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# Taxonomic redescription of *Tityus (Tityus) proseni* Abalos 1954 (Scorpiones: Buthidae) and first record for the departments of Beni and Santa Cruz - Bolivia

# Redescripción taxonómica de *Tityus (Tityus) proseni* Ábalos 1954 (Scorpiones: Buthidae) y primer registro para los departamentos de Beni y Santa Cruz - Bolivia

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## Article Data

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## Abstract

In 1954 Abalos described the species *Tityus proseni* with specimens found in Cochabamba-Bolivia, however, since then the data of the species have not been updated. New specimens were recently captured from the departments of Beni and Santa Cruz - Bolivia. In order to carry out a detailed redescription and expansion of the distribution data of the species in Bolivia, these were reviewed according to: its external morphology, pigmentation patterns and morphometric data. The data resulting from the analysis provide new characters for the species, not contemplated in the original description, new ranges in morphometric variables previously analyzed, new data on pigmentation patterns. On the other hand, the differential morphological and morphometric data of *T. proseni* with those of *T. argentinus* and *T. sorataensis* are presented, since they are apparently similar species within the country.



## Resumen

En 1954 Abalos describió a la especie *Tityus proseni* con especímenes hallados en Cochabamba-Bolivia, sin embargo, desde ese entonces a la actualidad no se actualizaron los datos de la especie. Recientemente se capturaron nuevos especímenes procedentes de los departamentos de Beni y Santa Cruz - Bolivia. Con el objetivo de realizar una redescripción detallada y ampliación de datos de distribución de la especie en Bolivia, estos fueron revisados según: su morfología externa, patrones de pigmentación y datos morfométricos. Los datos resultantes del análisis proporcionan nuevos caracteres para la especie, no contemplados en la descripción original, nuevos rangos en variables morfométricas previamente analizadas, nuevos datos sobre patrones de pigmentación. Por otro lado, se presentan los datos morfológicos y morfométricos diferenciales de *T. proseni* con los de *T. argentinus* y *T. sorataensis*, ya que son especies aparentemente similares dentro del país.

## Introduction

The species *T. proseni* was described in 1954, using 3 individuals from the town of Locotal, Chapare Province of the department of Cochabamba-Bolivia: 1 holotype male kept in the Institute of Regional Medicine of Buenos Aires, 1 allotype female, and 1 young specimen in the Mission of Studies for the Argentine Regional Pathology (MEPRA) Buenos Aires[1]. Since then, there have been no collections of this species and the information in the original description has been used for other studies[2-4].

The search and collection of new specimens of scorpions for study has several factors that hinder their execution. In the case of Bolivia, on the one hand, difficulties related to its finding, the territorial dimension of the country, the diversity of ecoregions, little information on collection sites, and little information generated on accidents with scorpions must be considered[5,6]. On the other hand, in Bolivia, most scientific publications are old and/or in foreign languages[2,5]. Thus, in the Neotropical region, Bolivian scorpions turn out to be the least studied.

Despite this, scorpions of the species *T. proseni* belong to one of the most diverse genera: *Tityus* C.L. Koch, 1836, which comprises more than 200 species distributed in South America, Central America and the Caribbean[3]. This diversity implies that there is a wide variety of shapes, morphological structures, pigmentation patterns and even sexual dimorphisms in terms of morphometry. In fact, many of the species could be studied with individuals of only one sex, either male or female, contributing greatly to the taxonomic description of species of the genus *Tityus*. Thus, De Sousa et al.[7] added information on males that was not known about the species *T. uquirensis*, thus complementing the original description, which was made with only one female, managing to expand the knowledge of the species. Likewise, males of *T. serrulatus* and *T. stigmurus* were redescribed in order to correct the identification characters[8]. In addition, it updated information on their reproductive strategies and their distribution in Brazil[9].

The objective of this work was to make a detailed redescription of *T. proseni*, as well as to expand information on its distribution, using all the specimens of the species, which are in the scientific collection of the Laboratory of Immunoglobulin Production (LPI) of the National Institute of Health Laboratories (INLASA).

## Materials and methods

*Taxonomy.* The original description of Abalos[1], the works of Lourenço & Maury[4], and the keys from Argentina[10,11] were used to identify the individuals.

*Description of diagnosis.* For the redescription of *T. proseni*, samples from INLASA's LPI were used. For terminology, the works of Polis[12], Ochoa[13] were used.

*Samples.* These samples only include male specimens, from the Rurrenabaque locality of the Beni department-Bolivia and from La Trinchera of the Santa Cruz department-Bolivia, which have not been correctly identified or cataloged to date.

*Distribution map.* For this section, a map was made using as reference points the localities of the original description and of the LPI samples. In both cases, neither had precise geographic data, hence Google Earth-generated data from the localities

were used (Figure 1).

**Figure 1 Localities of *Tityus proseni* used in this study. Distance from the communities of Rurrenabaque-Locotal=337.49 km, Rurrenabaque-La Trinchera=649.18 km, Locotal-La Trinchera 314.52 km**


*Morphometry.* For each individual, the measurement of each variable was performed 3 times and the average was taken to obtain an acceptable accuracy. The measurements were made with a 0.01 precision trupper electronic vernier, a Ken-A-Vision stereomicroscope model T-22061 at 2x and 4x views and a Zeiss Stemi DV4 stereomicroscope at 8-32x magnification, all the structures on the right side were measured in order to standardize the measurement. The variables used were based on the works[13,14].

## Results

*Taxonomy and redescription.*

Family Buthidae C. L. Koch 1837.

*Tityus* C. L. Koch, 1837. *Tityus (Tityus),* Lourenço 2006. *Tityus proseni*, Abalos 1954

*Material used.* 4 specimens from the scientific collection of the INLASA LPI: ILS-E13, ILS-E16 and ILS-E28 males, from the Locality: Bolivia, Santa Cruz Department, Cordillera Province, Cabezas municipality, Trincheras/Trincheron community, altitude 190 meters above sea level, latitude -14.11667° south, longitude -62.45° west, collected in 2008. ILS-E 89 male from the locality: Bolivia, Beni department, General José Ballivián Segurola Province, Rurrenabaque municipality, Rurrenabaque city, altitude 274 meters above sea level, latitude -14.44222°south, longitude -67.52833° west, collected in 2009.

*Trichobotrias.* The distribution is the same as that presented in Abalos[1] and is the most diagnostic trait for the identification of *T. proseni.* Additionally, Vachon's nomenclature[15] will be used in the figures. (Figure 2).

*Tibia dorsal-external view.* It has an arrangement of 1-2-2-3-3 trichobottries (1 dorsum-terminal, 2 finger terminals, 2 finger basals, 3 hand terminals and 3 hand basals) counting from the apical to the basal part. (Figure 2a.).

*Tibia ventral vision.* It has 2 trichobottries in a diagonal arrangement near the insertion of the movable finger, arranged (Figure 2b).

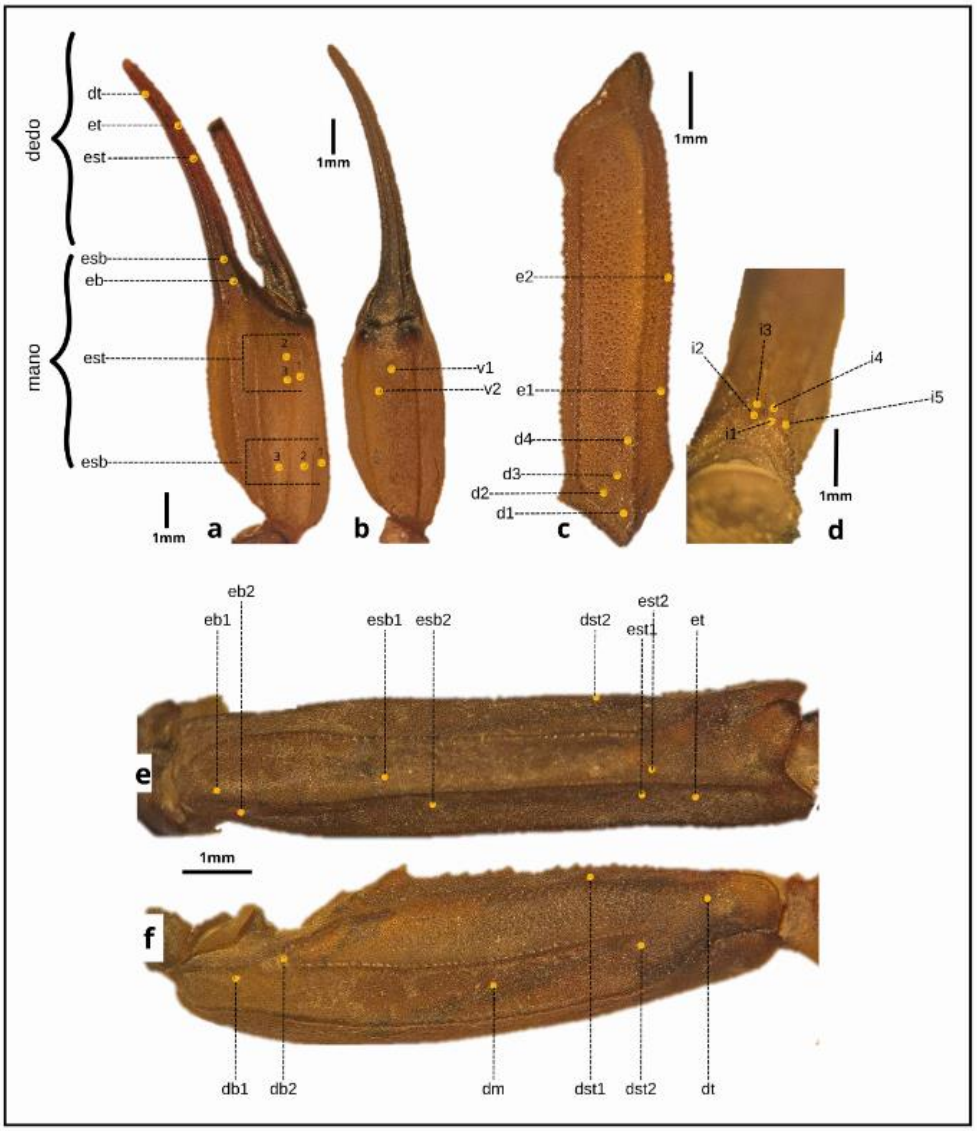
*Femur: dorsal view.* It has a 4-2 distribution (4 dorsal and 2 external), the first being very close to the trochanter and the next 2 in the middle part of the structure. (Figure 2c).

*Femur: internal view.* They have 5 trichobottries near the insertion with the trochanter. (Figure 2d).

*Kick external view.* It has a distribution between fairings of 1-3-4 (1 in the outer dorsal fairing, 3 in the outer hull and 4 in the ventral outer fairing). (Figure 2e).

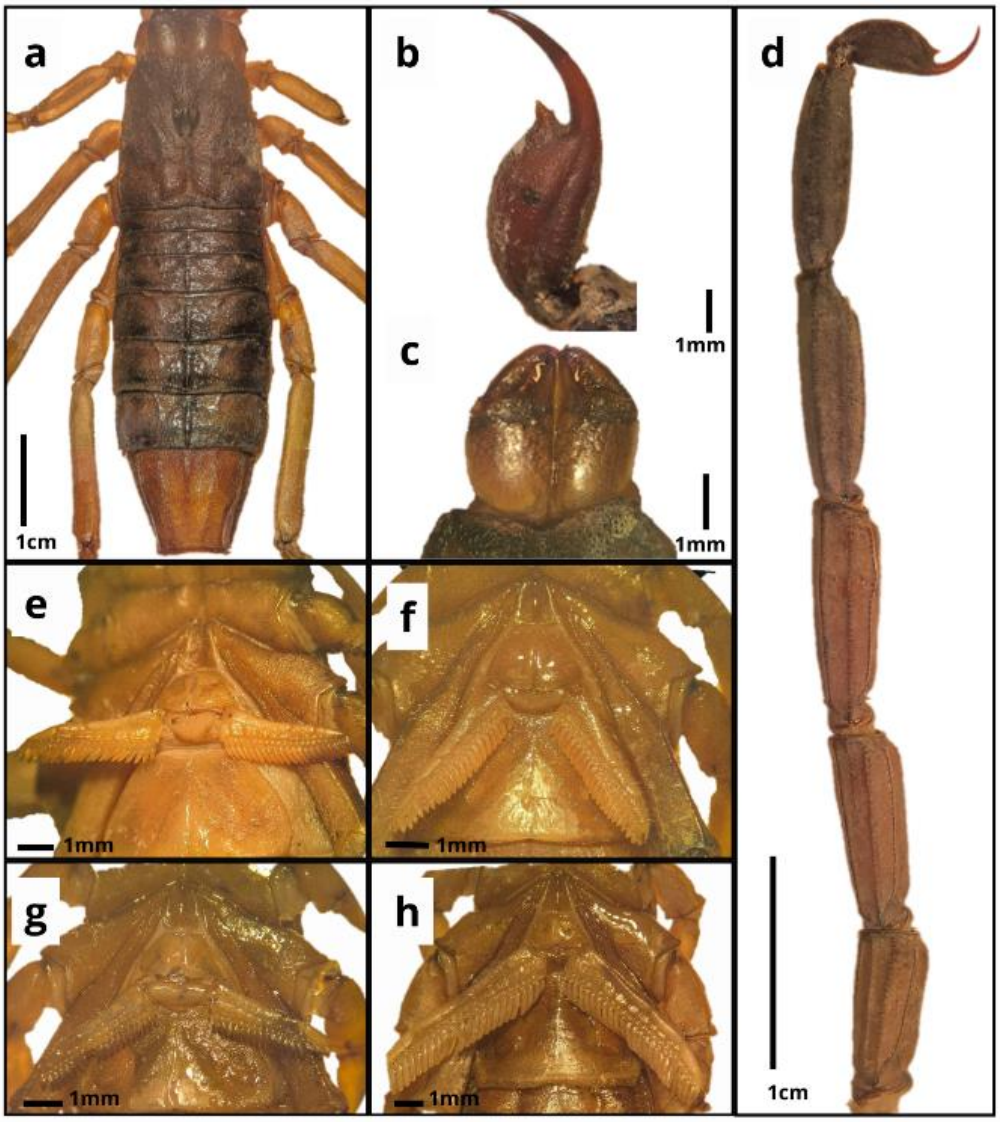
*Dorsal view patella*. It has a 1-2-3 distribution (1 in the inner dorsal fairing, 2 in the dorsal cavity, 3 in the outer dorsal fairing). (Figure 2f).

**Figure 2 Arrangement of trichobottries in the pedipalps a) Tibia external view, dt: dorsum terminal, et: external terminal, est: external subterminal, esb: external supra basal, eb: external basal. b) Tibia ventral vision, v1-v2: ventral. c) Dorsal view femur, e1-e2: external, d1-d4: dorsal. d) Femur internal view, i1-i5: internal. e) External view patella, eb1-eb2: external basal, esb1-esb2: external subassal, dst: dorsum supraterminal, est1-est2: external subterminals, et: external terminal. f) Dorsal view patella, db1-db2: basal backs, dm: middle back, dst1-dst2: subterminal back, dt: terminal back**




*Pigmentation. Prosoma.* It is uniformly dark brown (Figure 3a). *Chelicerae.* Dorsally, the pincers have a mustard-brown tone at the base of their tibia, then they take on a brown color that turns to dark brown, as we approach the apical end of the tibia and the tips of the teeth (except for the 2 distal teeth of the mobile toe or tarsus, which at their apices are mustard-brown). In addition, the edges of the basal and middle teeth of the tibia have the edges of their teeth also dark brown almost black (Figure 3c).

**Figura 3 *Tityus proseni.* (a) Prosoma y mesosoma del escorpión. (b) Telson. (c) quelíceros. (d) metasoma completo. (e) ILS-E 13. (f) ILS-E 16. (g) ILS-E 28. (h) ILS-E 89 operculogenital**




*Pedipalps-dorsal.* The coxa has a brown colour, which darkens at the edges, especially in the one that connects with the trochanter. Next, the trochanter is brown, but all edges are dark brown, as are the connections to the coxa and femur. The femur joint is also brown, and at its connecting ends they have edges that can vary from brown to dark brown almost black (Figure 2c-2d).

*The patella*. It has 1 to 2 diffuse spots on the inner dorsal hull, and 1 to 2 diffuse spots on the outer dorsal hull. Finally, the tibia and tarsus remain brown, with 1 to 2 diffuse spots on each careau, in addition to a black spot at the apical end of the fixed finger, and a diffuse spot at the base of the movable toe (Figure 2a, 2e-f).

*Ventral pedipalps.* The base coloration is mustard brown on the coxa, trochanter and femur. However, in the patella and tibia it can present a brown tone. The femur has a spot at the distal end that may be noticeable or diffuse.

**Table 1 Measurements in millimeters of the four specimens considered in the redescription**

| Measure | | ILS-E 13 | ILS-E 16 | ILS-E 28 | ILS-E 89 |
|---|---|---|---|---|---|
| **Prosoma** | Long | 6.41 | 6.24 | 5.88 | 7.1 |
| | Width A | 3.48 | 3.37 | 2.88 | 3.71 |
| | Width M | 6.02 | 5.81 | 5.33 | 6.28 |
| | Width P | 7 | 6.75 | 6.21 | 7 |
| | EyesL-eyesM | 2.93 | 2.95 | 2.24 | 3 |
| | EyeM-edgeA | 2.38 | 2.44 | 2.01 | 2.42 |
| | Wide eyeM | .4 | .37 | .35 | .38 |
| **Pedipalpos** | Long fixed finger | 8.42 | 7.25 | 6.38 | 9.51 |
| | Long moving finger | 8.24 | 8.4 | 7.48 | 10.04 |
| | Tibia length | 12.29 | 12.14 | 10.56 | 15.53 |
| | Width of the tibia | 2.49 | 2.4 | 2.18 | 3.21 |
| | Long patella | 7.48 | 7.45 | 6.58 | 9.6 |
| | Long femur | 7.22 | 6.54 | 5.89 | 8.79 |
| | Total length | 27 | 26.13 | 23.02 | 34 |
| **Mesosoma** | Long | 18.83 | 15.22 | 14.27 | 16.83 |
| | Wide on genital | 2.54 | 2.06 | 1.89 | 1.8 |
| | Long on Genital | 1.41 | 1.39 | 1.17 | 1.15 |
| | Long sentences | 3.88 | 4.27 | 3.36 | 6.71 |
| **Metasoma** | L segment I | 4.71 | 4.42 | 3.86 | 7.53 |
| | A segment I | 3.55 | 3.54 | 3 | 3.05 |
| | L segment II | 5.62 | 5.42 | 4.71 | 8.74 |
| | A segment II | 3.28 | 3.49 | 2.84 | 2.94 |
| | L segment III | 5.94 | 5.55 | 4.9 | 9.26 |
| | A segment III | 3.37 | 3.49 | 2.84 | 2.92 |
| | L segment IV | 6.48 | 6.46 | 5.79 | 10.6 |
| | A segment IV | 3.33 | 3.4 | 2.89 | 3.28 |
| | L segment V | 8.15 | 7.56 | 6.28 | 12.01 |
| | A segment V | 3.33 | 3.31 | 2.68 | 3.2 |
| | Long telson | 7.08 | 5.67 | 5.16 | 8.77 |
| | Wide gallbladder | .41 | .49 | .52 | .5 |
| | Long tail | 37.98 | 35.08 | 30.7 | 56.91 |
| **Total length** | | 63.22 | 56.54 | 50.85 | 80.84 |

**Table 2 Comparison of total lengths and proportion of structures among samples from Abalos 1954 (Abalos 1954) and those of the present study**

| | M Abalos 1954 | H Abalos 1954 | ILS-E 13 | ILS-E 16 | ILS-E 28 | ILS-E 89 |
|---|---|---|---|---|---|---|
| **Overall Length (mm)** | 72 | 68.5 | 63.3 | 56.5 | 50.8 | 80.9 |
| **Prosoma %** | 8.9 | 10.2 | 10.1 | 11 | 11.6 | 8.8 |
| **Mesosoma %** | 22.8 | 25.6 | 29.8 | 27 | 28 | 20.8 |
| **Metasome %** | 68.3 | 64.2 | 60.1 | 62 | 60.4 | 70.4 |

*Mesosoma.* Tergite I is grayish-brown in color with black granulation that obscures the lines they form. It has a lightening of the tergites that can start from the II or VI segment to a brown color on the posterior and central border of each tergite. Finally, in tergite VII it is chestnut with dark brown edges of carnae, mainly on the lateral edges (Figure 3a).

*Coxosternal region.* The pigmentation is uniformly mustard-brown (Figure 3e-3h).

*Genital operculum.* The basal piece is light mustard. The marginal lamella, intermediate lamella,

fulcra and pectinal teeth darken to brown, as we approach the most distal teeth of the basal piece (Figure 3e-3h).

*Sternites.* Pieces of the I-IV are chestnut or brown, with darker blowholes and mustard-colored back edges. Sternite V maintains the brown color, however, it takes on a dark brown hue as we approach the side edges.

*Metasome*. Brown pigmentation in metasomal segments I-III, segment IV-V are dark brown, telson can range from reddish brown to dark brown, aculeus has dark brown apical half, and subaculeus has a mustard-brown apex (Figure 3d).

*Granulation. Chelicerae.* It is uniformly smooth at the base of the tibia; however, moderate, black granulation appears near the intersection between the tibia and tarsus.

*Pedipalps-dorsal.* It is thin in the carenas of the coxa, the trochanter, the femur and the basal part of the patella. The tibia and tarsus have smooth carnae. Then the divisions between fairings are rows of moderate granules. In addition, there are 17 rows of granules on the pedipalp forceps on the movable finger.

*Ventral pedipalps.* The granulation of the ventral fairing is fine in the trochanter, and the femur. Then the coxa, patella, tibia and tarsus have a smooth ventral hull. The divisions between the ventral and lateral fairings are moderately granulated in the coxa, trochanter and femur. On the other hand, in patella the aforementioned edges are slightly grainy; and in the tibia they are smooth.

*Prosoma.* Dorsally, the granulation is light and fine in the fairings. However, there is moderate granulation in the dividing lines of these fairings.

*Mesosoma.* It has a moderate granulation (dark brown almost black, Figure 3a).

*Coxosternal region*. The coxapophyses, and the sternum have a smooth texture. On the other hand, the coxae of the 4 legs have a fine and light granulation.

*Genital operculum.* The basal piece, marginal lamella, intermediate lamella, fulcra and pectinal teeth, are smooth. Steternites I to V do not have granulation.

*Metasome*. Granulation is moderate in the I-V segments, and in the telson it is very slight (Figure 3d).

*Morphometry.*

*Pedipalps.* The pedipalps have an essentially oval and elongated tibia, with greater protrusion before the beginning of the fixed finger. Fixed and movable fingers are slender and long with a slight curvature towards the dorsal part (morphometric measurements in Table 1).

*Prosoma.* It is trapezoidal isosceles in shape, longer than it is wide, and with rounded edges. It has a central-posterior slit, which slightly raises the prosoma (morphometric measurements in Table 1).

*Coxosternal region.* The sternum has a subtriangular shape with more height than width, and has a noticeable depression towards the anterior end. On the other hand, the intermediate plate is not dilated and is composed of 11 plates. The pectinic teeth vary from 21-23 among the 4 males analyzed.

*Sternites.* they have a central and posterior cleft that slightly raises that section of the sternitus.

*Metasoma.* Metasomal, segment I presents 10 complete carenes, II, III, IV have 8 carenes, finally metasomal segment V has 5 notorious carenes. The telson has an oval, globose vesicle. The aculeum is elongated, with a greater thickness at the connection with the gallbladder, and less at the apex of the aculeus. The subaculeum is conoidal with a short apex, and with one or two shoots on the inside,

measuring approximately 1/4 of the size of the subaculeum (morphometric measurements in Table 1).

## Discussion

Morphologically, all the samples analyzed coincide with the description of Abalos[1] of *T. proseni* mainly because of the following diagnostic characteristics: number of pectinic teeth (which the present study proposes a range of 21-24), 16-17 rows of granules in the fingers of the pedipalp, the presence of granules on the dorsal aspect of the subacular tooth and the distribution of trichobottries in the pedipalps, these last 2 characteristics are what undoubtedly differentiate them from other national species[1,3,4].

Morphometrically, the ILS-E 89 sample from Rurrenabaque is closer to the values of the original description of Abalos[1], varying by 2 % in favor of the length of the metasome and against the mesosome. On the other hand, the ILS-E 13, ILS-E 16 and ILS-E 28 samples from Trincheron, despite being males, resemble the morphometric values of the female *T. proseni* allotype, but with the following differences: ILS-E 13 has an elongated mesosoma (4 %) but a shorter metasoma (4 %); ILS-E 16 has a slightly elongated prosoma and mesosome by 1% and a slightly reduced metasome (2 %), ILS-E 28 has a slightly elongated prosoma (1 %), an elongated metasome (3%) and a reduced metasome (4 %). Table 2.

The observed differentiation may be due to the fact that in the original description of *T. proseni* a male and female were used as a reference, which is why a range of measurements could not be made for the species. Now, with the data presented (although we also infer in a small sample size) we propose the following morphometric ranges for males: prosoma 8.8-11.6 %, mesosome 20.8-29 % and metasome, 60.1-70 %, these ranges could be modified over time and with a larger sample size by other researchers. Therefore, a minimum range is presented and the maximum size range for the males of the species is increased, with the minimum studied being 50.84 mm and the maximum 80.85 mm. Additionally, it was possible to evidence that there are differences in the morphometric proportions of the Rurrenabaque individual and those of Trincheron, the latter being small and with ranges more similar to females.

On the other hand, compared to *T. sorataensis*, it presents the following proportions: prosoma 9-11 %, mesosoma 26-32 %, metasome 60-64 %[4,14]. This species is differentiable from *T. proseni* because it mainly presents a more elongated mesosoma of between 3-10 % and a metasome reduced in equal proportions. On the other hand, *T. argentinus* presents the following proportions: prosoma 9.8 %, mesosome 29.5 %, metasoma 60.7 %[4], having a slightly more elongated mesosome and a metasome reduced in the same proportion.

The pigmentation patterns within the *T. proseni* species analyzed here refer to certain variations, which could be correlated with the places of origin. An intensification of pigmentation appears as altitude increases. This has been previously evidenced within the genus with *T. gasci*[17]. In the sample of Rurrenabaque (ILS-E 89), extensive spots with progressive blurring were observed on the patella (both in the outer dorsal and inner dorsal fairing) and the pincer (at the distal end), in addition to a lightened mustard-brown hue in the legs. On the other hand, the samples from La Trinchera (ILS-E 13, ILS-E 16 and ILS-E 28) have a larger surface area with more intense spots and in more places

than the Rurrenabaque sample (on the femur, patella and tweezers), as well as having a lighter brown tone than a brownish-mustard tone on the legs. Finally, the samples of the Locotal (from the original description) seem to have a darker tone in its metasoma and mesosoma (spruce), and with legs of a brown tone.

Regarding the differentiation of pigmentation patterns between *T. proseni* and the other 3 species present in Bolivia with similar patterns: *T. argentinus*, *T. sorataensis* and *T. confluens*, we highlight the mesosoma and the pincers as important parts to consider. The mesosoma of *T. proseni* is distinguished by a grayer shade of brown than that of the other species, and despite presenting a lightening towards a reddish brown, as we approach tergite VII, there is a uniformity in each shade of coffee. In the species of *T. argentinus* and *T. sorataensis*, dark brown longitudinal bands are evident, separated by depigmented longitudinal segments[14,17] On the other hand, the pincers of *T. confluens* have a yellowish hand and dark brown fingers in their entirety, and *T. argentinus* has diffuse brown spots on the hand and the pincers[17].

In this way, a more detailed redescription of *T. proseni* could be made from 4 male specimens, 70 years after the original description. New contributions from the present paper include: an extension of morphometric ranges for males of the species, a more developed description of pigmentation patterns, and morphological-morphometric comparisons between *T. proseni*, *T. argentinus*, *T. sorataensis*, *T. confluens* (apparently similar species within Bolivia). It also considers *T. proseni* as a species of wide national distribution and endemic to Bolivia, present in 3 departments of the country. Additionally, the findings of this work increase the range of hazardousness of the genus Tityus in the national territory.

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This study was self-financed by the Immunoglobulin Production Laboratory of the National Institute of Health Laboratories (INLASA).

## Conflicts of interest

After formal communication with the Director-Editor-in-Chief of the *Journal of the Selva Andina Research Society* (JSARS), the authors have requested through an official letter to make use of the bibliographic references, given that there is no information on the subject under study, updated in our country. All the samples used in this work belong to the collection of the Immunoglobulin Production Laboratory (LPI) of the National Institute of Health Laboratories (INLASA), and do not generate conflicts of interest.

## Acknowledgments

To Dr. David José Duran Alba for his collaboration, support and promotion of research activities in the Immunoglobulin Production Laboratory of INLASA.

## Ethical considerations

Each sample from the wet collection of the Immunoglobulin Production Laboratory was used with the greatest care, always maintaining hygiene as well as the integrity of the samples. No collections were made for this study, nor were live specimens analyzed for the present work.

## Limitations in the research

Lack of accurate geographic latitude and longitude data.

## Authors' contribution to the article

*Ciro Humboldt Paputsachis*, carried out the research with the support of researcher *Jeysa Camila Villarreal Carvajal*, finally *Evelin Fortun Fernández* supported the review of the article and facilitated the procedures for its approval.

## Permissions for publication

The work was previously approved by the INLASA scientific committee before being submitted to this journal. The authors after a thorough review of the paper, have decided to proceed with the publication.

## Access to data

The data and information of this research are present in the article.

## Use of artificial intelligence

We assume that the entire document was written based on ethical and professional criteria, and AI was not used to make the images or text.

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