A new record of a winged stick insect (Phasmatodea) from Mexico, with a checklist and key to the species of the family Pseudophasmatidae from continental North America

Manuel de Luna[1], Roberto García-Barrios[2], Gerardo Cuéllar-Rodríguez[1], Ulises López-Mora[3]

1 Facultad de Ciencias Forestales, Universidad Autonoma de Nuevo Leon, San Nicolás de los Garza, Mexico.
2 Facultad de Ciencias Biologicas, Universidad Autonoma de Nuevo Leon, San Nicolás de los Garza, Mexico.
3 Facultad de Ciencias, Universidad Nacional Autónoma de México, Ciudad de México, Mexico.

Corresponding author: Gerardo Cuéllar-Rodríguez (luis.cuellarrd@uanl.edu.mx)

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Abstract

The winged stick insect *Metriophasma iphicles* (Redtenbacher, 1906) (Phasmatodea: Pseudophasmatidae) is recorded for the first time from Mexico (state of Veracruz), making this the northernmost record of both the species and genus. A checklist of species in the family Pseudophasmatidae from Mexico and the USA is presented, and a key to the species listed is proposed. With the current record, the number of continental North American species of Phasmatodea increases to 108, and the number of genera in the region increases to 23.

Keywords

Metriophasma iphicles, neotropics, phasmid, Phasmida, Veracruz

Introduction

The order Phasmatodea (stick and leaf insects) is currently comprised of more than 3500 species worldwide (Brock et al. 2022). In continental North America (Canada, USA, and Mexico), this order is represented by 107 species, grouped into 22 genera and 7 (potentially distantly related) families (López-Mora and Llorentes-Bousquets 2018, 2023, de Luna, in press). Among the North American phasmid fauna, there are records of only 5 winged species: 1 macropterous species of the genus *Prisopus* Peltier de Saint Fargeau & Audinet-Serville, 1827 (Prisopodidae: Prisopodinae: Prisopodini); 1 brachypterous species of the genus *Haplopus* Burmeister, 1838 (Phasmatidae: Cladomorphinae: Haplopodini); 2 brachypterous species of the genus *Hypocyrtus* Redtenbacher, 1908 (Phasmatidae: Cladomorphinae: Hesperophasmatini); and 1 macropterous species of the genus *Agrostia* Redtenbacher, 1906 (Pseudophasmatidae: Stratocleinae: Stratocleini). These winged species are mostly found in neotropical Mexico (*Agrostia*, *Hypocyrtus*, and *Prisopus*), but one is found in the southernmost state of the United States, Florida (*Haplopus*) (Arment 2006, López-Mora and Llorente-Bousquets 2018).

The family Pseudophasmatidae is of the "Areolatae" group, meaning that its species possess an area apicalis; this is a sunken and usually triangular-shaped areola found in the ventral apex of the middle and hind tibiae (Bradley and Galil 1977, López-Mora and Llorente-Bousquets 2018). This character distinguishes the members of this family from most of the taxa of the region, except the members of the family Timematidae from which they differ most prominently in the number of tarsal segments: 5 in Pseudophasmatidae (and all other families) and 3 in Timematidae. Another exception is the members of the family Prisopodidae, from which they differ in the aspect of the last abdominal segments being laterally expanded into lobes in Prisopodidae (López-Mora and Llorente-Bousquets 2018). This family is currently divided into 3 subfamilies and 7 tribes: Pseudophasmatinae with 3 tribes, Anisomorphini, Paraprisopodini, and Pseudophasmatini; Stratocleinae with 1 tribe, Stratocleini; and Xerosomatinae with 3 tribes, Prexaspini, Setosini, and Xerosomatini (Brock et al. 2022). Pseudophasmatidae is represented in continental North America by 6 species: the macropterous *Agrostia rugicollis* (Gray, 1835); 3 apterous species of the genus *Anisomorpha* Gray, 1835 (Pseudophasmatinae: Anisomorphini), *Anisomorpha buprestoides* (Houttuyn, 1813), *Anisomorpha ferruginea* (Palisot de Beauvois, 1805), and *Anisomorpha paromalus* Westwood, 1859; and 2 apterous species of the genus *Autolyca* Stål, 1875 (Pseudophasmatinae: Anisomorphini), *Autolyca elena* Gorochov & Berezin, 2008 and *Autolyca pallidicornis* Stal, 1875. *Agrostia rugicollis*, *Anisomorpha paromalus*, and both species of *Autolyca* are found in neotropical Mexico; the remaining 2 species of *Anisomorpha* are found in southeastern USA (Arment 2006, López-Mora and Llorente-Bousquets 2018, de Luna in press). Until now, the genus *Agrostia* was the only recorded winged genus of this family in the region (Arment 2006, López-Mora and Llorente-Bousquets 2018).

The genus *Metriophasma* Uvarov, 1940 (Pseudophasmatidae: Xerosomatinae: Prexaspini) contains 11 macropterous species

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that are distributed in the neotropical region. They are divided further into 2 subgenera: *Acanthometriotes* Hebard, 1924, which comprises 3 stocky species native of South America; and *Metriophasma* Uvarov, 1940, which comprises 8 elongated species native mostly to South America. At least 2 species, *Metriophasma diocles* (Westwood, 1859) and *Metriophasma iphicles* (Redtenbacher, 1906), have been recorded in Central America (Brock et al. 2022). In the present publication, *Metriophasma iphicles* is recorded for the first time in Mexico, being found in the state of Veracruz; this is currently the northernmost distribution record of any species of the genus. A checklist of the species of the family Pseudophasmatidae from continental North America is presented, and a key to all listed species is proposed.

Methods

During a visit (July 2022) to the Estacion de Biologia Tropical "Los Tuxtlas", in the municipality of San Andres Tuxtla, state of Veracruz, Mexico, 8 specimens (7♂♂, 1♀) of a macropterous species of stick insect were collected at night (Fig. 1A). They were found perched on branches and vines, but there was no evidence indicating that the insects were feeding on these plants. The specimens were preserved individually in 70% ethanol and are kept at the Entomology Lab of the Facultad de Ciencias Forestales (FCF) of the Universidad Autonoma de Nuevo Leon (UANL) under the vouchers PHASM054–061, with 1 specimen being dry-mounted (PHASM056 – ♂ [Fig. 1B]) to obtain a better view of the pattern of the hindwings (Fig. 1B). Additionally, 3 other specimens from the same locality were examined; these are deposited in the Entomological Collection of the Estación de Biología Tropical "Los Tuxtlas" (EBTX45–47).

The keys of López-Mora and Llorente-Bousquets (2018) were employed in an attempt to identify the genus, the specimens keying to *Perliodes* (now a synonym of *Agrostia*). However, it was noted that the hindwings reached tergite IX (Figs 1B, 2A–C, 3A, C), while in *Agrostia*, it is known that the hindwings do not reach tergite VIII (Fig. 4A) (Aquino-Heleodoro et al. 2017). The presence of carinae in the middle and the hind femora was also noted, which are absent in all Stratocleinae including *Agrostia* (Zompro 2005). When the keys of Redtenbacher (1906) and Shelford (1909) were used instead, the specimens keyed to *Metriotes* (now a synonym of *Metriophasma* Uvarov, 1940), finding the same results when employing the key of Zompro (2005). After the genus was established, the keys to species present in the works of Redtenbacher (1906) and Shelford (1909) were employed, with the specimens keying to *Metriophasma iphicles*. Finally, the specimens were compared to photographs of the type material of *Metriophasma iphicles* from the Phasmida Species File website (Fig. 3A–C) (Brock et al. 2022), corroborating the identity of the collected material (Figs 1A, B, 2A–F).

Results and discussion

Checklist of species of Pseudophasmatidae from continental North America

The checklist includes records to state level, including those made or compiled by Redtenbacher (1906), Shelford (1909), Mariño and Marquez (1983), Conle and Hennemann (2002), Arment (2006), Gorochov and Berezin (2008), and López-Mora and Llorente-Bousquets (2018).

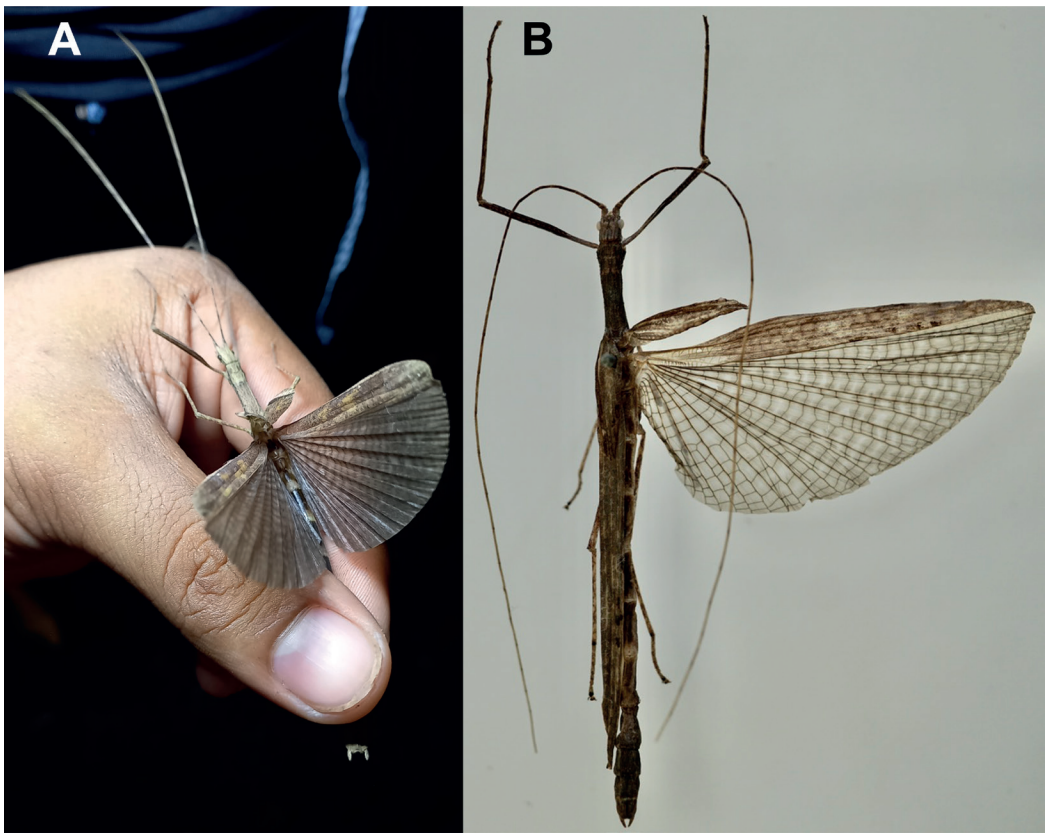

Fig. 1. *Metriophasma iphicles*, males. **A.** Live specimen found at night; wings spread; photo by Roberto García-Barrios; **B.** Dry-mounted specimen (PHASM056) with one tegmina and hindwing extended; photo by Manuel de Luna.

Family PSEUDOPHASMATIDAE Rehn, 1904
Subfamily Pseudophasmatinae Rehn, 1904
Tribe Anisomorphini Redtenbacher, 1906

Genus *Anisomorpha* Gray, 1835

1. ***Anisomorpha buprestoides* (Houttuyn, 1813)** USA (Alabama, Florida, Georgia, Louisiana, Mississippi, North Carolina, South Carolina, Texas).

2. ***Anisomorpha ferruginea* (Palisot de Beauvois, 1805)** USA (Delaware, Florida, Georgia, Illinois, Indiana, Kentucky, Louisiana, Mississippi, North Carolina, Nebraska [dubious record according to Arment 2006], Oklahoma, Pennsylvania, South Carolina, Texas, and Virginia).

3. ***Anisomorpha paromalus* Westwood, 1859** MEXICO (Yucatan).

Genus *Autolyca* Stål, 1875

4. ***Autolyca elena* Gorochov & Berezin, 2008** MEXICO (Chiapas).

5. ***Autolyca pallidicornis* Stal, 1875** MEXICO (Chiapas).

Subfamily Stratocleinae Günther, 1953
Tribe Stratocleini Günther, 1953

Genus *Agrostia* Redtenbacher, 1906

6. ***Agrostia rugicollis* (Gray, 1835)** MEXICO (Colima).

Subfamily Xerosomatinae Bradley & Galil, 1977
Tribe Prexaspini Zompro, 2004

Genus *Metriophasma* Uvarov, 1940

7. ***Metriophasma iphicles* (Redtenbacher, 1906)** MEXICO (Veracruz). **New record.**

Material examined.—MEXICO • 1 ♀; Estación de Biología Tropical "Los Tuxtlas", municipality of San Andres Tuxtla, state of Veracruz; 18.5848°N, -95.0741°W, 147 m a.s.l.; 25 July 2022; on branches and vines; Roberto García-Barrios and Manuel de Luna leg.; wet specimen (70% ethanol); collected under permit SGPA/DGVS/04352/22; voucher PHASM054 (FCF-UANL) • 1 ♂; same data; voucher PHASM055 (FCF-UANL) • 1 ♂; same data; dry-mounted specimen (Figs 2B, 3A–C); voucher PHASM056 (FCF-UANL) • 1 ♂; same data; voucher PHASM057 (FCF-UANL) • 1 ♂; same data; voucher PHASM058 (FCF-UANL) • 1 ♂; same data; voucher PHASM059 (FCF-UANL) • 1 ♂; same data; voucher PHASM060 (FCF-UANL) • 1 ♂; same data; voucher PHASM061 (FCF-UANL) • 1♀; same locality; 18.5831°N, -95.0741°W, 154 m a.s.l.; 24 September 2017; on Araceae; Ulises López Mora and Luis Rai Ruíz-Sánchez leg.; dry mounted; collected under permit SGPA/DGVS/03316/17; voucher EBTX45 (UNAM) • 1♀; same locality; 18.5847°N, -95.0735°W, 125 m a.s.l.; 25 September 2017; on Araceae; Ulises López Mora and Luis Rai Ruíz-Sánchez leg.; dry mounted; collected under permit SGPA/DGVS/03316/17; voucher EBTX46 (UNAM) • ♂; same locality; 18.5862°N, -95.0768°W, 170 m a.s.l.; 18 August 2018; on Araceae; Ulises López Mora leg.; dry mounted; collected under permit SGPA/DGVS/002646/18; voucher EBTX47 (UNAM).

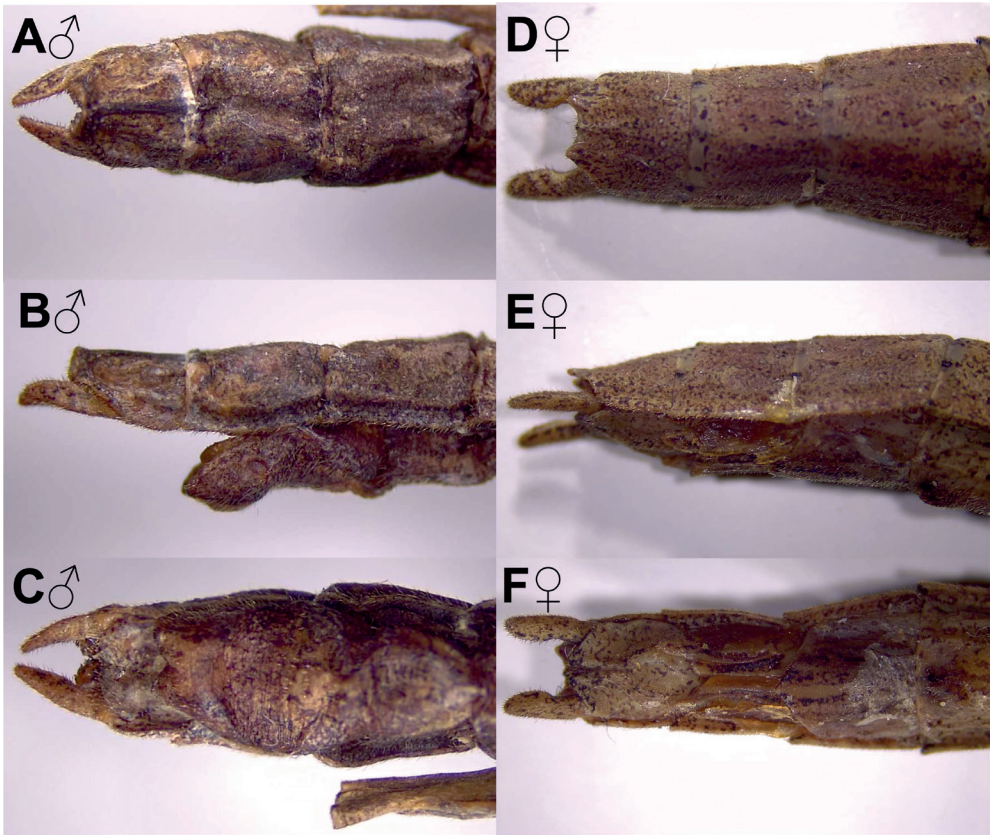

Fig. 2. *Metriophasma iphicles*, abdominal segments VIII, IX, and X. **A.** Dorsal aspect, male; **B.** Lateral aspect, male; **C.** Ventral aspect, male; **D.** Dorsal aspect, female; **E.** Lateral aspect, female; **F.** Ventral aspect, female. Photos by Manuel de Luna.

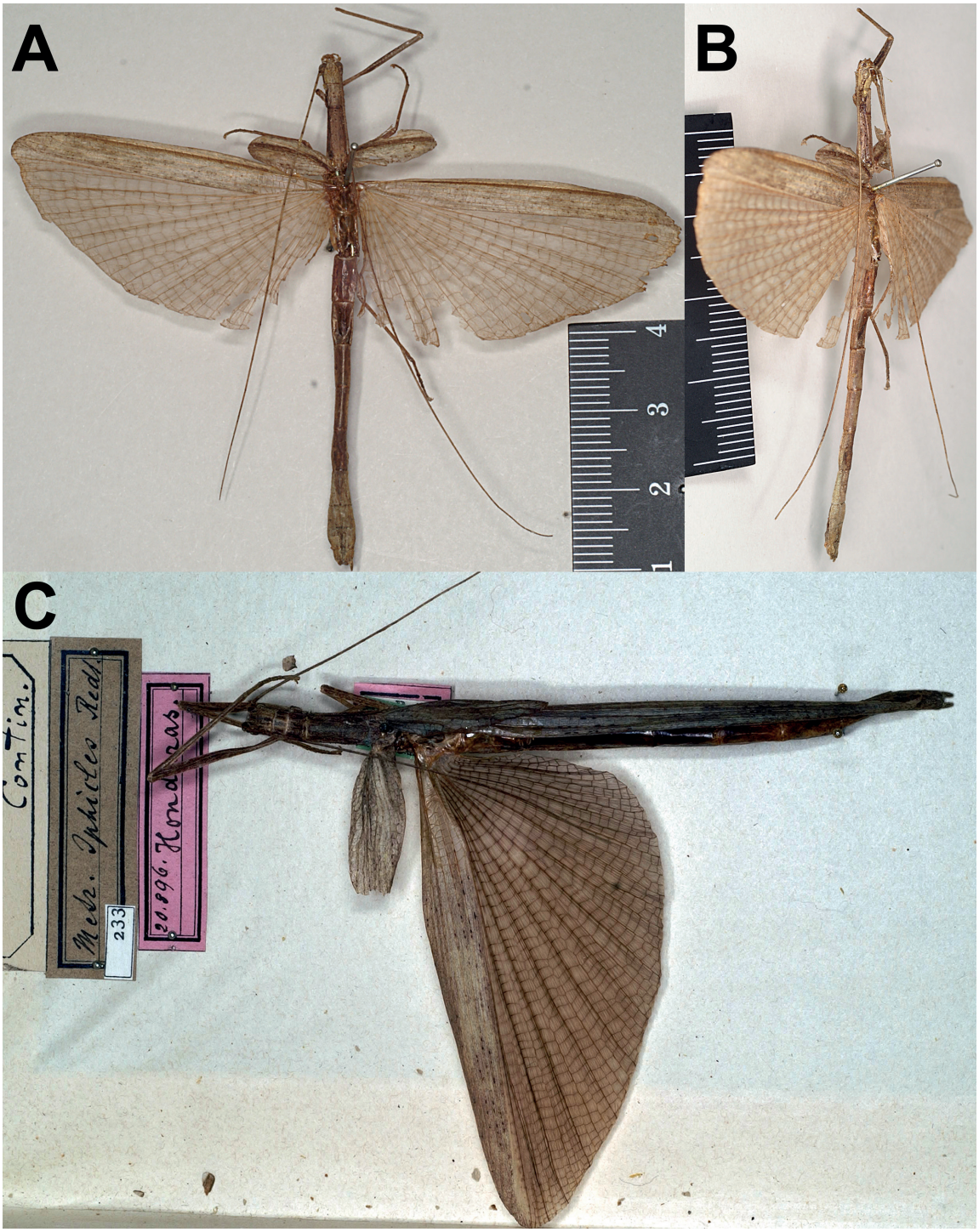

Fig. 3. *Metriophasma iphicles*; photographs by Dr. Paul D. Brock, copyright Natural History Museum of London. **A.** Dorsal aspect, male paralectotype; **B.** Lateral aspect, male paralectotype; **C.** Dorsal aspect, female lectotype.

New diagnosis.—*Metriophasma* has an area apicalis in the middle and hind tibiae, unlike all Diapheromeridae, *Parabacillus* Caudell, 1903, and Phasmatidae. It possesses 5-segmented tarsi, unlike the Timematidae. *Metriophasma* differs from all the North American genera, except 4 others, in having wings: the wings of *Metriophasma* are well-developed, unlike in the brachypterous species of *Haplopus* and *Hypocyrtus* (Phasmatidae). The abdomen of *Metriophasma* is not strongly lobed distally, as seen in macropterous species of *Prisopus* (Prisopodidae). Finally, *Metriophasma* has carinae on the ventral side of the middle and hind femora; these are lacking in all Stratocleinae, including *Agrostia* (Pseudophasmatidae) (Bradley and Galil 1977, Zompro 2005).

Metriophasma iphicles differs from the 3 species included in the subgenus *Acanthometriotes* for its elongated body and in having mesonotal carinae (Hebard 1924); from *Metriophasma armatum* (Redtenbacher, 1906), *Metriophasma baculus* (De Geer, 1773), and *Metriophasma stollii* (Gray, 1835) in having tubercles instead of spines in the dorsal aspect of the mesonotum (Redtenbacher

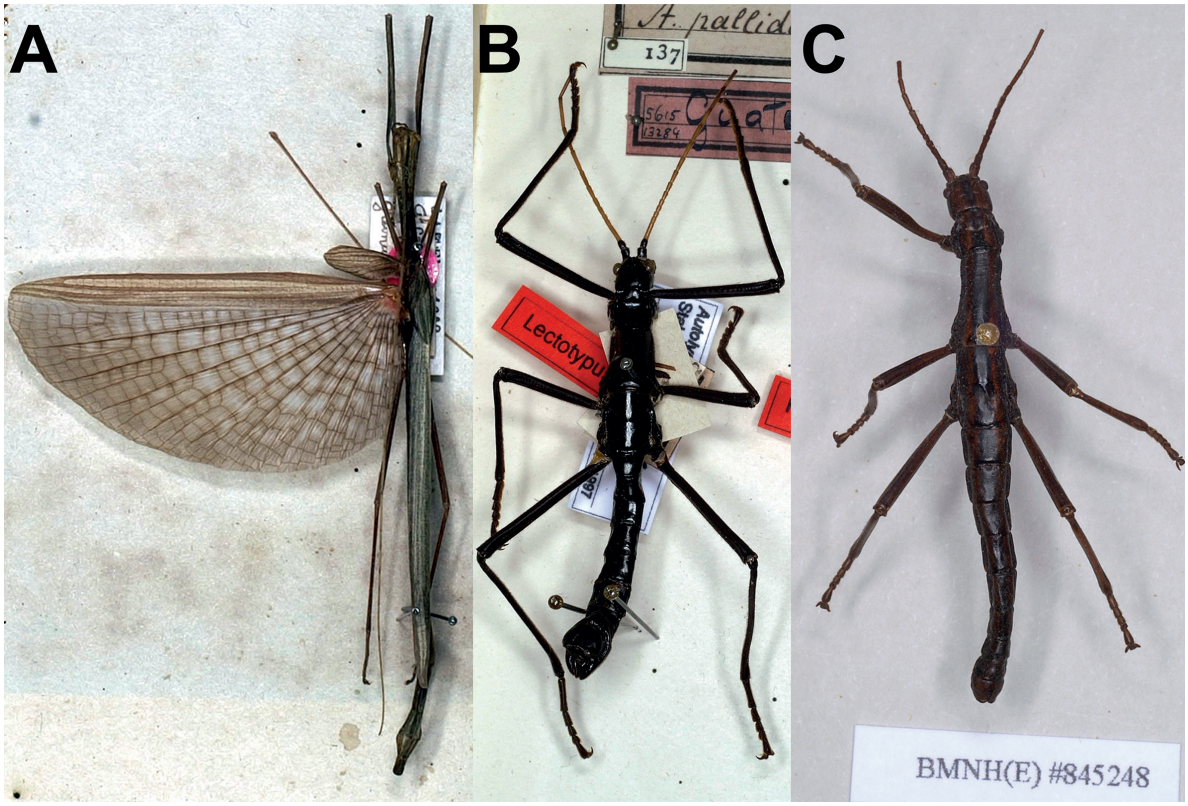

Fig. 4. Other North American representatives of the family Pseudophasmatidae; photographs by Dr. Paul D. Brock. **A.** *Agrostia rugicollis*, male syntype (type material of *Perliodes nigrogranulosus*, a synonym), copyright Naturhistorisches Museum Wien; **B.** *Autolyca pallidicornis*, male lectotype, copyright Naturhistorisches Museum Wien; **C.** *Anisomorpha paromalus*, male lectotype, copyright Natural History Museum of London.

1906); from *Metriophasma agathocles* (Stål, 1875), *Metriophasma baculus*, and *Metriophasma diocles* in having concolorous hindwings (Redtenbacher 1906, Shelford 1909); and from *Metriophasma pericles* (Redtenbacher, 1906) in not having a median carina in the mesonotum (Redtenbacher 1906).

This is the first time a species of the genus *Metriophasma* has been recorded for Mexico. The current record increases the number of species in continental North America to 108, the number of species of North American Pseudophasmatidae to 7, and the number of genera of the region to 23. *Metriophasma iphicles* had been previously recorded in the Central American countries of Honduras and Panama (Redtenbacher 1906, Shelford 1909), being the northernmost record of the species and genus. It is likely that this genus originated in South America, as this is where the majority of its species are found. At least 2 species reached Central America: *Metiophasma diocles* and *Metriophasma iphicles*. Following the tropical and subtropical areas found in the Atlantic versant, a population of *Metriophasma iphicles* reached Veracruz (Fig. 5). This distribution and tropical migration pathway has been observed in other animals, even those with low vagility, such as pit vipers (Saldarriága-Córdoba et al. 2017), so it is not surprising that a winged species could have easily followed it. The presence of this species is expected in more southern states, such as Chiapas or Oaxaca, as well as in northern Central American countries, such as Guatemala and Belize. Recently, there have been several instances of cryptic diversity in Phasmatodea; therefore, further molecular and morphological (internal genitalia) studies should follow to confirm whether this disjunct population is indeed *Metriophasma iphicles* or a closely related but undescribed species of the same species complex.

Fig. 5. Map of Mexico; pink circle points to the new record of *Metriophasma iphicles*.

Key to the North American Pseudophasmatidae

The following key works in adults of any sex from either the USA or Mexico. It follows keys and descriptions present in the works of Redtenbacher (1906), Shelford (1909), Conle and Hennemann (2002), Zompro (2005), Gorochov and Berezin (2008), and López-Mora and Llorente-Bousquets (2018). Care must be taken when examining specimens from neotropical Mexico, as some taxa might still be unreported or undescribed for this region.

1 Macropterous (tegmina reduced, hindwings well-developed, capable of flight) [Figs 1A, B, 3A–C, 4A] **2**
– Apterous (completely wingless and flightless) [Fig. 4B, C] **3**

2 Hindwings reaching the ninth abdominal tergite [Figs 1B, 3A–C]; middle and hind femora with a ventral carina. In the region, it has only been recorded in southeastern Mexico (Veracruz)..... ***Metriophasma iphicles***
– Hindwings shorter, not reaching the eighth abdominal tergite [Fig. 4A]; middle and hind femora without ventral carina. In the region, it has only been recorded in southwestern Mexico (Colima) .... ***Agrostia rugicollis***
3 Body concolorous [Fig. 4B] (juveniles can be speckled); forefemur mostly straight [Fig. 4B]. ♂♂ with ninth abdominal tergite with forcep-like lobes; ♀♀ subgenital plate large, reaching the tip of the anal segment or surpassing it. Found in southernmost Mexico..... ***Autolyca****: **4**
– Body striped (sometimes faded, but nonetheless visible) [Fig. 4C]; forefemur depressed and curved basally [Fig. 4C]. ♂♂ with small, non-convex poculum; ♀♀ subgenital plate short, reaching, at max, halfway the anal segment. Found in southeastern USA as well as the Yucatan Penninsula in Mexico ..... ***Anisomorpha*: 5**
4 ♀♀ operculum with rounded apex; ♂♂ genital plate apex bifurcated with 2 tubercle-like projections ..... ***Autolyca elena***
– ♀♀ operculum with angular apex; ♂♂ genital plate apex entire..... ***Autolyca pallidicornis***
5 Pronotum slightly wider than long; ♂♂ mesonotum 1.8 times larger than wide, at max; ♀♀ mesonotum 1.4 times larger than wide, at max. Found in the Mexican Yucatan Penninsula..... ***Anisomorpha paromalus***
– Pronotum slightly longer than wide; ♂♂ mesonotum 2.4 times larger than wide, at minimum; ♀♀ mesonotum 1.6 times larger than wide, at minimum. Found in southeastern USA **6**
6 Middle mesonotal suture clearly visible; with a distinctive black stripe that runs from the head to abdominal tergite X; ♂♂ tergite X with a concave prolateral incision, ♂♂ total body length 38–50 mm, ♀♀ total body length 58–85 mm ..... ***Anisomorpha buprestoides***
– Middle mesonotal suture not clearly defined; with a discontinuous and not clearly defined black stripe that usually runs from the head to abdominal tergite IX, although it can appear as a faint line in tergite X; ♂♂ tergite X without incisions; ♂♂ total body length 22–35 mm; ♀♀ total body length 40–55 mm ..... ***Anisomorpha ferruginea***

Remarks on *Autolyca*: Some authors have stated that "the known representatives of *Autolyca* are invariably apterous" (Conle et al. 2009), which holds true for the majority of the described species. However, *Autolyca albifrons* Redtenbacher, 1906 was described to possess brachypterous hindwings but not tegmina (Redtenbacher 1906). The origin of the lone male holotype is unknown but is unlikely to be from New Caledonia (Redtenbacher even marked this dubious locality with "(?)"). Much more recently, Bank and Bradler (2022) mentioned an undescribed brachypterous species of *Autolyca* from Panama. The revision and redescription of the holotype of *Autolyca albifrons*, the collection of more material, and the description of the undescribed Panamanian *Autolyca* are needed to begin resolving this matter.

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References

Aquino-Heleodoro R, de Mello-Mendes DM, Rafael JA (2017) Studies on Brazilian Pseudophasmatidae (Phasmatodea) with the description of a new species of *Agrostia* Redtenbacher and new records of *Metriophasma* Uvarov and *Parastratocles* Redtenbacher. Revista Brasileira de Entomologia 61: 170–177. https://doi.org/10.1016/j.rbe.2017.03.003

Arment C (2006) Walkingsticks of the continental U.S. and Canada. In: Arment C (Ed.) Stick Insects of the Continental United States and Canada, Species and Early Studies. Coachwhip Publications, Pennsylvania, 11–51.

Bank S, Bradler S (2022) A second view on the evolution of flight in stick and leaf insects (Phasmatodea). BMC Ecology and Evolution 22(62): 1–17. https://doi.org/10.1186/s12862-022-02018-5

Bradley JC, Galil BS (1977) The taxonomic arrangement of the Phasmatodea with keys to the subfamilies and tribes. Proceedings of the Entomological Society of Washington 79: 176–208.

Brock PD, Büscher T, Baker E (2022) Phasmida Species File Online Version 5.0/5.0. http://phasmida.speciesfile.org/HomePage/Phasmida/HomePage.aspx [Accessed on 27.11.2022]

Conle OV, Hennemann FH (2002) Revision neotropischer Phasmatodea: Die Tribus Anisomorphini sensu Bradley & Galil 1977. Spixiana 28: 1–141.

Conle OV, Hennemann FH, Ramírez-Mora MA, Quiroz JA (2009) Studies on neotropical Phasmatodea VIII: Revision of the genus *Decidia* Stål, 1875 with the description of a new species from Colombia (Phasmatodea: Pseudophasmatidae: Pseudophasmatinae: Anisomorphini). Zootaxa 2089: 33–51. https://doi.org/10.11646/zootaxa.2089.1.4

de Luna M (in press) Checklist of stick insects (Insecta: Phasmatodea) of North America, with three new records for Nuevo León, México. Phasmid Studies 21.

Gorochov AV, Berezin MV (2008) A new species of the genus *Autolyca* Stål (Phasmatoptera) from Mexico. Russian Entomology Journal 17: 135–138. https://doi.org/10.31610/zsr/2008.17.2.71

Hebard M (1924) Studies in the Dermaptera and Orthoptera of Ecuador. Proceedings of the Academy of Natural Sciences of Philadelphia 76: 109–248.

López-Mora U, Llorente-Bosquets J (2018) Lista de especies y clave ilustrada de los géneros de Phasmatodea (Insecta) de México. Revista Mexicana de Biodiversidad 89: 46–78. https://doi.org/10.22201/ib.20078706e.2018.1.2175

López-Mora U, Llorente-Bousquest J (2023) *Nooxapty* gen. nov. con dos especies nuevas (Phasmatodea: Diapheromeridae) de Oaxaca, México. Dugesiana 30: 11–33. https://doi.org/10.32870/dugesiana.v30i1.7272

Mariño PE, Márquez MC (1983) Primer registro del género *Autolyca*, Stål, 1875 para México (Insecta: Phasmatodea). Anales del Instituto de Biología, Universidad Nacional Autónoma de México, Serie Zoología 54: 213–215.

Redtenbacher J (1906) Die Insektenfamilie der Phasmiden, I. Phasmidae Areolatae. Wilhelm Engelmann, Leipzig, Saxony, 180p.

Saldarriaga-Córdoba M, Parkinson CL, Daza JM, Wüster W, Sasa M (2017) Phylogeography of the Central American lancehead *Bothrops asper* (Serpentes: Viperidae). PLoS ONE 12: e0187969. https://doi.org/10.1371/journal.pone.0187969

Shelford R (1909) Family Phasmatidae. In: Godman FD, Salvin O (Eds) Biologia Centrali Americana Orthoptera (Vol. 2). R. H. Porter, London, 343–377.

Zompro O (2005) A key to the genera of the Phasmatodea: Areolatae (Insecta). Phasmid Studies 12: 11–24.