosenbergi*. We also want to thank Ignazio Avella and Arie van der Meijden for their review of the manuscript. Finally, we thank Karen Pedersen and Nico Blüthgen for providing local weather data.

SUPPLEMENTAL MATERIALS

Two males of *Tityus* cf. *rosenbergi* engaged in combat in Canandé Reserve in the Chocó lowland forest in Esmeraldas, Ecuador.

Supplemental Video S1.—Males face each other with metasomas held vertically and pedipalps extended laterally; online at <https://doi.org/10.1636/JoA-S-23-009.s1>

Supplemental Video S2.—Males mirror each other's movements, rapidly knocking together their metasomas, grasping each other's chelae, and jockeying for position; online at <https://doi.org/10.1636/JoA-S-23-009.s2>

Supplemental Video S3.—Males make contact with their chelicerae; online at <https://doi.org/10.1636/JoA-S-23-009.s3>

LITERATURE CITED

- Alexander AJ. 1957. The courtship and mating of the scorpion, *Opisthophthalmus latimanus*. *Proceedings of the Zoological Society of London* 128:529–544.
- Benton TG. 1992. Determinants of male mating success in a scorpion. *Animal Behaviour* 43:125–135. doi: 10.1016/S0003-3472(05)80078-8
- Brito G, Borges A. 2015. A checklist of the scorpions of Ecuador (Arachnida: Scorpiones), with notes on the distribution and medical significance of some species. *Journal of Venomous Animals and Toxins Including Tropical Diseases* 21:23. doi: 10.1186/s40409-015-0023-x
- Campbell H, Engelbrecht I. 2018. The Baboon Spider Atlas - using citizen science and the 'fear factor' to map baboon spider (Araneae: Theraphosidae) diversity and distributions in Southern Africa. *Insect Conservation and Diversity* 11:143–151. doi: 10.1111/icad.12278
- Fox GA, Cooper AM, Hayes WK. 2015. The dilemma of choosing a reference character for measuring sexual size dimorphism, sexual body component dimorphism, and character scaling: cryptic dimorphism and allometry in the scorpion *Hadrurus arizonensis*. *PLOS ONE* 10: e0120392. doi: 10.1371/journal.pone.0120392
- Gardiner MM, Roy HE. 2022. The role of community science in entomology. *Annual Review of Entomology* 67:437–456. doi: 10.1146/annurev-ento-072121-075258
- González-Gómez JC, Valenzuela-Rojas JC, García LF, Pérez LMF, Guevara G, Buitrago S. et al. 2020. Sexual dimorphism in the biomechanical and toxicological performance in prey incapacitation of two morphologically distinct scorpion species (*Chactas* Sp. and *Centruroides* Sp.). *Biological Journal of the Linnean Society* 129:190–198. doi: 10.1093/biolinnean/blz146
- Kovářík F, Ranawana KB, Jayarathne VAS, Hoferek D, Štáhlavský F. 2019. Scorpions of Sri Lanka (Arachnida: Scorpiones). Part III. *Heterometrus yaleensis* sp. n. (Scorpionidae). *Euscorpius* 283:1–13. doi: 10.18590/euscorpius.2019.vol2019.iss283.1
- Lighton JRB, Brownell PH, Joos B, Turner RJ. 2001. Low metabolic rate in scorpions: implications for population biomass and cannibalism. *Journal of Experimental Biology* 204:607–613. doi: 10.1242/jeb.204.3.607
- Lourenço WR. 2002. Reproduction in scorpions, with special reference to parthenogenesis. Pp. 71–85. In *European Arachnology 2000*. (S Toft, N Scharff (eds.)), Aarhus University Press, Aarhus.
- Lourenço WR. 2011. The distribution of noxious species of scorpions in Brazilian Amazonia: the genus *Tityus* CL Koch, 1836, subgenus *Atreus* Gervais, 1843 (Scorpiones, Buthidae). *Entomologische Mitteilungen aus dem Zoologischen Museum Hamburg* 15:287–301.
- Lourenço WR, Flórez E. 2018. Further clarifications on some species of Genus *Tityus*, Subgenus *Atreus* (Scorpiones: Buthidae), from Colombia and Ecuador, with the description of a new species. *Revista Ibérica de Aracnología* 33:63–72.
- Lourenço WR, Ythier E. 2017. Description of *Tityus (Atreus) cisandinus* sp. n. from Ecuadorian Amazonia, with comments on some related species (Scorpiones: Buthidae). *Arachnida-Rivista Aracnologica Italiana* 15:18–34.
- McLean CJ, Garwood RJ, Brassey CA. 2018. Sexual dimorphism in the Arachnid orders. *PeerJ* 6: e5751. doi: 10.7717/peerj.5751
- Polis GA. 1990. *The Biology of Scorpions*. (Polis GA ed.) Stanford University Press.
- Polis GA, Yamashita T. 1991. The ecology and importance of predaceous arthropods in desert communities. Pp. 180–222. In *The Ecology of Desert Communities* (GA Polis, ed.), Tucson, AZ: University of Arizona Press.
- Rein JO. 2017. *The Scorpion Files*. Trondheim: Norwegian University of Science and Technology. Online at <https://www.ntnu.no/ub/scorpion-files/>, accessed on 2023.03.05.
- Rico-Guevara A, Hurme KJ. 2019. Intrasexually selected weapons. *Biological Reviews* 94:60–101. doi: 10.1111/brv.12436
- Simone Y, van der Meijden A. 2021. Armed stem to stinger: a review of the ecological roles of scorpion weapons. *Journal of Venomous Animals and Toxins Including Tropical Diseases* 27. doi: 10.1590/1678-9199-JVATITD-2021-0002
- Stockmann R. 2013. Introduction to scorpion biology and ecology. Pp. 25–59. In *Scorpion Venoms*. (Gopalakrishnakone P, Ferroni Schwartz E, Possani L, Rodríguez de la Vega R. (eds.)) Springer, Dordrecht. doi: 10.1007/978-94-007-6647-1_14-1
- Tallarovic SK. 2000. Reproductive and aggressive behaviors in the giant hairy desert scorpion. February. PhD Diss., Oregon State University.
- Tang V. 2023. Non-aggressive competition between males of *Srilankametrus yaleensis* (Kovářík et al., 2019) (Scorpionidae), and other types of agonistic behavior observed in scorpions. *Euscorpius* 2023:1–17.
- Visser JH, Geerts S. 2021. Sexual dimorphism and static allometry in the South African scorpion *Opisthophthalmus karrooensis*. *Arachnology* 18. doi: 10.13156/arac.2021.18.9.1057

Manuscript received 24 March 2023, revised 8 July 2023, accepted 9 July 2023.