

# First record of the predaceous midge *Schizonyxhelea zoologica* Huerta & Grogan, 2017 (Diptera: Ceratopogonidae) in South America, with description of the female

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## ABSTRACT

*Schizonyxhelea zoologica* Huerta & Grogan, 2017, previously known from North America (Mexico), is reported for the first time in South America (Brazil). Additionally, the female of this species is described and illustrated for the first time. The females were collected in association with males in a preserved forest and an urban forest fragment, located in Amazonas State, Brazil. *Schizonyxhelea zoologica* is the fifth species of the genus recorded in Brazil, and the first species of the genus documented in Amazonas. Finally, a brief commentary on the environment in which the specimens were found, as well as their biogeographical importance, is provided.

**KEYWORDS:** Brazilian Amazon, Aquatic insect, New record, Taxonomy.

## Primeiro registro do maruim predador *Schizonyxhelea zoologica* Huerta & Grogan, 2017 (Diptera: Ceratopogonidae) na América do Sul, com descrição da fêmea

## RESUMO

*Schizonyxhelea zoologica* Huerta & Grogan, 2017, previamente conhecida da América do Norte (México), é relatada pela primeira vez na América do Sul (Brasil). Além disso, a fêmea dessa espécie é descrita e ilustrada pela primeira vez. As fêmeas foram coletadas em associação com machos em uma floresta preservada e em um fragmento florestal urbano, localizados no estado do Amazonas, Brasil. *Schizonyxhelea zoologica* é a quinta espécie do gênero registrada no Brasil e a primeira espécie do gênero documentada no Amazonas. Por fim, é apresentado um breve comentário sobre o ambiente em que os espécimes foram encontrados, bem como sua importância biogeográfica.

**PALAVRAS-CHAVE:** Amazônia Brasileira, Inseto aquático, Novo Registro, Taxonomia.

*Schizonyxhelea* Clastrier, 1984 is one of several genera of predaceous midges within the Ceratopogoninae, which is the most diverse subfamily among the three extant subfamilies of Ceratopogonidae currently recognized (Borkent and Dominiak 2020). The genus was described based on a single female and distinguished from other genera by the presence of at least one basiconic sensillum on flagellomere III or IV, along with claws possessing a bifid end (Clastrier 1984). Borkent (2014) introduced a new identifying characteristic, noting

the reduction of the aedeagus to a unique and distinctive transverse band of cuticle ventrally.

The genus comprises 16 species distributed across the Nearctic, Neotropical, Afrotropical, and Oriental regions (Borkent and Dominiak 2020; Huerta and Grogan 2017). The Neotropical species, *Schizonyxhelea zoologica* Huerta & Grogan, 2017, was recently described from an urban area in Tabasco, Mexico, based on the morphology of the male adult, primarily the genital structures (Huerta and Grogan 2017). This study aimed to provide the first description of the female

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and expand the geographic distribution of *S. zoologica* to South America, specifically the Brazilian Amazon.

The specimens were collected in the municipality of Manaus, Amazonas, Brazil, in two areas: a preserved white-sand forest (Campina Biological Reserve; 2°36'18.96" S – 60°02'11.62" W) and an urban forest fragment (Mindu Municipal Park; 3°04'46.53" S – 60°00'18.23" W). Collection methods included the use of Malaise and suspended traps (Rafael and Gorayeb 1982), and the specimens were preserved in 70% ethanol. Subsequently, they were cleared, dissected, and mounted on microscope slides in Canada balsam using the techniques described by Wirth and Marston (1968). The morphological terminology followed Huerta and Grogan (2017) and Borkent (2017).

Measurements and photographs were obtained with a Leica Application Suite (LAS) software (version 4.10.0), used to capture stacks of images of structures which were combined into a single image using Helicon Focus® Pro stacking software (version 7.6.4). All photographs were edited and assembled into plates using Adobe Photoshop®.

The distribution map was created using QGIS Lima software (version 3.32) with the shapefile from Morrone et al. (2022), based on the Neotropical biogeographical regionalization proposed by Morrone (2014). The satellite images were obtained from Google Earth®. Distribution data for species were compiled from literature sources and specimens from this study.

The examined material is deposited in the Invertebrate Collection of the Instituto Nacional de Pesquisas da Amazônia (INPA), Manaus, Amazonas, Brazil.

***Schizonyxhelea zoologica*** Huerta & Grogan, 2017

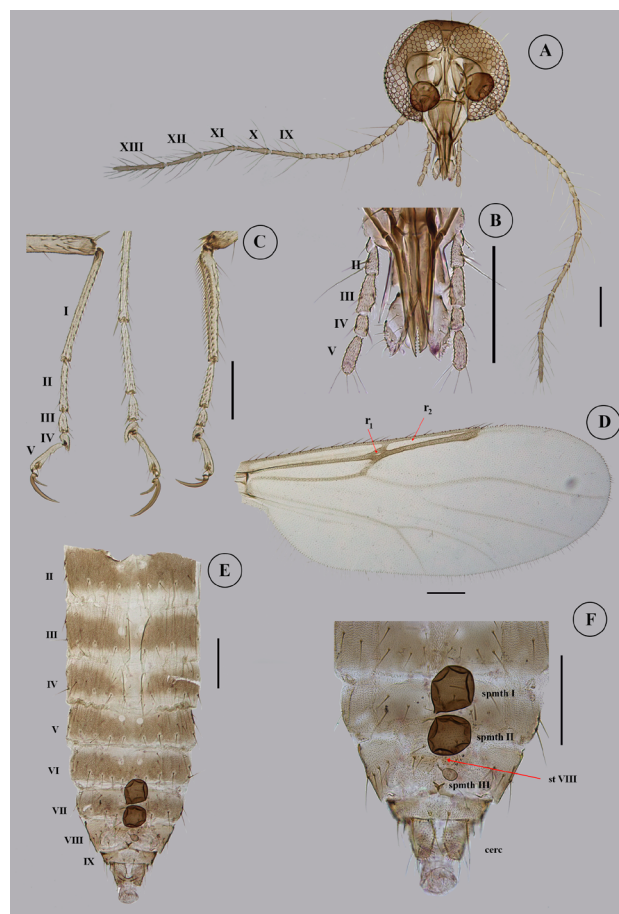
*Schizonyxhelea zoologica* Huerta & Grogan, 2017: 404, figs. 1–7, 24; Borkent and Dominiak 2020: 171 (World catalog).

**Type locality.** Mexico, Tabasco, Villahermosa, Centro, Zoológico.

**Material examined.** BRAZIL: Amazonas, Manaus, Mindu Municipal Park, 3°04'46.53" S – 60°00'18.23" W, 01.xi.2016, I.M. Da-Silva, R.L. Ferreira-Keppler legs., Light sheet trap, 1 female, 1 male (INPA); same data, except 07–10.vii.2016, Suspensa trap, 1 male (INPA); Manaus, Campina Biological Reserve, BR-174, 2°36'18.96" S – 60°02'11.62" W, 04–23.x.2018, I.M. Da Silva, R.L. Ferreira-Keppler legs, Malaise trap, 1 male (INPA).

**Diagnosis.** *Schizonyxhelea zoologica* is the only extant species of *Schizonyxhelea* with males that have three distinctive crenulations on the mesal surface of the gonostylus. Females of this species have elongated cercus with flattened apical margin, two well-developed and rounded spermathecae with short necks and a third, underdeveloped, small spermatheca with an elongated neck.

**Description.** *Adult female.* **Head:** brown. Eyes separated in frontal view. Antennal ratio 1.24; pedicel dark brown, flagellomeres brown. Palpal ratio 2.54; segment III moderately long, rounded sensory tip, with a few capitate sensilla; segment V nearly as long as III. Clypeus with 2 pairs of submarginal setae. Mandibula with 7-7 teeth (Figures 1a,b). **Thorax:** brown; scutum dark brown, scutellum brown, with 4 setae, 2 medial and 2 lateral; post scutellum dark brown; paratergite without setae; anepisternal cleft well developed; pleura without setae. Legs with mid, hind coxae dark brown; fore coxae brown. Mid and hind femora brown; hind one with darker subapical spot. Tibiae pale brown with dark brown base; hind tibial comb with 6 spines. Tarsi pale brown; prothoracic TR 2.21; mesothoracic TR 2.17; metathoracic TR 2.32. Claws single, as long as V tarsomere, with basal tooth (Figure 1c). Wing membrane hyaline, with R3 darker; 1st radial cell very small; 2nd radial cell 5.7 x longer than 1st; length 0.99 mm; width 0.39 mm; CR 0.64. Halter brown. (Figure 1d). **Abdomen:** pale brown, bearing tergite I-III and VII brown, tergites I-III and VII, darker, IV mesally pale; all with anteriomedial small white spots (Figure 1e).



**Figure 1.** *Schizonyxhelea zoologica*, female: **A** – head and antennae, frontal view; **B** – palpus, frontal view; **C** – tarsus, lateral view; **D** – wing; **E** – abdomen, ventral view; **F** – genitalia, ventral view. Scale bars = 0.1 mm.

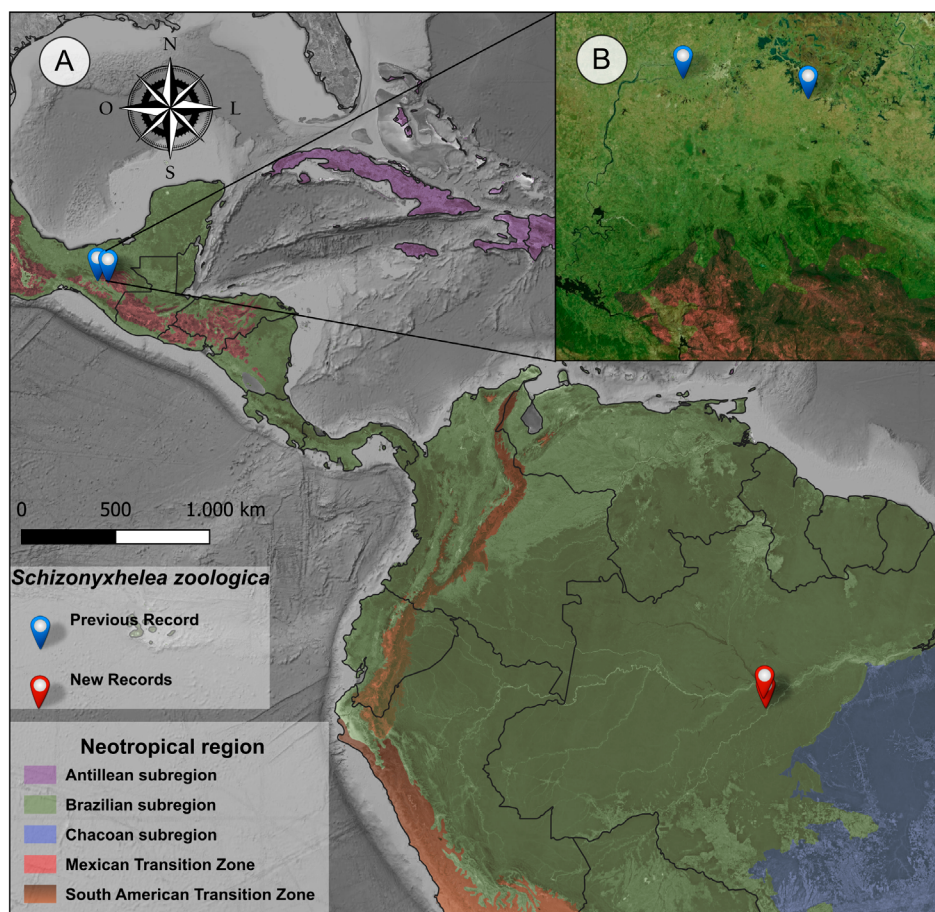
**Genitalia:** Sternite VIII with posteromedian excavation V-shaped; sternite IX narrowed, sclerotized inner margins; sternite X with anterior margin concave, deep and posterior margin rounded, with two long setae; cerci elongated; two well-developed, rounded spermathecae (spmth) with short necks, a third small, underdeveloped spermatheca with elongated neck; spmth I 56/51  $\mu\text{m}$  (length/wide); spmth II 46/48  $\mu\text{m}$  (length/wide); spmth III 18/14  $\mu\text{m}$  (length/wide) (Figure 1f).

**Distribution.** BRAZIL: Amazonas state, MEXICO: Tabasco state (Figure 2a).

**Remarks.** As mentioned by Huerta and Grogan (2017), males of this species resemble those of *S. thomsenae* (Wirth, 1953) and *S. bulla* (Thomsen, 1935) in size, hind femoral coloration, moderate eye separation, and the fusion of flagellomeres V-IX or V-X. However, their genitalia are different: the aedeagus of *S. bulla* is represented by a heavily sclerotized horn-shaped sclerite and the inner margin of the gonostylus bears a prominent, heavily sclerotized, plate-like lobe; *S. thomsenae* differs by the gonostylus with a basal thumb-like appendage.

We observed that females of *S. thomsenae* can be easily distinguished from those of *S. zoologica* by the abdominal terga II-VI, which have two anterior small white spots. Additionally, terga II-VI are dark brown except for a pale mid area, which is much broader on tergite IV (see Figure 1d of Cazorla and Diaz (2020)). In contrast, the females of *S. bulla* have shorter wings (0.8 mm), a black abdomen and only two spermatheca with short necks.

According to Santarém and Felipe-Bauer (2024), only four species of *Schizonyxhelea* have been recorded in Brazil: *Schizonyxhelea forattinii* Wirth & Grogan, 1988 (from Santa Catarina state), *S. guyana* Clastrier, 1984 (from Mato Grosso state), *S. panamensis* (Lane & Forattini, 1958) (from Rio de Janeiro and São Paulo states), and *S. thomsenae* (from Bahia and Pará states). With the addition of *S. zoologica*, Brazil now shares with Mexico the largest number of *Schizonyxhelea* species in the Neotropical region, with five documented species (Huerta and Grogan 2017; Borkent and Dominiak 2020). The record of this species in the state of Amazonas



**Figure 2.** Distribution of *Schizonyxhelea zoologica* in the Neotropical region and general views of its collection sites: **A** – map of the Neotropical region showing its sub-regions and Mexican and South American transition zones (highlighted in colours), with the geographic distribution of *Schizonyxhelea zoologica*; **B** – Satellite image showing the previous records of *S. zoologica*.

represents its first report in both South America and Brazil, as well as the first record of the genus in Amazonas.

The type locality of *S. zoologica* is in the state of Tabasco, Mexico, within the tropical rainforest biome. Both locations, the zoo in the center of the capital city, Villahermosa, and Huimango, a small village within the municipality of Cunduacán, are characterized by altered vegetation remnants of the tropical rainforest (Figures 2a,b).

The collection site of the specimens described here is the Mindu Municipal Park (Figures 2a), an anthropized park located in the heart of Manaus. This park encompasses four distinct ecosystem types: secondary capoeira forest, terra firme forest, mata de baixio (seasonally flooded forest), and regeneration areas (DOMM 2006). The species has also been identified in the Campina Biological Reserve (Figures 2a), situated in a rural area of Manaus. This is an open white-sand forest characterized by shrubs and small trees not exceeding six meters height, arranged in patches among bare sand. The flora of white-sand forests tends to differ widely from dense terra-firme forests, with macucu (*Aldina heterophylla* Spruce ex Benth), some Bromeliaceae, Orchidaceae and Araceae, as well as the grayish-green lichen *Cladonia* as characteristic elements (Oliveira et al. 2001).

Following Morrone (2014, 2020), the biogeographic classification of the Neotropical region, *S. zoologica* is situated within the Brazilian sub-region (Figures 2a,b). This sub-region encompasses central and southern Mexico, Central America, and northwestern South America. Between the remote locations where this species was found, there are two geographic barriers (Figure 2a): the Mexican transition zone, characterized by mountainous terrain (Morrone 2014, 2017) and the South American transition zone, which includes the Andean mountain chains, extending from Venezuela to southern Chile and Argentina (Morrone 2014, 2017, 2018). These zones, characterized by mountainous terrain and other geographic features, often act as barriers to dispersal and gene flow, leading to distinct biogeographic patterns (Morrone 2006). However, the presence of *S. zoologica* across these remote locations suggests that its distribution may not be significantly restricted by mountain barriers. This suggests that the species has some degree of ecological or evolutionary flexibility that allows it to thrive across these regions.

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## REFERENCES

- Borkent, A. 2014. The pupae of the biting midges of the world (Diptera: Ceratopogonidae), With a generic key and analysis of the phylogenetic relationships between genera. *Zootaxa* 3879: 001–327.
- Borkent, A. 2017. Ceratopogonidae (Biting Midges). In: Kirk-Spriggs, A.H.; Sinclair, B.J. (Eds.), Manual of Afrotropical Diptera. Vol. 2. Nematoceros Diptera and Lower Brachycera. Suricata 5. South African National Biodiversity Institute. Pretoria. p. 733–812.
- Borkent, A.; Dominiak, P. 2020. World species of biting midges (Diptera: Ceratopogonidae). *Zootaxa* 4787: 001–377.
- Cazorla C.; Diaz, F. 2020. *Schizonyxhelea thomsenae* (Wirth), description of the pupa and first records from Argentina, Brazil and Peru (Diptera: Ceratopogonidae). *Anais da Academia Brasileira de Ciências* 92: e20180500.
- Clastrier, J. 1984. *Schizonyxhelea guyana* n. g., n. sp. de la Guyane Française (Diptera: Ceratopogonidae). *Revue Française Entomologie* 6: 1–4.
- DOMM. 2006. Diário oficial do Município de Manaus Poder Executivo. Parque Municipal do Mindu. Número 1448, ANO VII. (<https://www.manaus.am.gov.br/semef/wp-content/uploads/sites/7/2023/04/dom20061448cad1.pdf>). Accessed on 31 May 2024.
- Huerta H.; Grogan, W. L., Jr. 2017. New species and new records of predaceous midges in the genera *Schizonyxhelea* Clastrier and *Stilobezzia* Kieffer from Mexico (Diptera: Ceratopogonidae). *Zootaxa* 4294: 401–418.
- Lane, J.; Forattini, O.P. 1958. Neotropical *Stilobezzia* II. Fourteen new species, chiefly from Panama (Diptera, Ceratopogonidae). *Revue Brasileira de Entomologia* 8: 203–224.
- Morrone, J. J. 2006. Biogeographic areas and transition zones of Latin America and the caribbean islands based on panbiogeographic and cladistic analyses of the entomofauna. *Annual Review of Entomology* 51:67–494.
- Morrone J.J. 2014. Biogeographical regionalization of the Neotropical region. *Zootaxa* 3782: 1–110.
- Morrone J.J. 2017. *Neotropical biogeography: Regionalization and evolution*. CRC Press, Taylor and Francis Group. Boca Raton. 282 p.
- Morrone J.J. 2018. *Evolutionary biogeography of the Andean region*. CRC Press, Taylor and Francis Group, Boca Raton. 250 p.

- Morrone J.J. 2020. *The Mexican Transition Zone: A natural biogeographic laboratory to study biotic assembly*. Springer, Cham. 191 p.
- Morrone, J.J.; Escalante, T.; Rodríguez-Tapia, G.; Carmona, A.; Arana, M.; Mercado-Gómez, J.D. 2022. Biogeographic regionalization of the Neotropical region: New map and shapefile. *Anais da Academia Brasileira de Ciências* 94: e20211167.
- Oliveira, A.A.; Daly, D.C.; Vicentini, A.; Cohn-Haft, M. 2001. Florestas sobre Areia: Campinaranas e Igapós. Capítulo 6. In: Oliveira, A.A.; Daly, D.C. *Florestas do Rio Negro*. Editora Schwarcz Ltda. p. 179-219. (<http://www.ecologia.ib.usp.br/guiaigapo/images/livro/RioNegro06.pdf>) Accessed on 02 Sep. 2024.
- Rafael, J.A.; Gorayeb, I.S. 1982. Tabanidae (Diptera) da Amazônia, I - Uma nova armadilha suspensa e primeiros registros de mutucas de copas de árvores. *Acta Amazônica* 12: 232-236.
- Santarém M.C.A., Felipe-Bauer M.L. 2024. Analysis of Brazilian Ceratopogonidae (Diptera: Culicomorpha) species diversity and knowledge assessment. *Zoologia* 41: e23066.
- Thomsen, L.C. 1935. New species of New York State Ceratopogonidae. *Journal of the New York Entomological Society* 43: 283–297.
- Wirth, W.W. 1953. Biting midges of the Heleid genus *Stilobezzia* in North America. *Proceedings of the United States National Museum* 103: 57–85.
- Wirth, W.W.; Marston, N. 1968. A method for mounting small insects on microscope slides in Canada balsam. *Annals of the Entomological Society of America* 61: 783–784.
- Wirth, W.W.; Grogan, W.L. Jr. 1988. *The predaceous midges of the world (Diptera: Ceratopogonidae; Tribe Ceratopogonini)*. Flora and Fauna Handbook 4. E.J. Brill, Leiden, New York, København and Köln. 160 p.

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