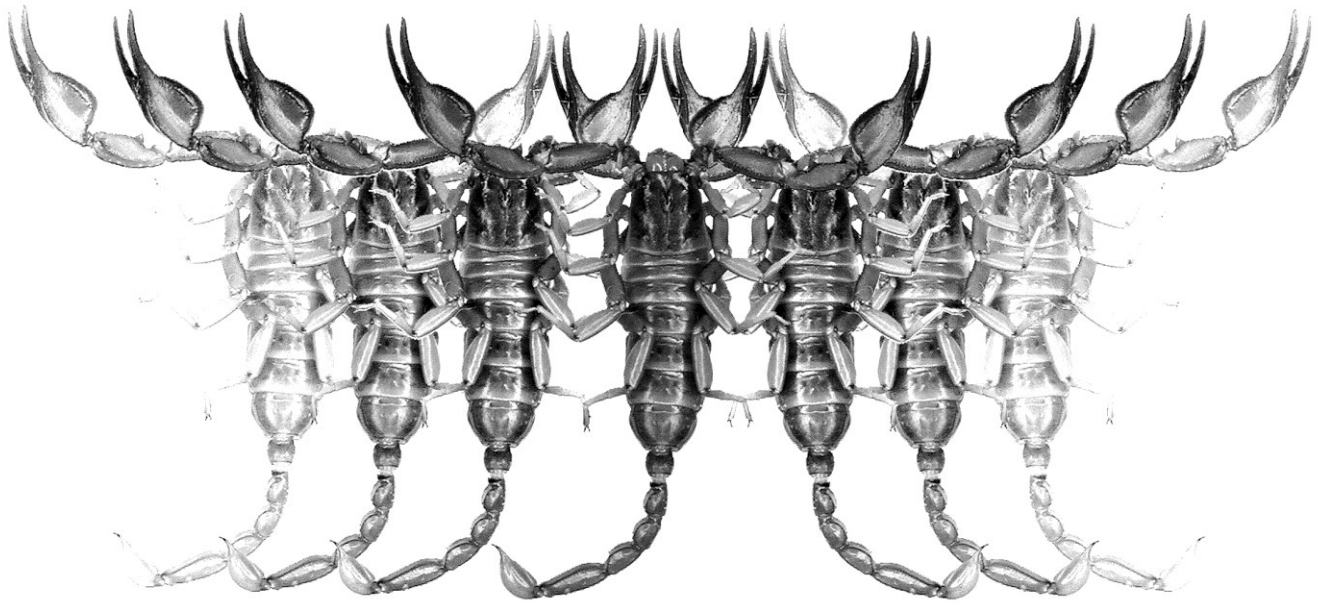


Euscorpius

Occasional Publications in Scorpiology



**Hermaphroditism, Gynandromorphism, and Four Pectines:
an Extreme Case of Developmental Anomaly in Scorpions
(Scorpiones: Vaejovidae)**

Rolando Teruel & José Guadalupe Baldazo-Monsivaiz

March 2015 — No. 197

Euscorpius

Occasional Publications in Scorpiology

EDITOR: Victor Fet, Marshall University, 'fet@marshall.edu'
ASSOCIATE EDITOR: Michael E. Soleglad, 'soleglad@znet.com'

Euscorpius is the first research publication completely devoted to scorpions (Arachnida: Scorpiones). *Euscorpius* takes advantage of the rapidly evolving medium of quick online publication, at the same time maintaining high research standards for the burgeoning field of scorpion science (scorpiology). *Euscorpius* is an expedient and viable medium for the publication of serious papers in scorpiology, including (but not limited to): systematics, evolution, ecology, biogeography, and general biology of scorpions. Review papers, descriptions of new taxa, faunistic surveys, lists of museum collections, and book reviews are welcome.

DERIVATIO NOMINIS

The name *Euscorpius* Thorell, 1876 refers to the most common genus of scorpions in the Mediterranean region and southern Europe (family Euscorpiidae).

Euscorpius is located at: <http://www.science.marshall.edu/fet/Euscorpius>
(Marshall University, Huntington, West Virginia 25755-2510, USA)

ICZN COMPLIANCE OF ELECTRONIC PUBLICATIONS:

Electronic ("e-only") publications are fully compliant with ICZN (*International Code of Zoological Nomenclature*) (i.e. for the purposes of new names and new nomenclatural acts) when properly archived and registered. All

Euscorpius issues starting from No. 156 (2013) are archived in two electronic archives:

- **Biotaxa**, <http://biotaxa.org/Euscorpius> (ICZN-approved and ZooBank-enabled)
- **Marshall Digital Scholar**, <http://mds.marshall.edu/euscorpius/>. (This website also archives all *Euscorpius* issues previously published on CD-ROMs.)

Between 2000 and 2013, ICZN did not accept online texts as "published work" (Article 9.8). At this time, *Euscorpius* was produced in two identical versions: online (*ISSN 1536-9307*) and CD-ROM (*ISSN 1536-9293*) (laser disk) in archive-quality, read-only format. Both versions had the identical date of publication, as well as identical page and figure numbers. Only copies distributed on a CD-ROM from *Euscorpius* in 2001-2012 represent published work in compliance with the ICZN, i.e. for the purposes of new names and new nomenclatural acts.

In September 2012, ICZN Article 8. *What constitutes published work*, has been amended and allowed for electronic publications, disallowing publication on optical discs. From January 2013, *Euscorpius* discontinued CD-ROM production; only online electronic version (*ISSN 1536-9307*) is published. For further details on the new ICZN amendment, see <http://www.pensoft.net/journals/zookeys/article/3944/>.

Publication date: 4 March 2015

<http://zoobank.org/urn:lsid:zoobank.org:pub:C1331C7F-54C5-4DBC-92BA-70479FF050D2>

Hermaphroditism, gynandromorphism, and four pectines: an extreme case of developmental anomaly in scorpions (Scorpiones: Vaejovidae)

Rolando Teruel ¹ & José Guadalupe Baldazo-Monsivaiz ²

¹ Centro Oriental de Ecosistemas y Biodiversidad (BIOECO), Museo de Historia Natural "Tomás Romay", José A. Saco # 601, esquina a Barnada, Santiago de Cuba 90100, Cuba. E-mail: rteruel@bioeco.ciges.inf.cu

² Unidad Académica No. 13, Universidad Autónoma de Guerrero, Av. Universidad s/n, Colonia El Limón, Zihuatanejo 40880, Guerrero, México.
<http://zoobank.org/urn:lsid:zoobank.org:pub:C1331C7F-54C5-4DBC-92BA-70479FF050D2>

Summary

In the present note, we describe in detail an aberrant anomalous specimen of the scorpion *Mesomexovis punctatus* (Karsch, 1879) (Vaejovidae). This strange individual is an adult and exhibits a combination of hermaphroditism, gynandromorphism, and pectinal duplication (i.e., presence of four pectines); the latter represents the first report ever made of such teratology. It was collected by the authors in northeastern Guerrero State, Mexico.

Introduction

The morphological anomalies of scorpions, though comparatively rare, have long attracted the attention of scorpologists. Especially prominent are spectacular cases of metasomal duplication, with more than 10 cases recorded over a period of about 135 years (see a compiled list of references in Seiter & Teruel, 2014), or even multiple metasomas in one case (Armas et al., 1995a–b). An opposite, but equally remarkable example of duplication was also described by Matthiesen (1979), a case that affected the anterior part of the body. So far, no cases of duplication of one or both pectines have ever been documented.

Regarding those anomalies affecting sexually dimorphic characters, records are even scarcer. Mattoni (2005) presented a compilation of all published occurrences and added two new ones, which all account for only eight cases: three gynandromorphs (Coken-dolpher & Sissom, 1988; Armas, 1990), two intersexuals (Mattoni, 2005), one hermaphrodite (Matthiesen, 1968), one double combination of hermaphroditism and gynandromorphism (Armas, 1990; Teruel, 2001), and one triple combination of hermaphroditism, gynandromorphism, and intersex condition (Maury, 1983).

During a field trip recently conducted by the present authors and some collaborators to a remote locality of northeastern Guerrero State, Mexico, several adult and juvenile specimens of *Mesomexovis punctatus* (Karsch,

1879) (Vaejovidae) were collected. All were brought alive to the laboratory and when accomplishing the identification process, we were shocked to discover that one specimen we had previously sexed in the field as an adult male had four well-developed pectines. A more detailed microscopic examination revealed that it also had a strange combination of sexual anomalies (hermaphroditism and gynandromorphism), and found evidence that it had been sexually active at least as female.

The specimen was photographed alive and preserved, in order to complete the study of such a weird developmental anomaly. Herein we describe, illustrate and discuss it in detail, and further mention briefly another case of pectinal anomaly detected in a second adult from the same sample.

Material and Methods

Specimens herein mentioned were studied under a Zeiss Stemi 2000-C stereomicroscope, equipped with a line-scale ocular micrometer for taking the measurements, and a Canon PowerShot A620 digital camera for the photographs; the habitus photographs of these same specimens were taken with a Nikon Coolpix S8100 digital camera. Digital images were slightly processed with Adobe Photoshop® CS3, only to optimize bright and contrast features. Nomenclature and measurements follow Stahnke (1970).



Figures 1–2: Anomalous specimen of *Mesomexovis punctatus* described herein. **1.** Photographed alive. Note the tips of both right side pectines are just visible between legs I and III (arrows). **2.** Same specimen, photographed after preservation in full dorsal (left) and ventral views. Note the general shape and proportions of body and appendages, typical of an adult male *Mesomexovis*.

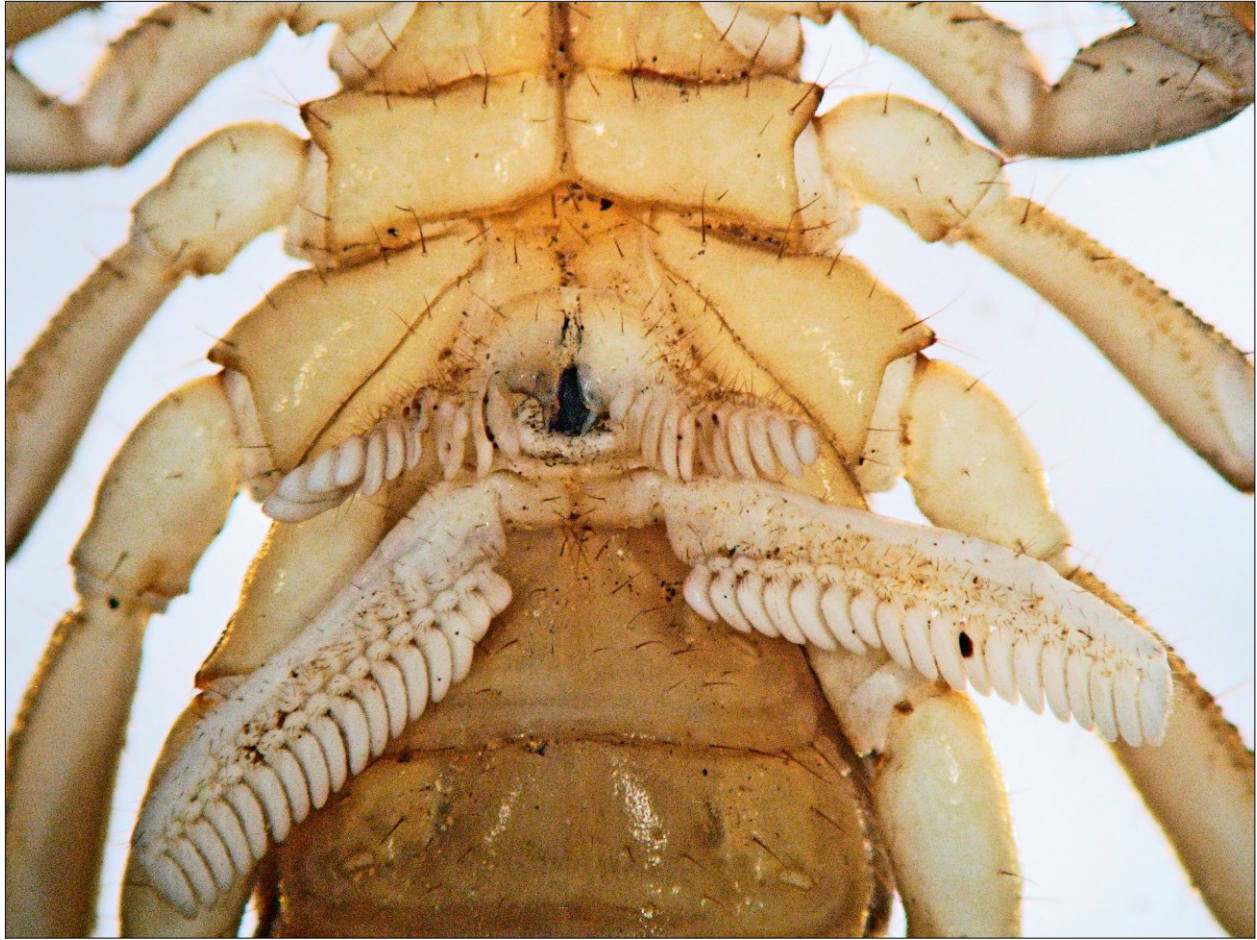


Figure 3: Close-up of sternopectinal region, showing the two pairs of well-developed pectines. Note that the posterior pair is typical of female, while the anterior pair is more characteristic of male.

Results and Discussion

The anomalous specimen herein described has at first sight and from all angles the standard habitus of an adult male *M. punctatus*, i.e., except for the sternopectinal region, all sexual secondary characters diagnostic for this sex are perfectly present (Figs. 1–2, 5; Tab. I): (1) the pedipalp chelae are robust and exhibit the basal lobe/notch combination of fingers well-developed; (2) the carapace and tergites are coarsely granulose and predominantly matt-sculptured, not glossy; (3) the mesosoma is shorter, when compared to carapace, and more slender when compared to metasoma; (4) the sternite V has the smooth patch well-developed, whitish and clearly delimited from surrounding tegument; (5) the metasoma has the segment IV widest; (6) the telson has the vesicle slender, not globose.

Nevertheless, the sternopectinal region (Fig. 3–4) reveals a very different situation: the most shocking detail is that it has **two pairs of different size but well-developed pectines**, plus a symmetric and balanced

combination of **masculine and feminine** diagnostic characters. The posterior pair of pectines is perfectly formed but **typical of female**: with 18/17 teeth that are relatively short, slender, conspicuously angled, the basal lamella of intermediate area is clearly enlarged, and the basal plate is very wide and short. The anterior pair of pectines is markedly shorter but with all parts well-formed, and possesses 11/13 teeth, which are **standard for a male**: relatively longer, stouter and essentially straight.

The genital operculum has completely **male** valves, i.e., subtriangular in shape and completely separated (without any traces of a connecting membrane), further accompanied by the ordinary pair of perfectly developed, highly protruding genital papillae. But below the operculum there is **female** genital atrium, which is wide and wrinkled, **and blocked by a large mating plug**. Using the degradation scale established precisely on *M. punctatus* by Contreras-Garduño et al. (2006), the one present in this specimen is clearly a Stage 3 plug, i.e., it is still solid but the basal plate (= "wings") has degraded.



Figure 4: A larger close-up of genital region. Note the male genital operculum (completely divided and with very well-developed genital papillae), but the female genital atrium blocked by a large Stage 3 mating plug.

We assume that the presence of a mating plug in this anomalous specimen is evidence that it was sexually active at least as female, because the mating plug is expected to have originated from a successful mating with another adult male. The degradation stage of the plug gives also a perfect match to this hypothesis: (1) Contreras-Garduño et al. (2006) found that female *M. punctatus* become receptive to males only from August through September and that the produced plug reaches Stage 3 about five months later; (2) we collected this specimen in late January and this time-frame places the occurrence of the presumed mating in late August, exactly at the peak of female receptivity in this species.

We regard the presence of well-developed, separate male and female external genitalia (i.e., masculine genital operculum plus genital papillae, but feminine genital atrium with a mating plug inside) as enough proof to classify this specimen as an hermaphrodite, without need of dissecting it to further examine internal genitalia. On the other hand, the overall male habitus coupled with female pectines and basal plate, both represent a class-

ical example of a gynandromorph. And last, the spectacular presence of four pectines cannot be unambiguously associated to any of these two malformations (pectines are wide-spectrum sensorial organs, not exclusively sex-related), and thus, we consider it best merely as a case of anatomical duplication. Hence, we conclude that this anomalous specimen possesses a weird combination of hermaphroditism, gynandromorphism, and pectinal duplication.

The complete collecting data of this anomalous specimen are as follows: MEXICO, *Guerrero State*, Xochihuehuetlán Municipality, environs of Cacalutla, 17°55'55.4" N - 98°27'23.1" W, altitude 1,164 m a.s.l., January 24, 2015, coll. R. Teruel, J. G. Baldazo, A. J. Cortés, M. Flores, E. A. Zárate, deposited in the first author's personal collection (housed at Bioeco). It was collected during an early-evening search (18:30–21:00 hrs) using standard UV-LED flashlights, together with other 10 conspecific individuals; all of them were found either sit-and-wait hunting or walking on the ground of a heavily disturbed, secondary grassland with sparse rocks

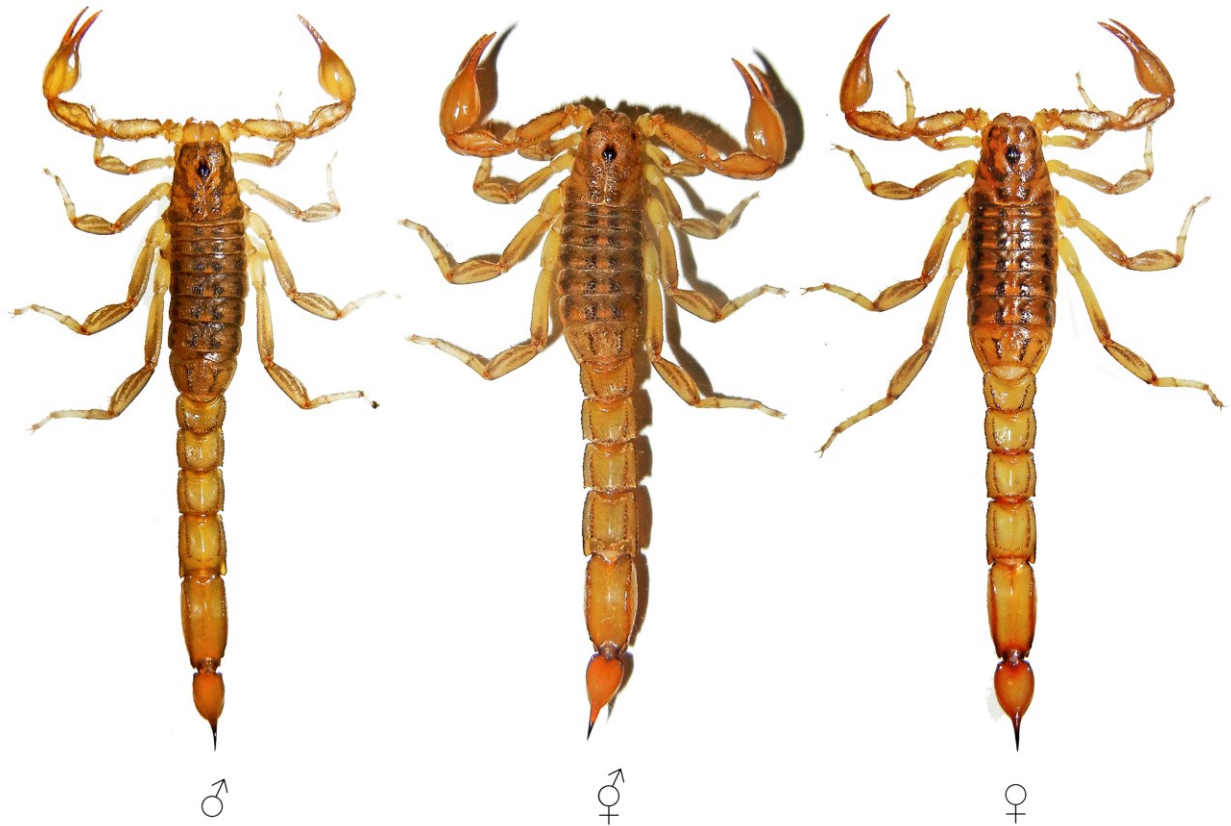


Figure 5: Anomalous specimen of *Mesomexovis punctatus* (center), directly compared to an adult male and female from the same sample. Note that the former is actually 8% larger than the male and 15% smaller than the female (see precise measurements in Tab. 1), but images of all three specimens have been resized to the same relative total length, in order to highlight secondary sexual dimorphism affecting body and appendage proportions.

and *Acacia* shrubs, but the original vegetation was the tropical caducifolious forest. Other scorpions collected syntopically were the very abundant buthid *Centruroides limpidus* (Karsch, 1879), also detected over the vegetation, and a single juvenile of an undetermined scorpionid member of the genus *Diplocentrus* Peters, 1861.

Further, an adult male from the same sample (deposited in the personal collection of the second author) also exhibits another pectinal teratology, but more ordinary: the right pecten has the five distal teeth basally fused into a round structure, which as a whole recalls a "soft hand". Other cases of pectinal teeth partially or almost completely fused have been already recorded by Armas (1987), Ayrey (2011), and Teruel & Cozijn (2013).

Last, this paper represents the first true record of *M. punctatus* in Guerrero State. All previous records mentioned in the literature were actually based upon *Mesomexovis variegatus* (Pocock, 1898), regarded as a subspecies of *M. punctatus* since Hoffmann (1931) until

its recent revalidation by González-Santillán & Prendini (2013).

Acknowledgments

First, we are greatly indebted to Miguel Flores Moreno (Centro de Investigación de Enfermedades Tropicales [CIET], Universidad Autónoma de Guerrero) for the logistic support and kind hospitality that made possible this visit of the first author to Mexico in January 2015, as well as for his valuable assistance during the field trip that yielded the scorpion described herein. This last process was also kindly contributed by Antonio Juan Cortés Guzmán (Secretaría de Salud, Guerrero), and Ewry A. Zárate Nahón (CIET). Also, Oscar F. Francke (Colección Nacional de Arácnidos, Universidad Nacional Autónoma de México, Mexico D.F.) and Michael E. Sologlad (Winchester, California, USA) donated supplementary specimens of *Mesomexovis punctatus* to the first author, which were useful as comparative material in the present study. Further, we

Dimensions (mm)		<i>Mesomexovis punctatus</i>		
		♂	Anomalous	♀
Carapace	L / Wp	4.17 / 4.00	4.67 / 4.48	5.35 / 5.40
Mesosoma	L	8.56	8.50	10.50
Tergite VII	L / W	2.20 / 3.59	2.20 / 4.38	2.75 / 5.30
Metasoma	L	19.35	21.59	25.31
Segment I	L / W / H	1.90 / 2.64 / 2.15	2.10 / 3.20 / 2.72	2.35 / 3.48 / 2.70
Segment II	L / W / H	2.25 / 2.59 / 2.20	2.50 / 3.10 / 2.70	2.78 / 3.38 / 2.65
Segment III	L / W / H	2.40 / 2.55 / 2.15	2.71 / 3.07 / 2.80	3.10 / 3.25 / 2.75
Segment IV	L / W / H	3.30 / 2.59 / 2.12	3.78 / 3.10 / 2.78	4.17 / 3.30 / 2.80
Segment V	L / W / H	4.85 / 2.53 / 2.25	5.50 / 3.10 / 2.70	6.71 / 3.27 / 2.85
Telson	L	4.65	5.00	6.20
Vesicle	L / W / H	3.00 / 1.70 / 1.33	3.10 / 2.10 / 1.62	4.06 / 2.66 / 1.98
Aculeus	L	1.65	1.90	2.14
Pedipalp	L	12.14	14.01	15.39
Femur	L / W	2.96 / 1.11	3.48 / 1.31	3.75 / 1.44
Patella	L / W	3.47 / 1.41	3.87 / 1.50	4.39 / 1.77
Chela	L	5.71	6.66	7.25
Hand	L / W / H	2.41 / 1.85 / 1.94	2.76 / 2.33 / 2.40	2.95 / 2.05 / 2.15
Movable finger	L	3.30	3.90	4.30
Total	L	32.08	34.76	41.16

Table 1: Measurements of the described specimen of *Mesomexovis punctatus*, compared to an adult male and female from the same sample. Abbreviations: length (L), width (W), posterior width (Wp), depth (H).

thank two anonymous reviewers for their valuable comments to the manuscript.

References

- ARMAS, L. F. DE. 1987. Morfometría de *Tityus quisqueyanus* Armas (Scorpiones: Buthidae), con notas sobre su historia natural. *Poeyana*, 338: 1–17.
- ARMAS, L. F. DE. 1990. Dos casos de anomalía sexual en escorpiones cubanos (Scorpiones: Buthidae). *Ciencias Biológicas*, 21–22: 173–175.
- ARMAS, L. F. DE, J. CAO & L. SOLÓRZANO. 1995a. Escorpión con tres metasomas y seis télsones. *Anales del Instituto de Biología de la Universidad Nacional Autónoma de México, Serie Zoología*, 66(1): 135–136.
- ARMAS, L. F. DE, J. CAO & L. SOLÓRZANO. 1995b. Escorpión con tres metasomas y seis télsones. *Avancient*, 14: 39–40.
- AYREY, R. F. 2011. An anomaly of pectinal organs in *Vaejovis lapidicola* (Scorpiones: Vaejovidae) *Euscorpius*, 130: 1–5.
- COKENDOLPHER, J. C. & W. D. SISSOM. 1988. New gynandromorphic Opiliones and Scorpiones. *Bulletin of the British Arachnological Society*, 7(9): 278–280.
- CONTRERAS-GARDUÑO, J., A. V. PERETTI & A. CÓRDOBA-AGUILAR. 2006. Evidence that ma-

- ting plug is related to null female mating activity in the scorpion *Vaejovis punctatus*. *Ethology*, 112: 152–163.
- GONZÁLEZ-SANTILLÁN, E. & L. PRENDINI. 2013. Redefinition and generic revision of the North American vaejovid scorpion subfamily Syntropinae Kraepelin, 1905, with descriptions of six new genera. *Bulletin of the American Museum of Natural History*, 382: 1–71.
- HOFFMANN, C. C. 1931. Monografías para la entomología médica de México. Monografía Número 2. Los escorpiones de México. Primera parte: Diplocentridae, Chactidae, Vaejovidae. *Anales del Instituto de Biología, Universidad Nacional Autónoma de México*, 2: 291–408.
- MATTHIESEN, F. A. 1968. On the male reproductive organs in some Brazilian scorpions. *Revista Brasileira de Pesquisas Medicas e Biológicas*, 1(5–6): 273–274.
- MATTHIESEN, F. A. 1979. An unusual developmental anomaly on scorpions (Scorpiones, Buthidae). *The Journal of Arachnology*, 8: 281.
- MATTONI, C. I. 2005. Tergal and sexual anomalies in bothriurid scorpions (Scorpiones, Bothriuridae). *The Journal of Arachnology*, 33: 622–628.
- MAURY, E. A. 1983. Singular anomalía sexual en un ejemplar de *Brachistosternus pentheri* Mello-Leitão 1931 (Scorpiones, Bothriuridae). *Revista de la Sociedad Entomológica Argentina*, 42(1–4): 155–156.
- SEITER, M. & R. TERUEL. 2014. Two new cases of metasomal duplication in scorpions, with notes on their reproductive biology (Scorpiones: Buthidae). *Revista Ibérica de Aracnología*, 24: 127–129.
- STAHNKE, H. L. 1970. Scorpion nomenclature and mensuration. *Entomological News*, 81: 297–316.
- TERUEL, R. 2001. Redescrición de *Alayotityus delacruzi* Armas, 1973 (Scorpiones: Buthidae). *Revista Ibérica de Aracnología*, 3: 17–24.
- TERUEL, R. & M. A. C. COZIIN. 2013. On the distribution of the genus *Rhopalurus* Thorell, 1876 (Scorpiones: Buthidae) in the southern Caribbean islands. *Euscorpius*, 179: 1–7.