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First record of *Stenoterommata platensis* (Araneae: Pycnothelidae) in Santiago del Estero, Argentina and niche modelling to unveil its distributional pattern

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ABSTRACT

Stenoterommata platensis is distributed in Argentina and Uruguay along the La Plata River basin, characterized by a predominantly humid climate and moist habitats. However, this contribution reports the presence of *S. platensis* outside its known distribution range, accompanied by an analysis of distribution models to assess the influence of bioclimatic variables on distribution patterns. This research confirms the current presence of *S. platensis* in the Santiago del Estero province, indicating a significant expansion of its geographic range and its ability to thrive in drier and high-temperature environments. Niche modeling under past conditions (~20000 years ago) indicated suitable areas for the establishing of this species in the Dry Chaco.

Keywords: Mygalomorphae, range expansion, species distribution model, Maxent

1. INTRODUCTION

The Mygalomorphae family Pycnothelidae Chamberlin, 1917 comprises 15 genera and 139 species of small to medium-sized spiders distributed mainly in the Neotropical region (World Spider Catalog, 2023). This family was recently erected by Opatova et al., (2020) to accommodate many genera previously included in Nemesiidae Simon, 1889. Pycnothelids spiders can be found living in loose silk tubes, in the leaf litter, under stones or logs, in burrows close with debris or with flapdoors or trapdoors (Goloboff, 1995; Ghirotto et al., 2021; Signorotto et al., 2023). The genus *Stenoterommata* Holmberg, 1881 includes 26 species known to date distributed in Argentina, Brazil and Uruguay (World Spider Catalog, 2023). Spiders of this genus are recognized by the presence of a high number of maxillary cuspules and a series of enlarged pumpkin-shaped spigots along the inner edge of the posterior lateral spinnerets spinning field, together with the presence of preening combs on the female metatarsi II.

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In addition, males can be distinguished by the tibia bearing an apical retrolateral megaspine and the palpal bulb with several low parallel keels along the embolus (Goloboff, 1995; Ghirotto et al., 2021). To date, eight species have been described from Argentina World Spider Catalog, (2023), including the type species of the genus *Stenoterommata platensis* Holmberg, 1881. This species is distributed in Argentina and Uruguay (Goloboff, 1995; Montes de Oca and Pérez-Miles, 2009; Ferretti et al., 2010). In Argentina, this species is mainly associated with the river banks habitats along the La Plata River basin in the provinces of Buenos Aires (northeast), Entre Ríos and Misiones, with some records in Santa Fé (Goloboff, 1995; Ferretti et al., 2018).

In these habitats, spiders inhabit moisty areas where they construct open and short burrows lined with abundant white silk, with the entrance slightly widened, and the silk often adheres to fallen branches or leaves; usually the burrows can be found under stones or fallen logs (Goloboff, 1995; Schwerdt and Copperi, 2014). Although this species had always been associated with moist habitats close to watercourses, Goloboff, (1995) mentioned the possible presence of this species in much drier habitats, such as Monte or Espinal, in the provinces of Catamarca and Córdoba. However, the author did not include those specimens to the examined material nor presented the description of the sex of the spiders and commented about the diagnostic features of those specimens. Indeed, in the case of a single specimen presumably collected in Córdoba, Goloboff, (1995) stated "A single specimen from Cordoba, could be mislabeled, since no additional records from that well-collected province exist".

From the examination of material deposited in the arachnid collection of the Facultad de Ciencias Naturales, Universidad Nacional de Buenos Aires, we found males and females of *S. platensis* collected in the dry Chaco ecoregion of Santiago del Estero province. Thus, we formally report the first record of *S. platensis* outside its current known distribution range and its presence in a different habitat. This was achieved by presenting photographs of the specimens and their diagnostic features to ensure proper identification. Then, to assess the influence of the past (Pliocene and LGM) and present-day climatic conditions on its distribution pattern, we performed a niche modeling using Maxent.

2. MATERIAL AND METHODS

Specimen identification

The material examined is deposited in the scientific collection of Chelicerata, Departamento de Biodiversidad y Biología Experimental, Facultad de Ciencias Exactas y Naturales, UBA (Emanuel Pereira curator). The images were obtained with an MShot digital camera attached to a Leica S APO stereoscopic microscope and then stacked using Helicon Focus. The spermathecae were dissected and cleaned with Naclens© enzymatic pills for photography. In the case of males, we removed the palpal bulb and photographed following the views of Goloboff, (1995) to a proper comparison of shape and keels. The maxillary and labial cuspules of males and females were counted with the use of the software TpsDig2. Relevant morphological features were compared to those proposed by Goloboff, (1995) for the recognition of the species.

Modeling procedure

We obtained 28 points for *Stenoterommata platensis*. The 19 bioclimatic layers for past (two scenarios), present and future conditions were downloaded from EcoClimate Lima-Ribeiro et al., (2015) at a resolution 0.5°. Past scenarios involved climatic conditions from Last Glacial Maximum (21Ka) and Pliocene (3Ma), modern scenario includes climatic conditions from 1950-1999. We performed all analyses covering an extended area of Southern South America to have the distributional range of *S. platensis*. We predicted the distribution of the species under different climate scenarios using MaxEnt 3.3.3k (Phillips et al., 2006). MaxEnt searches for the maximum entropy density using Robust Bayes Estimation and requires only presence points as input data (Elith et al., 2011). This program produces a model of environmental suitability for the occurrence of a given organism by estimating the relation between species presence and environmental variables in a geographic space. We ran the MaxEnt using default settings, validated in studies involving many species and ecological data (Zank et al., 2014; Jiang et al., 2016; Ferretti et al., 2018).

We set the random training data as 100% of the sample, given the number of occurrence records. The output of the MaxEnt model provides continuous habitat suitability, and hence, a threshold must be set to define the predictive presence or absence of a species. We selected the "equal training sensitivity and specificity option", which minimizes the absolute differences between sensitivity and specificity (Cantor et al., 1999). Additionally, we set the run to 20000 maximum iterations, allowing the logistic output format to remove the duplicates from the same grid cell. The model maps were edited with the software DIVA-GIS (www.diva-gis.org). To assess the model performance of the model we calculated the AUC (Area Under the receiver operating characteristics Curve), which are frequently used to evaluate distribution models based on presence-absence algorithms (Peterson et al., 2011). The program automatically estimates statistical significance of the prediction, using a binomial test of omission (Baldwing, 2009).

3. RESULTS

Taxonomy

Infraorder MYGALOMORPHAE Pocock, 1892

Family PYCNOTHELIDAE Chamberlin, 1917

Stenoterommata platensis Holmberg, 1881

Figures 1-4.

Material examined

Two ♂♂ and two ♀♀ (DBBE-Che 115), ARGENTINA, Santiago del Estero, Tintina, 21.01.2005 (Cecilia Villaruel).

Diagnosis

Males can be distinguished from those of other known species, except for *S. iguazu*, by the presence of a thin, slender, and well-sclerotized embolus (Figure 1A–C), along with a curvature along the end of embolus (Figure 1A). Additionally, they can be distinguished from males of *S. iguazu* by their slightly larger size (Figure 2) and the more gradual tapering of the apical portion of the bulb duct (Figure 1A-C). Females can be distinguished easily from those of all other species in the genus, except for *S. iguazu*, by the presence of 2 + 2 spermathecae (Figure 3F). In the case of *S. iguazu*, they are differentiated by the spermathecae, which have an outer lobe bearing numerous receptacles, as opposed to a single one Goloboff, (1995) and an inner lobe that is longer (Figure 3F).

Distribution

This species is distributed in Argentina and Uruguay. Argentinean records include the provinces of Buenos Aires, Entre Ríos, Misiones and Santa Fé. There is a new record from Tintina, Santiago del Estero province (Figure 4).

Niche modeling

The models produced by MaxEnt of suitable areas yielded AUC value of 0.990, which suggest that an accurately representativeness of the spider habitat relationships was found. The bioclimatic variables that made the most significant contributions were BIO2 (Mean Diurnal Range) with percentage contribution of 44.6% and BIO14 (Precipitation of Driest Month) with 20.9%. Other important bioclimatic variables with less contributions were BIO17 (Precipitation of Driest Quarter) and BIO8 (Mean Temperature of Wettest Quarter), with about a 10% percentage contribution.

The niche modelling projected with present-day climatic conditions (Figure 4A) yielded a suitable area along the La Plata River basin, mainly in southern Entre Ríos province, north of Buenos Aires province, Misiones province in Argentina and western coast of Uruguay without including the new record in Santiago del Estero. The model obtained under past climatic conditions (Pliocene, ~3 Ma) (Figure 4C) projected its distribution displaced to the eastern portion of La Plata River basin including most of Uruguayan territory and southern Brazil. Finally, the model under Last Glacial Maximum (~20000 years ago) yielded suitable habitats with a displacement into the northern and central portion in Argentina, along the provinces of Entre Ríos, Corrientes, Misiones, north of Santa Fe and extending towards the northeast region of Santiago del Estero.

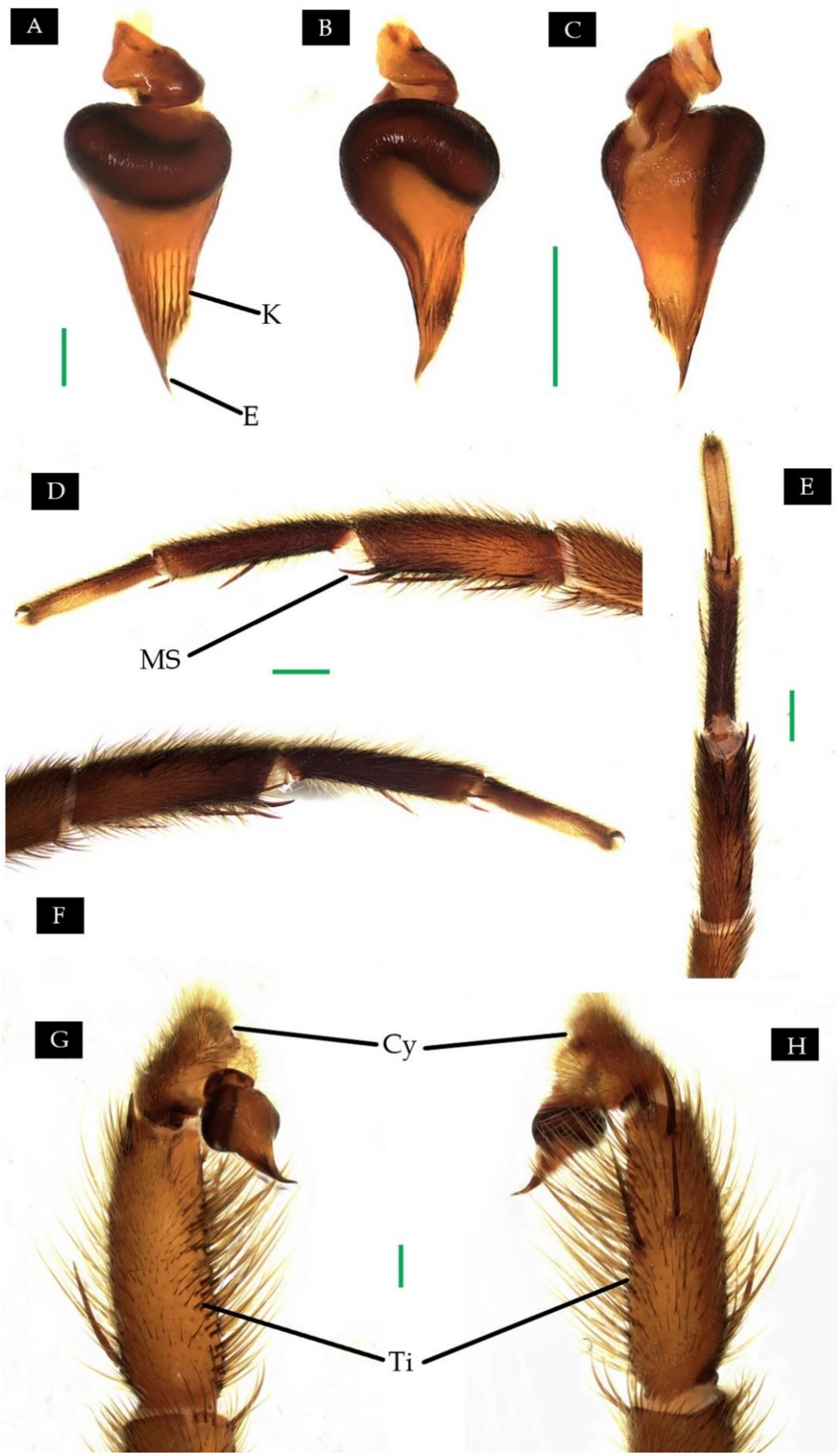

Figure 1 *Stenoterommata platensis*, male. A. Palpal bulb, dorsal view. B. Palpal bulb, retrolateral view C. Palpal bulb, ventral view; D. Leg I, prolateral view. E. Leg I, ventral view; F. Leg I, retrolateral view; G. Palp, prolateral view; H. Palp, retrolateral view. K: Keels; E: Embolus; MS: Megaspine; Cy: Cymbium; Ti: Tibia. Scale bars = 1 mm.

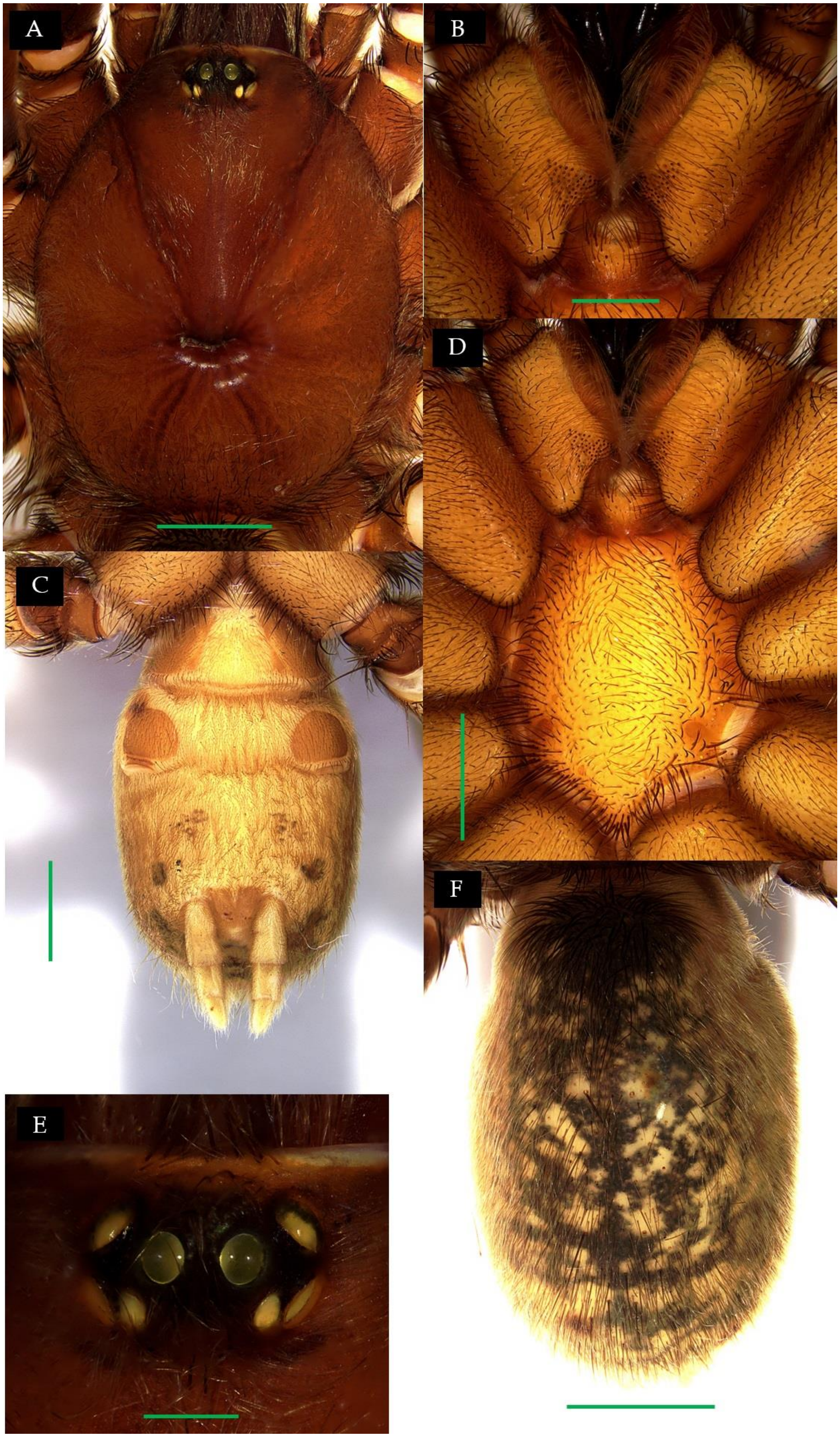

Figure 2 *Stenoterommata platensis,* male. A. Carapace, dorsal view; B. Labium and maxillae, ventral view; C. Abdomen, ventral view; D. Sternum, ventral view; E. Eyes, dorsal view; F. Abdomen, dorsal view. Scale bars = 1 mm.

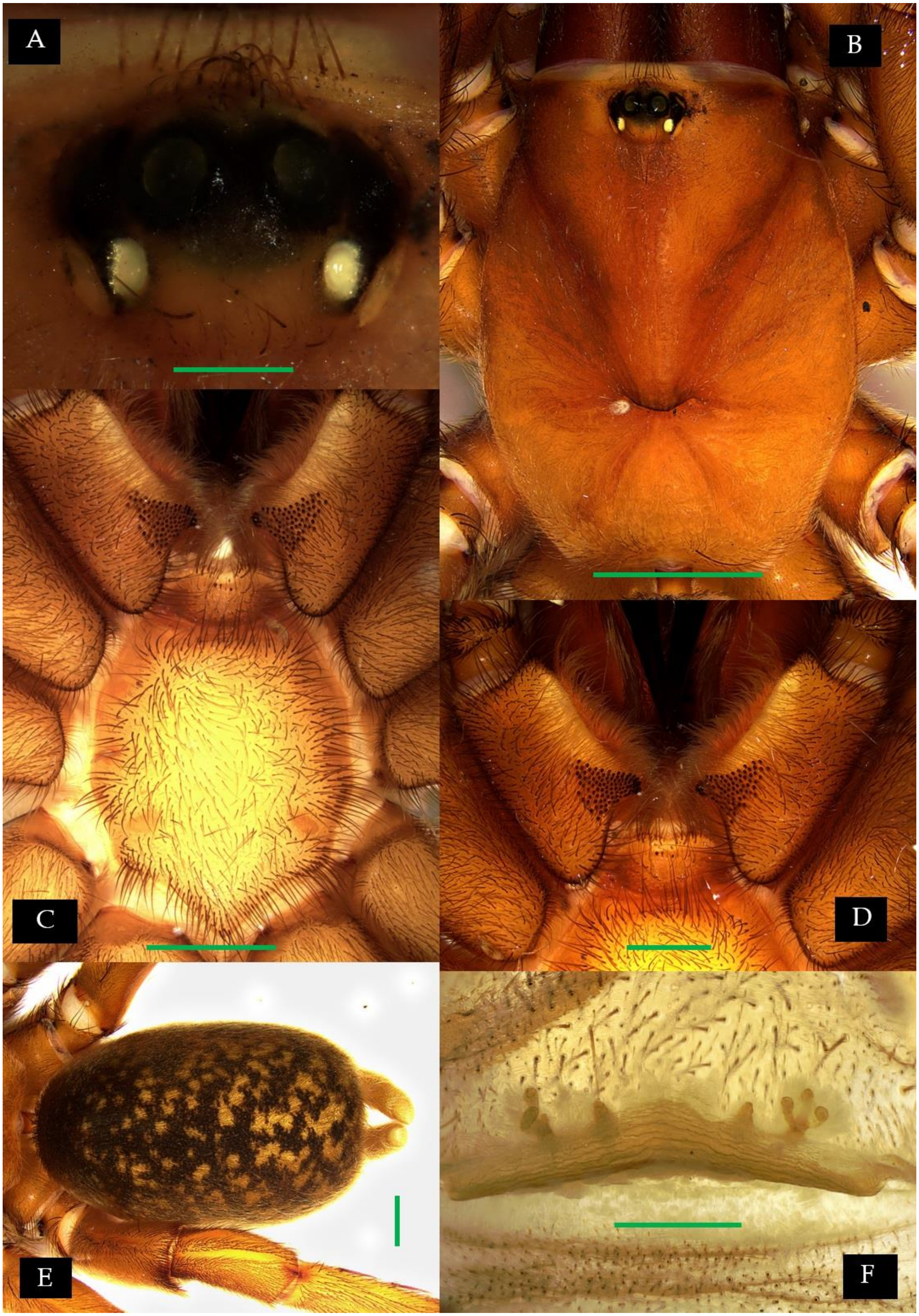

Figure 3 *Stenoterommata platensis,* female. A. Eyes, dorsal view; B. Carapace, dorsal view; C. Sternum, ventral view; D. Labium and maxillae, ventral view; E. Abdomen, dorsal view; F. Spermathecae, dorsal view. Scale bars = 1 mm.

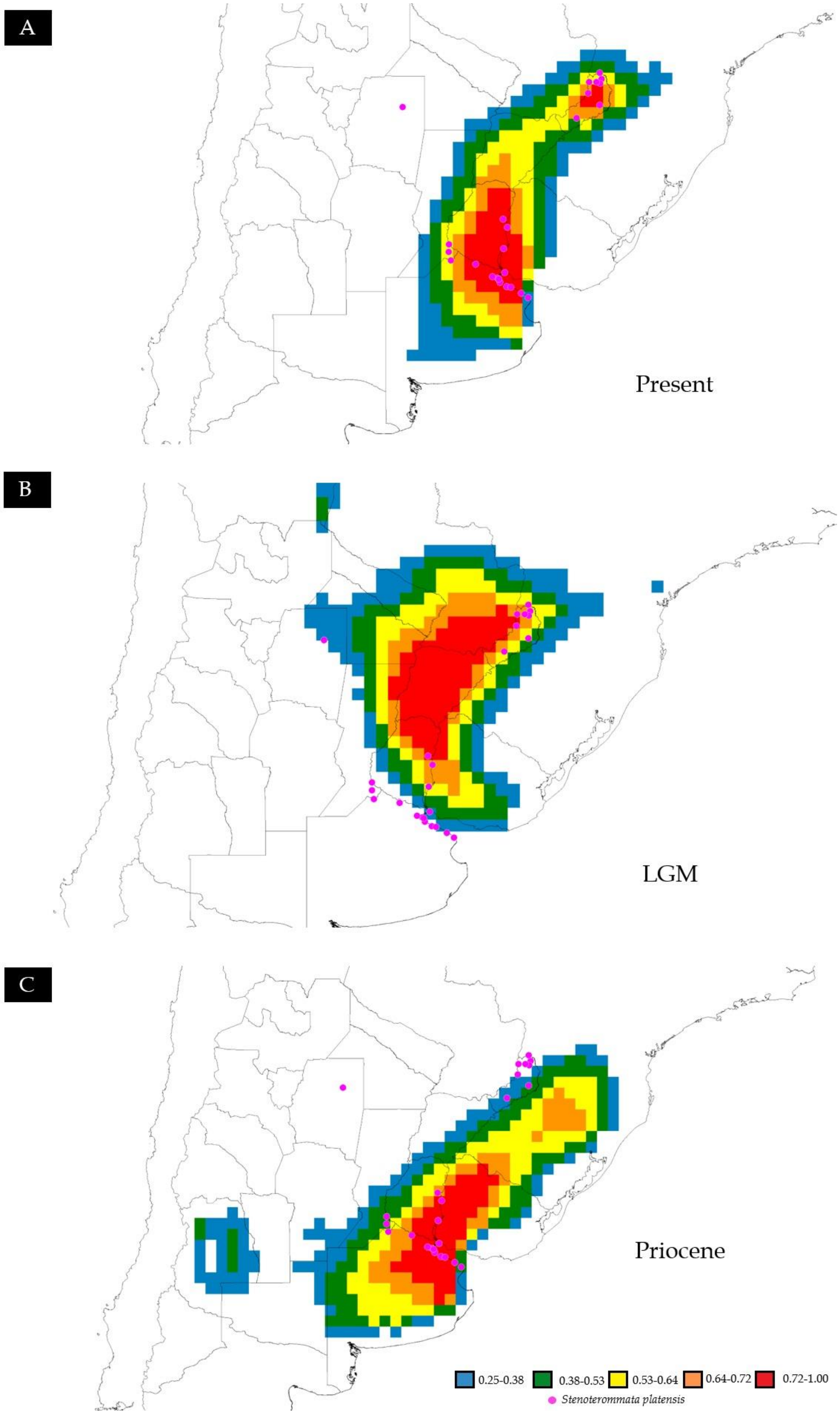

Figure 4 Species distribution models obtained with MaxEnt. A. Under current climatic conditions; B. Under climatic conditions dated 120.000 years ago in the Last Glacial Maximum; C. Under climatic conditions dated 5.3 and 2.6 million years ago in the Pliocene.

4. DISCUSSION

In this study, we have confirmed the presence of *S. platensis* in the province of Santiago del Estero, which implies a considerable expansion of its known geographic distributional range. In addition, a new habitat type is confirmed in the Dry Chaco ecoregion which is characterized by a forest with *Schinopsis lorentzii* (Griseb) Engl 1881 as a dominant species together with *Aspidosperma* quebracho-blanco (Schltr) Lyons 1861. Other abundant plant species that are found in this area are *Prosopis nigra* (Griseb) Hieron, *Prosopis alba* (Griseb) and *Zizyphus mistol* (Griseb) which form an intermediate tree stratum. Dense lower layers of shrubs of *Acacia* spp. are also standard (Brassiolo et al., 2001). The region´s climate is highly seasonal, with a dry winter (from June to September) and a rainy summer. The mean yearly precipitation is almost 700 mm along the year with 80% of the rain falling from October to March. The mean annual temperature is 21.9ºC, and mean maximum and minimum temperatures are 35.5ºC and 20.2ºC in January and 23.0ºC and 7.1ºC in July (Bolković et al., 1995).

The only predicted model that yielded suitable climatic conditions for the new populations recorded was during the LGM. This period was characterized by cold-dry climates with the contraction of the areas occupied by subtropical and tropical biomes, resulting in the concomitant expansion and interconnection of open biomes (Kalin-Arroyo et al., 1988). However, along the eastern flank of the Andes, a savanna corridor was formed during periods of cold-dry climates, providing a north - south corridor for animals and plants (Webb and Rancy, 1996; Ortuiz-Jaureguizar and Cladera, 2006). Conversely, when open areas retreated during interglacial periods of warm-wet climates, rainforest expanded, which could have influenced the distribution expansion of *S. platensis* to those environments.

Probably during the Middle Pleistocene, rainforest biomes were uniformly distributed for the first time throughout the North and South American tropics (Webb and Rancy, 1996). Arguably, due to the current climatic conditions in the province of Santiago del Estero, characterized by a dry season with extreme temperatures, this population remained a relict of a more widespread geographic distribution, and this could probably affect their persistence in the future. This is congruent with that reported from Ferretti et al., (2018) when projections in the future (2050–2070) indicated that the geographic range noticeable decreases for this species along La Plata River basin.

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Author's contributions

Fiorella Signorotto and Micaela Nicoletta examined the specimens and made the identification. Fiorella Signorotto photographed the specimens. Fiorella Signorotto, Micaela Nicoletta and Nelson Ferretti conceived the idea of the work and participated in the writing of the manuscript. Fiorella Signorotto made the niche modeling. Micaela Nicoletta prepared the database.

Conflicts of interests

The authors declare that there are no conflicts of interests.

Ethical approval

The Animal ethical guidelines are followed in the study for species observation & identification.

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Data and materials availability

All data associated with this study are present in the paper.

REFERENCES AND NOTES

1. Baldwing RA. Use of maximum entropy modeling in wildlife research. Entropy 2009; 11(4):854–866. doi: 10.3390/e11040854
2. Bolković ML, Caziani SM, Protomastro JJ. Food habits of the three-banded armadillo (Xenarthra: Dasypodidae) in the dry Chaco, Argentina. J Mammal 1995; 76(4):1199-1204.

3. Brassiolo M, Tasso A, Abt M, Merletti G. Diagnóstico socioeconómico y de uso del suelo en la zona de amortiguamiento del Parque Nacional Copo. Administración de Parques Nacionales, Argentina 2001; 10.
4. Cantor SB, Sun CC, Tortolero-Luna G, Richards-Kortum R, Follen M. A comparison of C/B ratios from studies using receiver operating characteristic curve analysis. J Clin Epidemiol 1999; 52(9):885–892. doi: 10.1016/s0895-4356(99)000 75-x
5. Elith J, Phillips SJ, Hastie T, Dudík M, Chee YE, Yates CJ. A statistical explanation of MaxEnt for ecologists. Divers Distrib 2011; 17(1):43–57. doi: 10.1111/j.1472-4642.2010.00725.x
6. Ferretti NE, Arnedo M, González A. Impact of climate change on spider species distribution along the La Plata River basin, southern South America: projecting future range shifts for the genus *Stenoterommata* (Araneae, Mygalomorphae, Nemesiidae). Ann Zool Fenn 2018; 55(1-3):123–133. doi: 10.57 35/086.055.0112
7. Ferretti N, Pérez-Miles F, González A. Mygalomorph spiders of the Natural and Historical Reserve of Martín García Island, Río de La Plata River, Argentina. Zool Stud 2010; 49(4):481-49 1.
8. Ghirotto VM, Guadanucci JPL, Indicatti RP. The genus *Stenoterommata* Holmberg, 1881 (Araneae, Pycnothelidae) in the Cerrado and Atlantic Forest from southeastern and central Brazil: description of four new species. Zoosystema 2021; 43 (17):311-339.
9. Goloboff PA. A revision of the South American spiders of the family Nemesiidae (Araneae, Mygalomorphae). Part I: species from Peru, Chile, Argentina, and Uruguay. Bull Am Mus Nat Hist 1995; 224:1-189.
10. Jiang H, Liu T, Li L, Zhao Y, Pei L and Zhao J. Predicting the potential distribution of *Polygala tenuifolia* Willd. under climate change in China. PLoS One 2016; 11(9):e0163718. doi: 10.1371/journal.pone.0163718
11. Kalin-Arroyo MT, Squeo FA, Armesto JJ, Villagrán C. Effects of aridity on plant diversity in the northern Chilean Andes: results of a natural experiment. Ann Missouri Bot Gard 1988; 75:55–78. doi: 10.2307/2399466
12. Lima-Ribeiro MS, Varela S, González-Hernández J, Oliveira G, Diniz-Filho JAF, Terribile LC. EcoClimate: a database of climate data from multiple models for past, present, and future for Macroecologists and Biogeographers. Biodiversity Informatics 2015; 10:1-21. doi: 10.17161/bi.v10i0.4955
13. Montes de Oca L, Pérez-Miles F. Las arañas Mygalomorphae del Uruguay: clave para familias, géneros y especies. INNOTEC 2009; 4(4):41-49.
14. Opatova V, Hamilton CA, Hedin M, De-Oca LM, Král J, Bond JE. Phylogenetic systematics and evolution of the spider infraorder Mygalomorphae using genomic scale data. Syst Biol 2020; 69(4):671-707. doi: 10.1093/sysbio/syz064
15. Ortuiz-Jaureguizar E, Cladera GA. Paleoenvironmental evolution of Southern South America during the Cenozoic. J Arid Environ 2006; 66(3):498-532.
16. Peterson AT, Soberón J, Pearson RG, Anderson RP, Martínez-Meyer E, Nakamura M, Araújo MB. Ecological niches and geographic distributions. Monogra Popul Biol 2011; 49(49). doi: 10.1515/9781400840670
17. Phillips SJ, Anderson RP, Schapire RE. Maximum entropy modeling of species geographic distributions. Ecol Modell 2006; 190:231–259. doi: 10.1016/j.ecolmodel.2005.03.026
18. Schwerdt LV, Copperi MS. A contribution to the knowledge of burrows and reproductive biology of *Stenoterommata platensis* Holmberg (Mygalomorphae: Nemesiidae). Mun Ent Zool 2014; 9(1).
19. Signorotto F, Mancini M, Ferretti N. A new small *Acanthogonatus* Karsch, 1880 (Mygalomorphae, Pycnothelidae) species from Argentinean Patagonia: description of *A. messii* Signorotto & Ferretti n. sp. and its phylogenetic placement. Zoosystema 2023; 45(17):499-512.
20. Webb SD, Rancy A. Late Cenozoic evolution of the Neotropical mammal fauna. In: Jackson JBC, Budd AF, Coates AG, editors. Evolution and Environments in Tropical America. Chicago: University of Chicago Press, Chicago 1996; 335–358.
21. World Spider Catalog. World Spider Catalog. Version 24.5. Natural History Museum Bern, online at http://wsc.nmbe.ch, accessed on {date of access}, 2023. doi: 10.24436/2
22. Zank C, Becker FG, Abadie M, Baldo D, Maneyro R, Borges-Martins M. Climate change and the distribution of Neotropical red-bellied toads (Melanophryniscus, Anura, Amphibia): How to prioritize species and populations? PLoS One 2014; 9(4):e94625. doi: 10.1371/journal.pone.0094625