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Estudo taxonômico de *Mecistogaster* Rambur, 1842 e *Platystigma* Kennedy, 1920 da Mata Atlântica (Odonata: Pseudostigmatidae)

Belo Horizonte - MG
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SUMÁRIO

RESUMO

Os pseudostigmatídeos da Mata Atlântica do Brasil foram estudados com base em 242 espécimes de várias instituições científicas. O estudo permitiu a revalidação do gênero *Platystigma*, colocado previamente na sinonímia de *Mecistogaster*. Os dois gêneros diferem principalmente pelo terceiro segmento do pênis, constituído por um flagelo em *Mecistogaster*, e uma placa em *Platystigma*. As duas espécies de *Platystigma* da Mata Atlântica, *P. astictum* e *P. pronoti* são redescritas. Destaca-se a utilização de dois caracteres estruturais ainda não utilizados na taxonomia de Pseudostigmatidae: hâmulo anterior e epiprocto das fêmeas. Com base principalmente na estrutura do penis, do hâmulo anterior e da coloração do mesepimeron, quatro espécies novas de *Mecistogaster* são descritas e ilustradas: *Mecistogaster eustaquioi* n. sp., *M. jacatinga* n. sp., *M. kesselring* n. sp. and *M mielkei* n. sp. Foi possível fazer a associação sexual de *Mecistogaster kesselring*, baseado em um casal encontrado em cópula. Discute-se o *status* taxonômico de *Mecistogaster amalia*, cujo holótipo, que se supunha estar no Museu de Halle, está desaparecido. Os exemplares de *M. amalia* descritos por Selys e todos os outros identificados com base nas descrições dele não correspondem à descrição original de Burmeister e, portanto, não pertencem àquela espécie. Foi realizado, também, um estudo do comportamento de oviposição em *Platystigma* e apresentada a possível correlação entre a estrutura da valva lateral do ovipositor com o tipo de oviposição.

Palavras-chave: Zygoptera, fitotelmata, oviposição, espécies novas, conservação.

ABSTRACT

The pseudostigmatid damselflies from the Atlantic Forest of Brazil are studied based on 242 specimens from various scientific institutions. The study allowed the revalidation of the genus *Platystigma,* which has been previoulsy synonymized with *Mecistogaster.* The two genera differ mainly by the penis segment 3, which is a flagellum in *Mecistogaster* and plate-like in *Platystigma*. The two species of *Platystigma* from the Atlantic Forest, *P. astictum* and *P. pronoti* are redescribed. Emphasis is given to the utilization of two structural character hitherto never used before in Pseudostigmatidae taxonomy: anterior hamule and female epiproct. Four new species (*Mecistogaster eustaquioi* n. sp., *M. jacatinga* n. sp., *M. kesselring* n. sp. and *M. mielkei* n. sp.) are described and illustrated, based mainly on penis structure, anterior hamule morphology and color of the mesepimeron. Sex association of *Mecistogaster kesselring* was done, based on a couple found in copula.The taxonomic *status* of *Mecistogaster amalia* is discussed; its holotype, supposed to be in Halle Museum, is actually lost. The *M. amalia* specimens described by Selys and all other identified according to his description do not correspond to Burmeister's original description and, therefore, do not belong to *M. amalia*. A study of the oviposition behavior in *Platystigma* and a possible correlation between the structure of lateral valve of ovipositor and the type of oviposition were presented.

Keywords: Zygoptera, phytotelmata, oviposition, new species, conservation.

Introdução geral

Odonata compreende as subordens Zygoptera, Anisoptera e Anisozygoptera. Dentro de Zygoptera, Pseudostigmatidae é caracterizada pela presença de um falso pterostigma (pseudostigma), fronte angulada, e abdômen grande, variando entre 50 mm e 137 mm. Fêmeas desta família ovipositam em fitotelmata como orifícios nos troncos de árvores, colmos de bambu ou tanques de bromélia (Corbet, 1983).

Pseudostigmatidae foi proposta por Selys (1860) e a última revisão da família foi feita por ele em 1886; a chave mais recente para os gêneros de Pseudostigmatidae foi elaborada por Garrison *et al.* (2010). Dijkstra *et al.* (2014) propôs a inclusão de Pseudostigmatidae, como subfamília, em Coenagrionidae, posição não muito bem justificada e com amostragem insuficiente. Segundo Garrison *et al.* (2010), Pseudostigmatidae inclui 28 espécies e cinco gêneros, todas neotropicais. No Brasil, são encontrados apenas dois gêneros, *Mecistogaster* Rambur, 1842 e *Microstigma* Rambur, 1842 (Lencioni 2005).

Há poucos estudos sobre o gênero *Mecistogaster* no Brasil e, segundo Garrison *et al.* (2010) e Heckman (2008), ele apresenta vários problemas taxonômicos e necessita urgentemente de uma revisão. Entre estes problemas, podem-se citar 1) a existência de mais de uma espécie em *Mecistogaster amalia* (Burmeister, 1839) e, provavelmente, também em *M. lucretia* (Drury, 1770), *M. linearis* (Fabricius, 1776) e *M. ornata* (Rambur, 1842); 2) a dificuldade de definir essas espécies e suas subespécies sem o estudo dos tipos, alguns dos quais estão desaparecidos;e 3) a possível revalidação do gênero *Platystigma* Kennedy, 1920, proposto há quase 100 anos.

Aqui, procede-se ao estudo das espécies de Pseudostigmatidae da Mata Atlântica, tendo como principais objetivos: 1) resolver os problemas taxonômicos em *Mecistogaster* e *Platystigma*; 2) descrever as novas espécies presentes nesse domínio fitogeográfico; 3) elaborar chaves taxonômicas para identificação de machos; e 4) definir a distribuição geográfica das espécies assinaladas na Mata Atlântica.. O estudo foi dividido em três partes. A primeira é relativa ao gênero *Mecistogaster*, a segunda, a *Platystigma*, e a terceira, ao comportamento de oviposição de algumas espécies dos dois gêneros, com ênfase em *Platystigma*.

Material e Métodos

Foram estudados, no total, 242 exemplares adultos de machos e fêmeas de *Mecistogaster* e *Platystigma*. A maioria do material encontra-se depositada na coleção A. B. M. Machado, das Coleções Taxonômicas da UFMG.

Os desenhos foram produzidos com câmara clara acoplada a uma lupa Leica. As características de cor do pseudostigma e da área apical das asas de *Platystigma* foram estudadas por fotografia, usando uma lupa estereomicroscópica Leica M205A, equipada com iluminação LED 5000-RL (Ring Light) que, de acordo com o fabricante (Leica Microsystems) permite a reprodução da cor real do material. Fotos tiradas com valores de baixa saturação (0.55) e alta saturação (2.7) foram obtidas e comparadas. Quando necessário, as fotos foram tratadas no Photoshop CC (2015) e todas as pranchas foram montadas neste programa.

Para o estudo do pênis pingou-se uma gota de amônia na parte ventral dos segmentos abdominais 2 e 3 para amolecimento; introduziu-se um alfinete entre as bordas laterais da vesícula seminal e os tergitos dos segmentos 2 e 3, liberando a vesícula, que foi retirada, permitindo a visualização do pênis em vista ectal. A seguir retirou-se uma seção lateral no tergito do segmento 2, o que permitiu a observação do pênis em vista lateral.

A terminologia anatômica usada para hâmulo foi modificada de Schmidt (1915) – a placa interna (internal plate) foi denominada apenas como placa (plate) e a placa externa (outer plate) como alula. Acreditamos que este termo, do latim "asa pequena", representa melhor o formato dessa estrutura em *Platystigma* e *Mecistogaster*. A indicação das estruturas da fossa genital do macho está representada na figura 2. A terminologia relativa à venação é a de Riek and Kukalová-Peck (1984), e a relativa ao segmento do pênis é a empregada por Kennedy (1916). Uma nova nomenclatura foi criada para as estruturas do pênis e apresentada na figura 3.

O comprimento do abdômen foi tomado incluindo os apêndices caudais. As medidas do comprimento do abdômen e das asas foram realizadas com paquímetro. As medidas foram apresentadas em milímetros.

Na confecção do mapa de distribuição geográfica das espécies, foram considerados, apenas, registros geográficos obtidos de exemplares das coleções e de registros fidedignos da literatura. Assim, não foi incluído no mapa o registro de *Mecistogaster ornata* para o Rio Grande do Sul (Kittel & Engels 2014), obtido a partir de uma fotografia do inseto vivo na natureza. A mancha distal amarela clara das asas deste exemplar é muito diferente da

observada em 22 exemplares de *M. ornata* da Amazônia da coleção ABMM e de algumas fêmeas jovens de *Mecistogaster* da Mata Atlântica. A identificação correta só poderia ser feita com o estudo do exemplar que, entretanto, não foi coletado.

As coordenadas geográficas, quando não mencionadas nas etiquetas dos espécimes, foram obtidas no Google Earth e, se não encontradas, procuradas no speciesLink (http://www.splink.cria.org.br/geoloc). A definição dos limites da Mata Atlântica original e de seus remanescentes foram obtidos em Scarano (2014).

As abreviaturas utilizadas para os nomes de estruturas morfológicas foram: Fw= asa anterior (forewing); Hw= asa posterior (hindwing); Px= pós-nodal (postnodal); S1–10= segmentos abdominais 1–10. Foram usadas as seguintes siglas referentes ás coleções:

ABMM – Coleção Angelo B. M. Machado, Departamento de Zoologia, Universidade Federal de Minas Gerais, Belo Horizonte, Brazil.

DZUP – Coleção Entomológica Padre Jesus Santiago Moure, Universidade Federal do Paraná, Curitiba, Brazil.

FSCA – Florida State Collection of Arthropods, Gainesville, Flórida, Estados Unidos.

FAAL – Coleção Frederico A. A. Lencioni, Jacareí, São Paulo, Brazil.

MCZ – Museum of Comparative Zoology, Universidade Harvard, Cambridge, Estados Unidos.

MNRJ – Coleção do Museu Nacional do Rio de Janeiro, Universidade Federal do Rio de Janeiro, Brazil.

NHMS – Naturhistoriska Ricksmuseet, Estocolmo, Suécia.

Part I – The damselfly genus *Mecistogaster* Rambur, 1842 in the Brazilian Atlantic Forest Domain

The damselfly genus *Mecistogaster* Rambur, 1842 in the Brazilian Atlantic Forest Domain

Introduction

Mecistogaster is one of the largest known odonates. This genus has a distinct feeding behavior, capturing spiders and their prey directly in the webs, being the only odonate that capture immobile prey (Fincke, 1984).

The type species of *Mecistogaster* Rambur, 1842 is *Agrion linearis* Fabricius, 1776, designated by Kirby (1890). Currently, the genus contains 10 species from South and Central America (Garrison *et al*. 2010), *M. amalia* (Burmeister, 1839), *M. asticta* Selys, 1860, *M. buckleyi* McLachlan, 1881, *M. jocaste* Hagen, 1869, *M. linearis* (Fabricius, 1776), *M. lucretia* (Drury, 1773), *M. martinezi* Machado, 1985, *M. modesta* Selys, 1860, *M. ornata* Rambur, 1842 and *M. pronoti* Sjöstedt, 1918. Seven of these species occur in Brazil, and only *M. amalia* and *M. linearis* have been recorded for Atlantic Forest (Lencioni 2005). The species *M. asticta*, *M. buckleyi*, *M. jocaste*, *M. martinezi* and *M. pronoti* have been transferred to *Platystigma* Kennedy, 1920 by Machado & Soldati (2017).

The characters that identify *Mecistogaster* have been provided by Selys (1860, 1886), Kennedy (1919), Münz (1919), Calvert (1911), and Heckman (2008). The best description of the genus is that of Garrison *et al* (2010). This description, however, has to be modified to exclude the characters of *Platystigma*.

Material studied

We studied 85 specimens male and female of *Mecistogaster amalia*, being one couple found in copulation. The specimens are deposited in ABMM Collection, of which 31 were loaned from MNRJ and one from DZUP. No specimens of *Mecistogaster linearis* were studied, and the diagnosis was made based on the literature.

Results

Generic characterization

A reviewed diagnosis of *Mecistogaster* follows: very large (Hw 40–64, abdomen 75–135). Apex of wings hyaline, pseudostigma present with variable shape and color. RP2 branching from RP at less than half the distance from subnodes to tip of wing. One cell row between CuA and the wing border. Quadrangle free. Tooth of tarsal claw well developed. Penis with inner fold, very large, and elaborated in some species. Segment 3 constituted by a long whip-like flagellum. Male cercus in lateral view distally bent ventrally. Male paraprocts vestigial.

Mecistogaster is a Central and South American genus. The map (Fig. 1) represents only the distribution of *Mecistogaster* in the Brazilian Atlantic Forest.

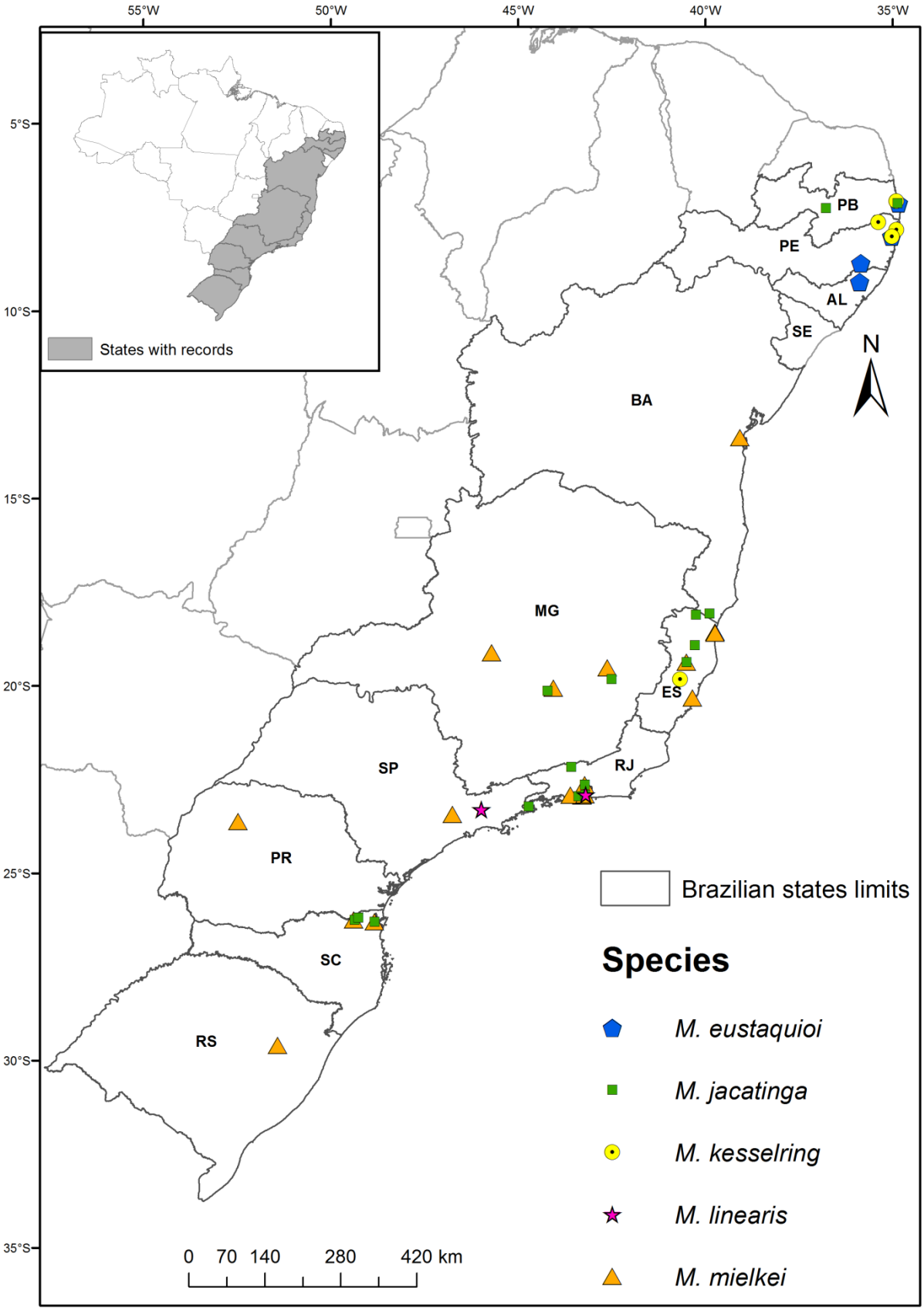

FIGURE 1. Map of species distribution of *Mecistogaster* in the Atlantic Forest. Abbreviations for Brazilian states: Paraíba (PB), Pernambuco (PE), Alagoas (AL), Bahia (BA), Minas Gerais (MG), Espírito Santo (ES), Rio de Janeiro (RJ), São Paulo (SP), Paraná (PR), Santa Catarina (SC), Rio Grande do Sul (RS).

Key to males of *Mecistogaster* recorded in the Brazilian Atlantic Forest Domain

1 Border of Hw not angulated. Cerci horizontal ……...……*M. linearis*
- Border of Hw angulated (Fig. 12). Cerci bent ventrally (not known in *M. amalia*) (Fig. 25) …… 2

2 Mesepimeron and median lobe of prothorax bronze black, thoracic venter white ……. *M. amalia*
- Mesepimeron with brownish red area (Figs. 8, 9). Median lobe of prothorax with large brownish red marking (Fig. 5). Thoracic venter with black stripes (Figs. 6-7) …… 3

3 Anterior hamule with alula (Fig. 15) ……..…… 4
- Anterior hamule without alula (Fig. 16) ……. 5

4 Mesepimeron totally brownish red (Fig. 9). Penis segment 2 in ectal view with one lateral elevation, in lateral view with contour foot-shaped ……..…….…… *M. mielkei*
- Mesepimeron with brownish-red area restricted to lower 1/5 of sclerite (Fig. 8). Penis segment 2 in ectal view with two lateral elevations, in lateral view with contour not foot-shaped ……..... *M. eustaquioi*

5 Mesepimeron totally brownish red (Fig. 9). Apex of inner fold hardly visible. Contour of segment 2 in lateral view dorsally undulated and ventrally irregular…… *M. jacatinga*
- Mesepimeron with reddish-brown area restricted to lower 1/5 of sclerite. Apex of inner fold projected ventroapically. Contour of segment 2 in lateral view dorsally and ventrally straight. ……...……...….. *M. kesselring*

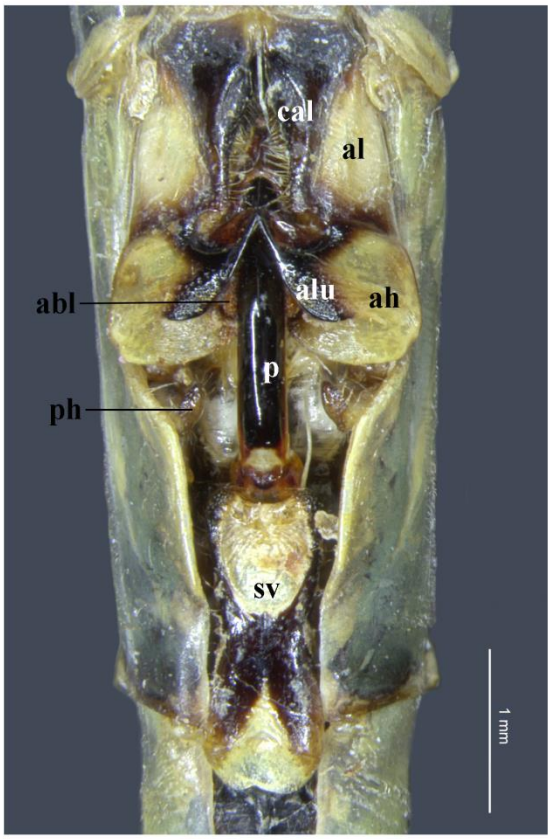

FIGURE 2. Venter of second abdominal segment of *Mecistogaster mielkei*: **abl-** arm of batilliform lamina; **ah-** anterior hamule; **al-** anterior lamina; **alu-** alula; **cal-** cleft of anterior lamina; **p-** penis segment 1; **ph-** posterior hamule; **sv-** seminal vesicle.

FIGURE 3. Penis of *Mecistogaster* (holotype *M. mielkei*) in lateral view: **aif-** apex of inner fold; **f-** flagellum; **pll**- plate-like lateral lobe; **s-** spine; **tf-** terminal fold.

***Mecistogaster amalia* (Burmeister, 1839)**

Burmeister (1839: 818); Selys (1860: 11, 1886:15, 1890: 119); Kirby (1890: 150); Calvert (1907: 354); Kennedy (1919: 112); Kennedy (1920: 85); Calvert (1948: 57); Davies & Tobin (1984: 58); Machado (1985: 36); Bridges (1994: 7–8); Vick & Chelmick, D.G. (2001: 5); Lencioni (2005: 151); von Ellenrieder & Paulson (2006); Fliedner (2006: 12); Muzón, Muñoz & Campos (2010: 138); Dalzochio *et al.* (2011: 78); Ingley *et al.* (2012: 641); Kompier (2016: 87).

Etymology: Burmeister did not inform why he chose the name *amalia*. In his study of the scientific names in Burmeister's Handbuch der Entomologie, Fliedner (2006) states that Amalia is the name of a lady that lived in the sixth century and belonged to the Austrogoths royal family. According to him, Burmeister liked to choose names from classical antiquity.

Material examined: none

Description of the holotype (original)

"Nigro-aeneun, subtus albidum; mesonoto vita lateralis alba; halis yalinis tutis, pterostigmatibus nigris postac dé latatis. Long. 5 1/3. Aus Brasilien"(Bronze black, below white; mesonotum with a white lateral stripe. Wings totally hyaline. Pterostigma black, dilated posteriorly. 5 1/3 long. From Brazil).

Remarks

The statement in the description above that the mesonotum has a white lateral stripe is no doubt an error because the mesonotum in odonates is very small with no space for a lateral stripe. Although the description is very short, it shows three important characters still used nowadays in *Mecistogaster* taxonomy: color of mesepimeron, venter and pseudostigma, as well as wing border at level of the pseudostigma dilated. These characters are enough to separate *M. amalia* from the other five species of *Mecistogaster* here reported from the Atlantic Forest.

The types of *Mecistogaster amalia*

According to Calvert (1898) and Bridges (1994) the type of Burmeister's *Agrion amalia* is in Sommer's collection at the Zoologicher Institute at Halle. On his detailed study of Burmeister's types of Odonata in Halle, Calvert (1898) stated most of the specimens were without pin-labels, standing below written labels pinned to the bottom of the drawers containing the collection. These labels had the name of the species in Burmeister handwriting and were green for the South American species. Besides this bottom label, Calvert added a pin-label with the following text: "Considered by me as Burmeister's type of *Agrion amalia* PP Calvert, May, 1896".

In order to better define the present situation of *M. amalia*'s type we asked the help of Dra. Karla Schneider, curator of the Zoological Collection at the Halle Museum. According to her (in litt) the presumed type was the only *Mecistogaster* in a drawer containing types of Burmeister and had no label. She kindly sent us several photos of this specimen. To our surprise the photos revealed that, although having the hindwing border dilated, the thorax of this specimen (Fig. 10) was very different from that of the original description. The main difference was the presence of a wide and very evident brownish-red mesepimeral area that certainly would not have escaped the attention of Burmeister. The photographed specimen has indication of a midventral black stripe present in all known species of *Mecistogaster*. These differences indicate that the photographed specimen is not the type *M. amalia*. This fact is corroborated by the absence of the labels on the specimen.

The possibility that it might be elsewhere in the museum was ruled out after a careful search made by Dra. Schneider. The possibility remained that, during the 120 years elapsed after the study by Calvert (1898), the type might have been borrowed by some odonatologist and would be in some other scientific institution. However, we verified that it is not present in the Institute Royale de Science Natural de Belgique as it was not mentioned by Selys (1860, 1886). It is present neither in the British Museum (Kimmins 1970), the Naturhistorisches Museum Wien (St. Quetin 1970), the Museum of Comparative Zoology, Harvard University (http://mczbase.mcz.harvard.edu), nor in the Museum of Zoology, University of Michigan (Garrison, von Ellenrieder & O'Brien 2003).

No types of Burmeister are mentioned by Montgomery (1969) in the following museums: Naturmuseum, Senckenberg; Muséum National d'Histoire Naturelle, Paris; Rijksmuseum van Natuurlijke Histoire, Leiden and Copenhagen Universit ets Zoologisk Museum. The type is, therefore, most probable lost, in as much that, after Calvert (1898), no

author reported having seen it. Dr. Schneider (in litt) informed that the labels of the specimen of the Halle Museum might have been lost when it was transferred to an exhibition in 1913. One cannot rule out the possibility that the holotype was also lost in that occasion.

According to the code, such situation calls for the erection of a neotype. We refrain to do it now, however, in our material there is no specimen that fits Burmeister's description, whose type locality is only Brazil.

The *Mecistogaster amalia* of Selys (1860, 1886)

The first author to redescribe *M. amalia* after Burmeister (1839) was Selys (1860, 1886), based on specimens from his own collection and that of Hagen, without seeing the holotype. Initially, Selys (1860, 1886) named the specimens as *Mecistogaster lucretia* (Drury, 1773). Later, Selys (1890) changed their identification to *M. amalia* (Burmeister, 1839), following a suggestion of Hagen (in litt) and MacLachlan (in litt).

The main characters in Selys' description are: Pseudostigma in both wings with 5-7 cells and 1-2 cells in row below, on adults black, and yellowish, dark brown on young. Apex of wings of fully adult hyaline, of semi-adult infuscated, and milky on young. Median lobe of prothorax with two large rounded reddish markings. Two yellowish humeral lines originating in opposite directions, inner one touching the anterior border, but not the sinus, and outer one touching the sinus, but not the anterior border. Mesepimeron brownish red. Lower part of thorax with a large black median stripe not surrounded by black.

According to Selys (1860, 1886), the species occur in Rio de Janeiro, São Paulo, Bahia and Minas Gerais. He quotes McLachlan as having a specimen from Peru. This description is quite different from that of Burmeister (1839) by the whole mesepimeron reddish brown, as well as similar color on the curved marking on the median lobe of the prothorax. In *M. amalia* these areas are bronze black. Another difference is the median black stripe on the venter in Selys' specimens, and white in Burmeister's description. Selys (1860, 1886) comments that the identification is very easy because of the brownish-red mesepimeron, which is black in all other *Mecistogaster*.

It is now opportune to present the reasons that led Selys and possibly also Hagen to initially identify the specimen in his collection as *Mecistogaster lucretia.* It is probable that two characters present in Drury's description (1773) of *M. lucretia* were used for this identification: the very large size and the dilatation of the border of hindwings shown in Drury's plate 48. According to Selys (1890), the reason that led him to change this position

and regard his *M. lucretia* as *M. amalia* was the fact pointed out by Hagen and McLachlan (in litt) that the dilatation of the border of the hindwing was longer and less angulated in *M. lucretia* than in his specimens.

As already mentioned, the species regarded as *M. amalia* by Selys, widely distributed in the Atlantic Forest, is quite probably not the "true" *M. amalia*. It is reasonable to assume that Selys' description (1860, 1886) of *M. amalia* and not that of Burmeister (1839) has been used by all subsequent authors. Therefore, we come to the conclusion that all identifications and records of *M. amalia* since the publication of Selys' Synopsis (1860) and revision in 1886 are wrong and possibly correspond to some of the new species described herewith. This would include the identification and records of *M. amalia* made by all authors in the reference list given in page 14 in this dissertation, except Burmeister (1839).

***Mecistogaster eustaquioi* n. sp.**

Figures 17, 18

Etymology: Named in honor of our friend, the biologist José Eustáquio Santos Júnior, who collected part of this material and has contributed with many valuable Odonata species to the ABMM Collection.

Material examined:

Holotype ♂. Brazil, Pernambuco State, São Lourenço da Mata (08° 00' S, 35° 01' W), 17.VI.1976, J. Kesselring leg. Type deposited in the ABMM Collection

4 paratypes ♂. 2♂, Brazil, Paraíba State, João Pessoa, 7.IX.1974 and 10.XI.1951, J. Kesselring leg. (ABMM); 1♂, Brazil, Pernambuco State, Jaqueira, RPPN Frei Caneca, 9.X.2012, Santos Jr. leg. (ABMM); 1♂, Brazil, Pernambuco State, Vicência, Água Azul, 04.VI.1971, J. Kesselring leg. (ABMM).

Description of the male holotype

Head. Labium yellow; labrum black; anteclypeus black with greenish markings; postclypeus black; genae yellow connected to yellow stripes in antefrons, whose middle is black (similar

to figure 4); upper part of head black with yellow stripes between lateral ocelli and base of antennae; rear of head yellow.

Thorax. Prothorax: pronotum (similar to figure 5) black with C-shaped brownish red and yellow lateral marking on median lobe connected with yellow marking on anterior lobe. Posterior lobe black with yellow spot laterally. Propleuron (similar to figure 5) black with yellow and brownish-red markings. Pterothorax: mesepisternum black with metallic dark green and metallic brown reflections along the middorsal carina. Middorsal carina black. Antehumeral yellow stripe occupying half of sclerite. Mesinfraepisternum black with brownish-red spots and mesepimeron black with brownish-red area restricted to its lower 1/5 (similar to figure 8) with yellow stripe along mesopleural suture, metapleuron black with yellow stripe along metapleural suture. Venter pale yellow with median and lateral black stripes (similar to figure 7).

Wings. Both Fw and Hw hyaline with black venation (similar to figures 11–12). Pseudostigma dark brown in Fw and Hw. Fw with 6 cells and 3 cells in row below, and Hw with 5 cells and 2 cells in row below. Border of Hw with elevation at level of pseudostigma (similar to figure 12). Venation: Px in Fw 41, in Hw 37. RP2 in Fw arising before level of Px 16, in Hw before Px 12. IR1 arising at Px 27 in Fw, at Px 20 in Hw. RP2 in both wings branching from RP at less than half distance from subnode to tip of wing. Petiolation in Fw originated at level of CuP, in Hw distal to CuP by same length of CuP.

Legs. Femora flexural and extensor surface black. Tibiae flexural surface yellow, extensor surface black. Tarsi black.

Abdomen. S1–S10 dorsally black with metallic blue reflections, S1–S7 laterally yellow, S8–S10 with yellow markings laterally. Cercus black externally and internally.

Structural characters

Hind prothoracic lobe rounded laterally and slightly concave in the middle of hind border (similar to figure 5). Supplementary tooth of tarsal claw developed. Cleft of anterior lamina shaped as ogival gothic arch. Anterior hamuli with alula (Fig. 15) and its hind border straight with incisure. Arm of batilliform lamina visible (Fig. 15). Posterior hamuli curved antero-

medially. Penis segment 3 constituted by a flagellum disposed vertically with a single anterior curvature. Segment 2 in ectal view (Fig. 17) with two pairs of lateral elevations: terminal fold anteriorly and the plate-like lateral lobe posteriorly. Inner fold very complex with an anterior cavity limited posteriorly by a transverse septum. At each side of the inner fold there is large sclerotized spine partly covering the inner fold. The two spines have at apex a small group of hairs. The spine and its attached inner fold project distally forming an angle with the base of terminal fold. In lateral view (Fig. 18), the plate-like lateral lobe appears in its full extension continuous posteriorly with the terminal fold that forms a hood around flagellum base. Hind border of S10 in dorsal view with median concavity (similar to figure 25). Cercus in lateral view horizontal, and distally, bent ventrally (similar to figure 26). Vertical portion of cercus slightly elevated, not forming 90 degrees with horizontal portion (similar to figure 26). Cercus in dorsal view convergent distally (similar to figure 25).

Measurements (mm): Hw 57.8, abdomen 116.1

Variation in paratypes

Anteclypeus yellowish. Yellow lateral marking on median lobe not connected with a yellow marking on anterior lobe. Posterior lobe of prothorax marginated with yellow and its border concave. Mesepimeron with its lower ¼ reddish brown. Antehumeral yellow stripe occupying more than half of sclerite. Antehumeral stripe and stripes along mesopleural e metapleurol suture pale yellow. Pseudostigma of both wings yellow with dark brown venation. Number of cells of pseudostigma varies in Fw from 6 to 7 and 2 cells in row below; in Hw from 5 to 6 cells and 2 cells in row below. S8–S10 with lateral brown markings. Cercus brown externally and internally.

Measurement (mm), n= 2: Hw 55 and 58.3, abdomen 114.8 and 119.4

Female: Not identifiable.

Remarks

M. eustaquioi shares with *M. mielkei* the anterior hamule with alula. It differs from this species by having the mesepimeron with brownish-red area restricted to the lower 1/5 of

sclerite, and penis segment 2 in ectal view with two lateral elevations and in lateral view with contour not foot-shaped. Unlike *M. mielkei*, *M. eustaquioi*, it has a small distribution confined to the states of Paraiba, Pernambuco and Alagoas.

***Mecistogaster jacatinga* n. sp.**

Figure 5, 19, 20

Etymology: Jacatinga is the first popular name of a dragonfly in Brazil registered by Marcgrave.

Material examined:

Holotype ♂. Brazil, Santa Catarina State (27° 14' S, 50° 13' W), IV.1976. Type deposited in the ABMM Collection.

24 paratypes ♂ (ABMM). 5 ♂, Brazil, Santa Catarina State, Joinville, 1980, XI.1980, 13.XII.1981, 20.II.1985, 10.III.1985, Miers leg. (ABMM); 1♂, Brazil, Santa Catarina State, Campo Alegre, 24.III.1985; 1♂, Brazil, Santa Catarina State, São Bento do Sul, 6.III.1985; 1♂, Brazil, Rio de Janeiro, 21.IV.1971; 1♂, Brazil, Rio de Janeiro, Jacarepaguá, Represa dos Ciganos, 1.V.1963, Berla leg. (MNRJ); 1♂, Brazil, Rio de Janeiro, Jacarepaguá , Represa dos Ciganos, 30.V.1965, N. Santos leg. (ABMM); 1♂, Brazil, Rio de Janeiro, Covanca de Jacarepaguá, 28.IV.1963, Mielke col. (ABMM); 1♂, Brazil, Rio de Janeiro, Represa da Covanca, Jacarepaguá, 2.V.1963, Berla leg. (MNRJ); 1♂, Brazil, Rio de Janeiro State, Duque de Caxias, Imbariê, 30.II.1964, Ebert leg.(ABMM); 2♂, Brazil, Rio de Janeiro State, Paraty, Pedra Branca, XII.1944 (same for both), O. Silva leg. (ABMM);1♂, Brazil, Rio de Janeiro State, Fazenda União, 13.IV.1989, Brown leg. (ABMM); 2♂, Brazil, Espírito Santo State, Colatina, VIII-IX.1937, X.1936, M. Rosa leg. (MNRJ); 1♂, Brazil, Espírito Santo State, 2 Km N. São Sebastião, 17.XII.1987, Brown leg. (ABMM).; 1♂, Brazil, Espírito Santo State, Serra W de São João de Petrópolis, 22.IV.1988, Brown leg.; 1♂, Brazil, Minas Gerais State, Brumadinho, Inhotim, 20.III.2013, Karina leg. (ABMM), 1♂, Brazil, Bahia State, Mucuri, II.1974, Elias col. (MNRJ); 1♂, Brazil, Paraíba State, João Pessoa, X.1980, J. Kesselring leg. (ABMM); 1♂, Brazil, Paraíba State, 27.IV.1952; J.Kesselring leg. (ABMM).

4 additional ♂. 1♂, Brazil, Pernambuco State, Timbaúba, Água Azul, 15.X.1988, J. Kesselring leg. (ABMM); 1♂, Brazil, Espírito Santo State, Linhares, III.1978, Elias leg.; 1♂, Brazil, Rio de Janeiro, Jacarepaguá, Três Rios, 14.IV.1935, d'Almeida leg. (MNRJ); 1♂, Minas Gerais State, Matipó, IX.19??, O. Fonseca leg. (ABMM).

Description of the male holotype

Head. Labium light-brown; labrum black; anteclypeus brown; postclypeus black; genae light-brown with brown markings; antefrons black with brown spots; upper part of head black with brown stripes between lateral ocelli and base of antennae; rear of head pale yellow.

Thorax. Prothorax: pronotum (Fig. 5) black with C-shaped brownish red and yellow lateral marking on median lobe connected with yellow marking on anterior lobe. Posterior lobe black with yellow spot laterally. Propleuron (Fig. 5) black with yellow and brownish-red markings. Pterothorax: mesepisternum black with metallic dark green reflection. Middorsal carina black. Antehumeral yellow stripe occupying more than half of sclerite. Mesinfraepisternum black with brownish-red spots and mesepimeron brownish red (similar to figure 9) with yellow stripe along mesopleural suture, metapleuron yellow with black stripe along metapleural suture. Venter pale yellow with median black stripe (Fig. 6).

Wings. Both Fw and Hw hyaline with black venation (similar to figures 10–11). Pseudostigma in both wings black. Fw with 7 cells and 4 cells in row below, and Hw with 5 cells and 2 cells in row below. Border of Hw with elevation at level of pseudostigma (similar to figure 12). Venation: Px in Fw 43, in Hw 41. RP2 in Fw arising at level of Px 13, in Hw before Px 11. IR1 arising near Px 22 in Fw, at Px 18 in Hw. RP2 in both wings branching from RP at less than half distance from subnode to tip of wing. Petiolation in Fw and Hw originated at level of CuP.

Legs. Femora flexural surface yellow, extensor surface brown. Tibiae flexural surface brown. Tarsi black.

Abdomen. S1–S9 dorsally metallic dark blue and laterally yellow. S10 dorsally black in the base and V-shaped posteriorly, achieving medially the margin; remaining S10 yellow. Cercus mostly yellow externally and black internally.

Structural characters

Hind prothoracic lobe rounded laterally and slightly concave at the middle of hind border (Fig. 5). Supplementary tooth of tarsal claw developed. Cleft of anterior lamina shaped as ogival gothic arch. Anterior hamuli without alula (Fig. 16). Arms of batilliform lamina not visible. Posterior hamuli curved antero-medially. Penis segment 3 constituted by a flagellum. In ectal view (Fig. 19), inner fold very complex with a pair of large sclerotized spines with tuft of hairs apically. The spines delimitate a rectangular depression, the fossa of the inner fold. The terminal fold projects laterally to the spines in ectal view, and the anterior part of the plate-like lateral lobe is connected with inner fold overpassing the spine. In lateral view (Fig. 20), the plate-like lateral lobe appears in its full extension continuous posteriorly with terminal fold. The apex of inner fold hardly visible. The contour of segment 2 in lateral view has the dorsal contour undulated and the ventral contour irregular. Hind border of S10 in dorsal view with median concavity (similar to figure 25). Cercus in lateral view horizontal, and distally, bent ventrally (similar to figure 26). Vertical portion of cercus slightly elevated, not forming 90 degrees with horizontal portion (similar to figure 26). Cercus in dorsal view convergent distally (similar to figure 25).

Measurements (mm): Hw 63.5, abdomen 129.5.

Variation in paratypes

Hind prothoracic lobe with border straight. Pronotum black with metallic dark green reflections, with or without brown stripes parallel to middorsal carina. Antehumeral stripe occupying less than half of sclerite. Mesepimeron reddish brown. Cercus externally dark brown, or anteriorly yellow and distally black; mostly yellow, brown or black internally. Pseudostigma and venation yellow with some cells brown in Fw (ventral face), or cells and venation light-brown to brown in Fw, or cells yellow to light-brown with black venation in Hw. Number of cells of pseudostigma varies in Fw from 5 to 11 and from 2 to 6 in row below; in Hw from 4 to 8 and 2 to 4 in row below. In one specimen, the pseudostigma in one of Hw is less angulated.

Measurement (mm), n= 15: Hw 56.3–66.7, abdomen 91.5–133.6

Female: Not identifiable.

Remarks

M. jacatinga shares with *M. kesselring* the anterior hamule without alula. It differs from this species by having the mesepimeron brownish red, and contour of segment 2 in lateral view dorsally undulated and ventrally irregular. It extends along the Atlantic Forest from the states of Paraiba to Santa Catarina with an interruption between Pernambuco and Southern Bahia (Fig. 1).

***Mecistogaster kesselring* n. sp.**
Figures 11, 12, 13, 14, 21, 22, 27, 28, 29

Etymology: Kesselring, noun in apposition. Named after the lepidopterologist Jorge Kesselring, who collected a great part of the specimens studied herewith.

Material examined:

Holotype ♂. Brazil, Paraíba State, João Pessoa (07° 07' S, 34° 50' W), 12.X.1974, J. Kesselring leg. Allotype ♀. Brazil, Paraíba State, Santa Rita, Gargaú (07° 03' 01" S, 34° 54' 00" W), IX.1951, J. Kesselring leg. (ABMM). Holotype and allotype deposited in the ABMM Collection.

5 paratypes ♂. 1♂, Brazil, Espírito Santo State, Colatina, VIII–IX.1937, M. Rosa leg. (MNRJ); 1♂, Brazil, Pernambuco State, Igarassu (07° 49' S, 34° 54' W), Usina S. José, 24.V.1945, Berla leg. (MNRJ); 1♂, Brazil, Paraíba State, João Pessoa, X.1974; 1♂, Brazil, Paraíba State, João Pessoa (07° 07' S, 34° 50' W), Mata do Buraquinho, ix.1975, Machado & Kesselring leg. (ABMM); 1♂, Brazil, Pernambuco State, São Lourenço da Mata (08° 00' S, 35° 01' W), 30.VI.1975, J. kesselring leg. (ABMM).

4 additional ♂. 1♂, Brazil, Espírito Santo State, Colatina, VIII–IX.1937, M. Rosa leg. (MNRJ); 1♂, Brazil, Paraíba State, João Pessoa, Mata do Gargaú, ix.1975, J. Kesselring leg. (ABMM); 1♂, Brazil, Pernambuco State, Igarassu, Usina S. José,12.III.1945, Berla leg.

(MNRJ); 1♂, Brazil, Pernambuco State, Timbaúba, Água Azul, 15.X.1988, J. Kesselring (ABMM).

3 paratypes ♀. 1♀, Brazil, Paraíba State, Jõao Pessoa, 10.XI.1974, J. Kesselring leg. (ABMM); 1♀, Brazil, Bahia State, Simões Filho, 15.XI.1984, Unidade Ecológica do Campo Industrial de Aratú, Machado, Smith & Raw leg. (ABMM); 1♀, Brazil, Pernambuco State, Timbaúba, Água Azul, II.1989, Kesselring & Brown leg (ABMM).

The additional specimens were not designated as paratype because they are very damaged or missing taxonomically important structures.

Description of the male holotype

Head. Labium yellow; labrum black; anteclypeus dark brown; postclypeus black; genae pale yellow connected to pale yellow stripes in antefrons, whose remaining is black; upper part of head black with dark brown stripes between lateral ocelli and base of antennae; rear of head yellow.

Thorax. Prothorax: pronotum (similar to figure 5) black, with C-shaped brownish red and pale lateral markings on median lobe. Anterior and posterior lobes black with yellow spot laterally. Propleuron (similar to figure 5) black, with pale yellow and brownish-red markings. Pterothorax: mesepisternum black. Middorsal carina black. Antehumeral brownish yellow stripe occupying less than half of sclerite. Mesinfraepisternum black with brownish-red spots and mesepimeron black with reddish-brown area restricted to its lower 1/5 (Fig. 8) with brownish-yellow stripe along mesopleural suture and yellow marking posteriorly on sclerite, metapleuron black with brownish-yellow stripe along metapleural suture. Venter pale yellow with median and lateral black stripes (Fig. 7).

Wings. Both Fw and Hw hyaline with black venation (Figs. 10–11). Pseudostigma black in Fw and Hw. Fw with 8 cells and 2 cells in row below, and Hw with 7 cells and 2 cells in row below. Border of Hw with elevation at level of pseudostigma. Venation: Px in Fw 38, in Hw 34. RP2 in Fw arising at Px 16, in Hw before Px 12. IR1 arising at Px 26 in Fw, at Px 22 in Hw. RP2 in both wings branching from RP at less than half distance from subnode to tip of wing. Petiolation in Fw and Hw originated at level of CuP.

Legs. Femora flexural surface dark brown and extensor surface black. Tibiae flexural surface yellow. Tarsi black.

Abdomen. S1–S9 dorsally metallic dark blue, S1–S7 with laterally yellow stripe, S8–S9 with laterally brown stripe. S10 black with brownish yellow markings laterally and ventrally. Cercus black externally, and internally black with pruinosity.

Structural characters

Hind prothoracic lobe rounded laterally and straight at hind border. Supplementary tooth of tarsal claw well developed. Cleft of anterior lamina shaped as ogival gothic arch. Anterior hamuli without alula (Fig. 16). Arms of batilliform lamina not visible. Posterior hamuli curved antero-medially. Penis segment 3 constituted by a flagellum disposed vertically with an anterior and a posterior curvature. In ectal view (Fig. 21), inner fold very complex with a pair of large sclerotized spines with agglomerated hairs apically. The spines delimitate subrectangular depression, the fossa of inner fold. Terminal fold projects laterally to the spines. In lateral view (Fig. 22), the plate-like lateral lobe appears in its full extension continuous posteriorly with terminal fold. The apex of inner fold is projected ventroapically. The contour of segment 2 is dorsally and ventrally straight. Hind border of S10 in dorsal view with median concavity (similar to figure 25). Cercus in lateral view horizontal, and distally, bent ventrally (similar to figure 26). Vertical portion of cercus slightly elevated, not forming 90 degrees with horizontal portion (similar to figure 26). Cercus in dorsal view convergent distally (similar to figure 25).

Measurement (mm): Hw 58, abdomen 117.8

Variation in paratypes

Posterior lobe of prothorax marginated with yellow and slightly concave at the middle. Mesepisternum black with metallic dark green reflections along the middorsal carina; antehumeral stripe yellow, occupying a litlle more than half of sclerite. Venter without lateral black stripe (15% of specimens studied). Pseudostigma of both wings dark brown or Hw brown and Fw black. Number of cells of pseudostigma varies in Fw from 6 to 8 and 2 to 3 in row below; in Hw from 5 to 7 and 2 in row below. S1–S6 with laterally yellow stripe, S7–S8

with laterally brown stripe, S8 and/or S9 with yellow spots laterally, S10 totally black or dorsally black in the base and V-shaped posteriorly, achieving medially the margin; remaining S10 yellow. Cercus mostly yellow externally and black internally or mostly dark brown externally and internally.

Measurement (mm), n= 7: Hw 52–58.2, abdomen 115.5–122.

Description of female allotype

Head, pronotum, pterothorax, pleuron, venter and legs with colors similar to those of the holotype. Hind prothoracic lobe with hind border straight.Wings hyaline with pseudostigma light-brown and dark brown venation (Figs.13–14), with 6 cells in both wings. Border of Hw with no elevation (Fig. 14). Abdomen S1–S7 dorsally black, laterally yellow. S8–S10 black with incomplete lateral yellow stripe on S8. Cercus black, conical, slightly shorter than S10. Cercus in dorsal view slightly divaricated (Fig. 27). Ovipositor black.

Structural characters

Hind prothoracic lobe with border straight. Epiproct (Fig. 28) very elaborated, shaped with large base and a much narrow apex. Surface longitudinally striated posteriorly with small transverse elevation in the middle and longitudinal cleft anteriorly. Laterally with a pair of elliptical yellow body and distolaterally with another yellow body medially excavated. Ovipositor (Fig. 29) reaching about the level of S10 border. Lateral valve with row of spines, the distal one larger and curved preceeded by 9 spines of equal size and more proximally by small tubercles extended to the surface of the valve.

Measurements (mm). Hw 60.8, abdomen 94.6

Variation in paratypes

Border of hind prothoracic lobe slightly concave. Pseudostigma light-yellow with black venation in both wings. Number of cells of pseudostigma varies from 6 to 7 in Fw, and from 5 to 6 in Hw. S1–S6 dorsally metallic dark blue to purple or S1 metallic green and S2–S6 metallic blue, S7–S8 with light-brown stripe laterally, S9 with light-brown marking laterally,

S10 black. Cercus slightly longer than S10 in dorsal view, and parallel. Valve with five distal spines of equal size, with distal third spine smaller. Two paratypes have missing cerci. In paratypes the structure of epiproct surface are less clearly distinct.

Measurement (mm), n=2: Hw 53.2–60, abdomen 83.4–98

Remarks

M. kesselring shares with *M. jacatinga* the anterior hamule without alula. It differs from this species by having the mesepimeron brownish red restricted to the lower 1/5 of sclerite, segment 2 in lateral view with apex of inner fold directed ventroapically and with contour dorsally and ventrally straight. It occupies the Atlantic Forest of the states of Paraiba, Pernambuco and Espírito Santo. In Northeastern Brazil it is sympatric with *M. eustaquioi* and *M. jacatinga* and in Espírito Santo besides being sympatric with *M. jacatinga* it is also sympatric with *M. mielkei* (Fig. 1).

***Mecistogaster mielkei* n. sp.**
Figures 9, 23, 24, 25, 26

Etymology: Named in honor of our good friend Prof. Olaf H. H. Mielke, who collected part of this material and has contributed with many valuable Odonata species to ABMM Collection.

Material examined:

Holotype ♂. Brazil, Santa Catarina State, Joinville (26° 18' S, 48° 50' W), 6.III.1979, Miers leg. Type deposited in the ABMM Collection.

32 paratypes ♂. 1♂ (teneral), Brazil, Bahia State, Valença, 9.XII.1986, Mata da Viúva, L. F. Netto leg. (ABMM); 1♂, Brazil, Minas Gerais State, Coronel Fabriciano, Parque Estadual do Rio Doce, IV.1959, Machado leg. (ABMM); 1♂, Brazil, Minas Gerais State, Ibirité, Parque Estadual da Serra do Rola-Moça, Taboões, IV.1979, Machado leg. (ABMM); 1♂, Brazil, São Paulo State, Morro do Jaraguá, 26.III.1961, Vulcano leg. (ABMM); 2♂, Brazil, Rio de

Janeiro State, Duque de Caxias, Imbariê, 22.II.1965, 10.II.1966, Ebert leg. (MNRJ); 1♂, Brazil, Rio de Janeiro, Jacarepaguá, Represa dos Ciganos, 1.V.1963, N. Santos leg.(MNRJ); 1♂, Brazil, Rio de Janeiro, Represa do Camorim, 22.III.1964, N. Santos, Ipiranga & Borges leg. (MNRJ); 16♂, Brazil, Espírito Santo State, Conceição da Barra, 13.IV.1968, 13-18.V.1968, 28-31.X.1968 (14 specimens), Paulo Elias leg. (MNRJ); 1♂, Brazil, Espírito Santo State, Vitória, IX.1937, M. Leitão leg. (MNRJ); 1♂ (teneral), Brazil, Espírito Santo State, Conceição da Barra, Córrego do Agelim,16.X.1968, Paulo Elias leg. (MNRJ);1♂ (teneral), Brazil, Espírito Santo State, Linhares, IV.1974, Elias & Paulo leg. (DZUP); 1♂, Brazil, Santa Catarina State, Joinville, 14.XI. 1980, Miers leg. (ABMM); 1♂ (teneral), Brazil, Santa Catarina State, Joinville, 15.XI.1979, Miers leg. (ABMM); 1♂, Brazil, Santa Catarina State, São Bento do Sul, 22.III.1982, Miers, leg. (ABMM); 1♂, Brazil, Paraná State, Jussara, 12.XII.1975, Mielke leg. (ABMM); 1♂, Brazil, Rio Grande do Sul State, Pareci Novo, I.1938, P. Buck leg. (ABMM).

4 additional ♂. 1♂, Brazil, Minas Gerais State, Fazenda do Cedro, 27.I.1959; 1♂, Brazil, Espírito Santo State, Linhares, Sooretama, X.1962, Vulcano leg. (ABMM); 1♂, Brazil, Rio de Janeiro, Covanca de Jacarepaguá, 5.I.1963, Mielke leg. (ABMM); 1♂, Brazil, Santa Catarina State, Joinville, 3.II.1980, Miers leg. (ABMM).

The additional specimens were not designed as paratype because they are very damaged or lacking taxonomically important structures.

Description of the male holotype

Head. Labium yellow; labrum black; anteclypeus yellowish; postclypeus black; genae yellow connected to yellow stripes in antefrons, whose middle is black (Fig. 4); upper part of head black with yellow stripes between lateral ocelli and paraocular; rear of head yellow.

Thorax. Prothorax: pronotum (similar to figure 5) black with C-shaped brownish red and yellow lateral marking on median lobe connected with yellow marking on anterior lobe. Posterior lobe black with yellow spot laterally and marginated with yellow. Propleuron (similar to figure 5) black with brownish-red and yellow markings. Pterothorax: mesepisternum black with metallic dark green and metallic brown reflections along the middorsal carina. Middorsal carina black. Antehumeral yellow stripe occupying more than

half of sclerite. Mesinfraepisternum black with brownish-red spots and mesepimeron totally brownish red (Fig. 9) with yellow stripe along mesopleural suture, metapleuron black with yellow stripe along metapleural suture. Venter pale yellow with median black stripe (similar to figure 6).

Wings. Both Fw and Hw hyaline with black venation (similar to figures 11–12). Pseudostigma black dorsally and brown and yellow ventrally in Fw, and brown in both sides of Hw. Fw with 7 cells and 5 cells in row below, and Hw with 7 cells and 3 cells in row below. Border of Hw with elevation at level of pseudostigma (similar to figure 12). Venation: Px in Fw 46, in Hw 41. RP2 in Fw arising before level of Px 16, in Hw before Px 11. IR1 arising at Px 26 in Fw, at Px 19 in Hw. RP2 in both wings branching from RP at less than half distance from subnode to tip of wing. Petiolation in Fw originated at level of CuP, in Hw distal to CuP by same length of CuP.

Legs. Femora flexural and extensor surface dark brown with yellow markings. Tibiae flexural surface yellow, extensor surface black. Tarsi black.

Abdomen. S1–S3 dorsally black with metallic blue reflections, laterally yellow, S4–S7 dorsally and laterally dark brown with metallic blue reflections, S8–S9 dorsally black with metallic green reflection and yellow markings laterally. S10 black in the base and V-shaped dorsally, reaching medially the border; remaining S10 yellow. Cercus mostly yellow externally and mostly brown internally.

Structural characters

Hind prothoracic lobe rounded laterally and straight in hind border. Supplementary tooth of tarsal claw developed. Cleft of anterior lamina shaped as an ogival gothic arch. Anterior hamuli with alula (Fig. 15) and its hind border convex. Arm of batilliform lamina visible (Fig. 15). Posterior hamuli curved anteromedially. Penis segment 3 constituted by a flagellum. Segment 2 in ectal view (Fig. 23) with a pair of lateral elevation corresponding to the terminal fold. Inner fold very complex with a pair of large sclerotized spines that delimitates a subquadrate depression, the fossa of inner fold. In lateral view (Fig. 24), the plate-like lateral lobe appears in its full extension continuous posteriorly with terminal fold. The spine is parallel to the base of the flagellum. The apex of the inner fold is projected ventrodistally. The

contour of segment 2 in lateral view looks like a foot in which the apex of the inner fold is the hallux. Hind border of S10 in dorsal view with median concavity (Fig. 25). Cercus in lateral view horizontal, and distally, bent ventrally (Fig. 26). Vertical portion of cercus slightly elevated, not forming 90 degrees with horizontal portion (Fig. 26). Cercus in dorsal view convergent distally (Fig. 25).

Measurements (mm): Hw 63, abdomen 122.7

Variation in paratypes

Teneral paratypes present the posterior lobe of prothorax brownish with its hind border black or yellow; mesepisternum, mesinfraepisternum and mesepimeron brownish with or without yellow stripes; venter with lateral black stripes (8% of specimens studied); pseudostigma whitish yellow or yellow to light-brown, its venation whitish yellow or yellow to dark brown; cercus black or mostly yellow externally and internally. Adults paratypes present yellow stripes on antefrons connected in the middle. Mesepimeron reddish brown. Besides hind border of anterior hamuli be convex, it can be almost straight or with very slight incisure. Pseudostigma of both wings light-brown, with brown to black venation, or pseudostigma in ventral face of Fw yellow, or pseudostigma yellow with black venation in both sides of Hw. Number of cells of pseudostigma varies in Fw from 7 to 10 and 2 to 4 in row below; in Hw from 5 to 10 and 2 to 4 in row below. Cercus mostly brown externally and internally.

Measurement (mm), n= 25: Hw 52–67.8, abdomen 109.5–128.6

Female: Not identifiable.

Remarks

M. mielkei shares with *M. eustaquioi* the anterior hamule with alula. It differs from this species by having the mesepimeron totally brownish red, penis segment 2 in ectal view with one lateral elevation and in lateral view with contour foot-shaped. *M. mielkei* is the species of *Mecistogaster* of the Atlantic Forest with larger distribution, occupying the Brazilian Atlantic Forest from Bahia to Rio Grande do Sul (Fig. 1), and it is sympatric with *M. jacatinga* and *M. kesselring* at Espírito Santo State and with *M. linearis* and *M. jacatinga* at Rio de Janeiro.

***Mecistogaster linearis* (Fabricius, 1776)**

Selys (1860: 16, 1886: 23); Kirby (1890: 150); Kennedy (1919: 112); Fraser (1946: 462); Calvert (1948: 55); Davies & Tobin (1984: 54); Tsuda (2000: 57); Hedström & Sahlén (2001: 1045); Lencioni (2005: 154); Heckman (2008: 210); Garrison, von Ellenrieder & Louton (2010: 391); Ingley *et al.* (2012: 643); Dijkstra *et al.* (2014: 76); De Marmels (2015: 8); Rodrigues *et al.* (2016: 212).

Syn. *fililigera* Rambur, 1842
Syn. *flavistigma* Rambur, 1842

Diagnosis

Very large species (♂ abdomen 100-125, Hw 49-60). Color black, ventrally pale yellow. Face dark brown. Pterothorax with two humeral yellow stripes originating in opposite sides, the anterior reaching the anterior border but not the sinus, the posterior reaching the sinus but not the anterior border. Venter surrounded by black with a median black stripe. Hw with anterior border not angulated at level of pseudostigma. Pseudostigma in mature specimen black, extending to the cell row below it. S10 slightly elevated and excavated. Cercus in dorsal view spatulated and horizontal.

Remarks

The diagnosis above was based in Selys (1860, 1886) according to whom the male specimens agree with the specimen in collection Banks of British Museum, believed to be labeled by Fabricius. According to Calvert (1948) this male is the lectotype of *M. linearis*. Also, Bridges (1994) regards this specimen as the type of Fabricius *M. linearis*. *M. linearis* has a very large distribution that according to Tsuda (2000) and Rodrigues *et al.* (2016) comprises Bolivia, Brazil, Colombia, Ecuador, Peru and Venezuela. Its updated distribution in Brazil is shown in the map of Rodrigues *et al.* (2016) and involves all Amazonian States, Rio de Janeiro and São Paulo. The record in São Paulo (Jacareí) was obtained by Lencioni (2005) and is represented in the map (Fig. 1). The record for Rio de Janeiro was obtained by Janira Costa (in litt).

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FIGURES 4–7. Head in frontal view (4): *M. mielkei*, Rio de Janeiro; prothorax in dorsal view (5): holotype *M. jacatinga*; venter without lateral black stripes (6): *M. jacatinga*, Joinville, Santa Catarina; venter with lateral black stripes (7): *M. kesselring*, João Pessoa, Paraíba.

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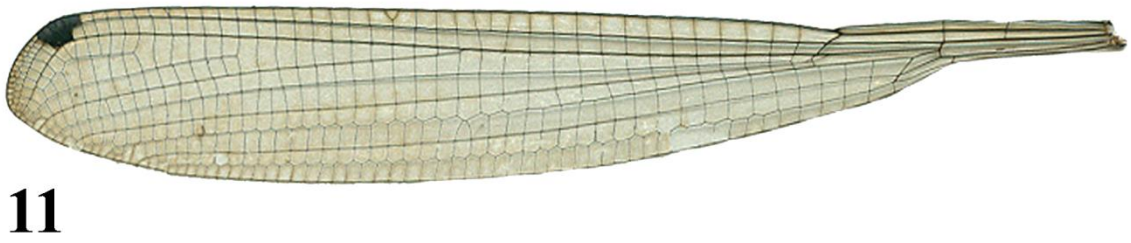
FIGURES 8–10. Pterothorax in lateral view: with reddish-brown area in mesepimeron restricted to its lower 1/5 (8): *M. kesselring*, São Lourenço da Mata, Pernambuco; with mesepimeron totally brownish red (9): holotype *M. mielkei*; presumed type of *M. amalia* in Halle Museum (10).



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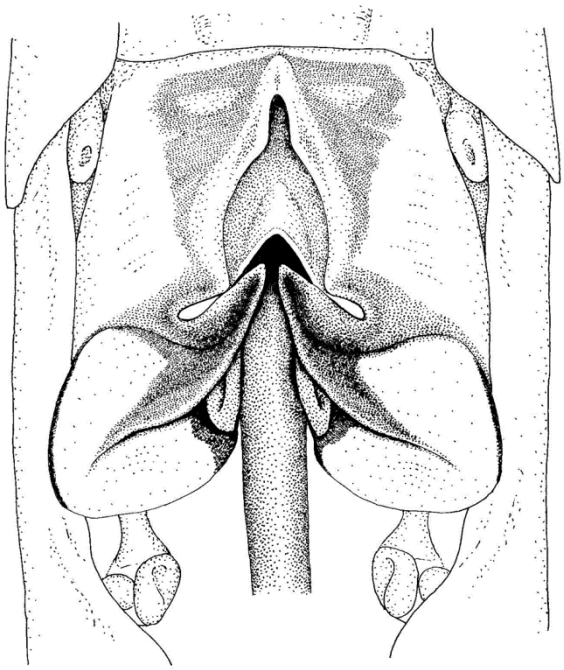
FIGURES 11–14. Wings in *M. kesselring*. Male holotype: Fw (11), Hw (12); female: João Pessoa, Paraíba, Fw (13), Hw (14).



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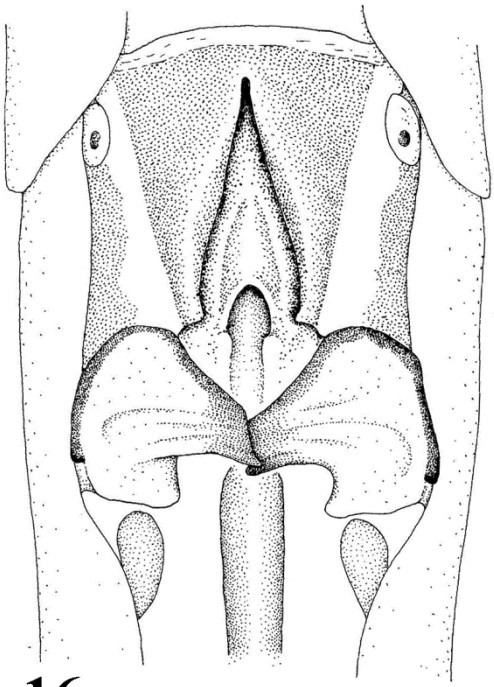

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FIGURES 15–16. Genitalia of second segment: anterior hamuli with alula (15), anterior hamuli without alula (16).

FIGURES 17–20. Penis in ectal (17) and lateral (18) views (part of flagellum cut to fit the image): holotype *M. eustaquioi*; penis in ectal (19) and lateral (20) views, with flagellum broken: *M. jacatinga*, Paraty, Rio de Janeiro.

FIGURES 21–24. Penis in ectal (21) and lateral (22) views (part of flagellum cut to fit the image): *M.kesselring*, João Pessoa, Paraíba; penis in ectal (23) and lateral (24) views (part of flagellum cut to fit the image): *M.mielkei*, Conceição da Barra, Espírito Santo.

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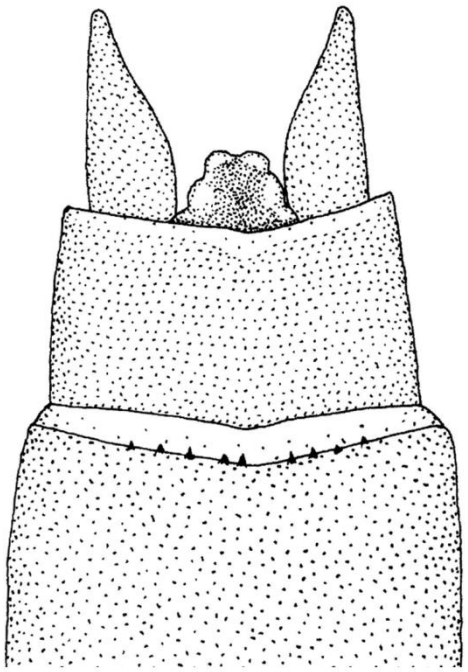
FIGURES 25–26. Male cercus in dorsal (25) and lateral (26) views: holotype *M. mielkei*.



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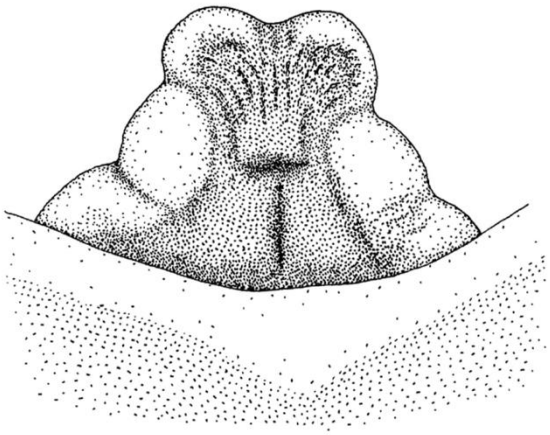

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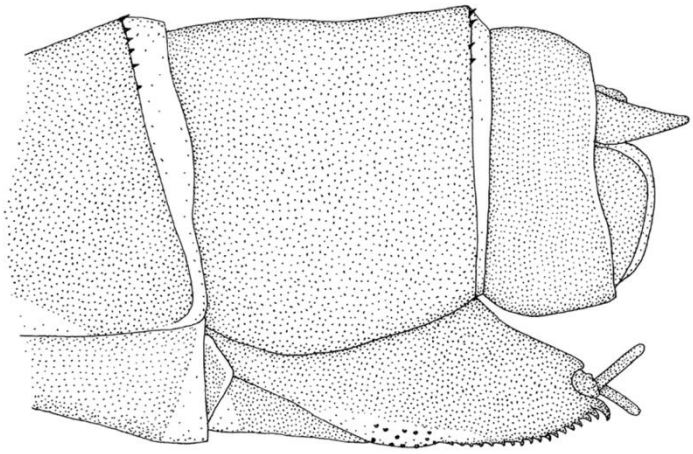

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FIGURES 27–29. Female allotype of *M. kesselring*: Cercus in dorsal view (27), epiproct in dorsal view (28), S9–S10 showing ovipositor in lateral view (29).

Part II – The damselfly genus *Platystigma* Kennedy, 1920 in the Brazilian Atlantic Forest Domain

The damselfly genus *Platystigma* Kennedy, 1920 in the Brazilian Atlantic Forest Domain

Introduction

Platystigma is a genus of Pseudostigmatidae created by Kennedy (1920) in a paper in which he describes three more genera of this family: *Goniostigma*, *Haplostigma* and *Xanthostigma*. These new genera were regarded as subgenera by Davies & Tobin (1984) and synonimized with *Mecistogaster* by Garrison *et al*. (2010). It is a monotypic genus that has as type species *Mecistogaster jocaste* Hagen, 1869, as designated by Kennedy (1920). Unfortunately, this species is poorly known.

The description of Hagen (1869) was based in a single male specimen from Bogotá, Colombia, deposited in the Museum of Comparative Zoology, Harvard University. It has no illustration, and its main diagnostic character is the hindwing with apex whitish yellow, preceded by a dark brown band. According to Hagen (1869) the species is notable for the color of the hindwing and was regarded by him as very beautiful. In spite of that, the species remained difficult to identify with certainty by lack of published drawings of the holotype's penis.

Material studied

We studied eight specimens male and female of *Mecistogaster asticta* and the type species female of *Mecistogaster pronoti*. The specimens are deposited in ABMM Collection, four borrowed from the MNRJ, one from the FAAL and the type of *M. pronoti* from the NHMS.

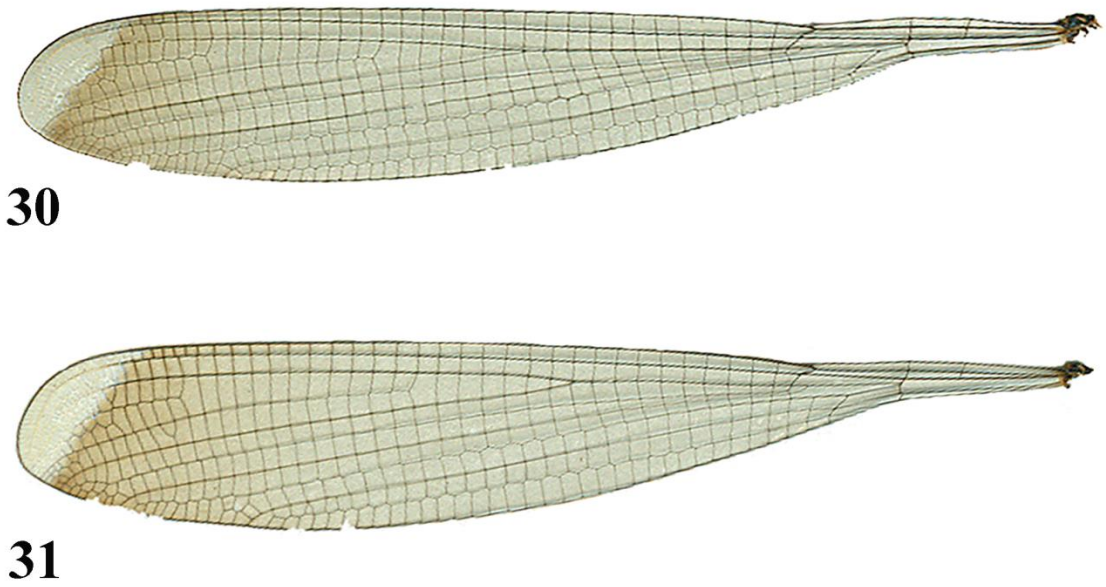
Results

We had access to the unpublished manuscript of Kennedy's PhD thesis (1919) that has two drawings of the holotype penis made by himself. In the figure explanation Kennedy (1919) wrote: "*Platystigma jocaste* (Hagen.); genotype. St. Fe de Bogota, Colombia, in coll. Hagen, M. C. Z." Therefore, the penis illustrated by Kennedy (1919) is that of the holotype of *P. jocaste*, and that illustrated by Garrison *et al.* (2010) as *M. jocaste* is actually a new species. The morphological organization of this penis is completely different from that of *Mecistogaster* and from the other four recognized genera of Pseudostigmatidae.

Generic characterization

Kennedy (1920) characterized the genus *Platystigma* as follows: "Penis with a broad, toothed terminal segment. Dense black part of stigma reduced to one cell in hind wing." The penis with broad toothed terminal segment (Figs. 32–33) is a good generic character, present not only in the type species *P. jocaste*, but in *P. astictum*. However, none of these species has a reduced black "stigma" that we regard as a specific rather than a generic character. The decision to revalidate *Platystigma* was made possible by the examination of the illustration of the penis of the type species in Kennedy (1919). Without access to this illustration we would have maintained its synonymy with *Mecistogaster*, as proposed by Garrison *et al.* (2010).

Based on the species studied here, *Platystigma* can be characterized as follows: Small to medium-sized species of Pseudostigmatidae (Hw 32–48, abdomen 48–65). Face yellow or gray. Upper part of head predominantly black. Prothorax mainly black with pale markings. Mesopleuron black with antehumeral and posthumeral oblique stripe. Metapleuron pale with oblique black stripe along metapleural suture. Wings with distal pale areas at least in hindwings (Figs. 30–31) of males and females (except males of *Platystigma astictum* that have no pale area in any wing). Venation: only one cell row between CuA and wing border along most of its extension. Wings stalked well before nodus. RP2 branching from RP at less than half distance from subnodus to tip of wing. Supplementary tooth of tarsal claws absent or vestigial. Abdomen dominantly black with metallic dark green reflections. Penis with well-developed plate-like segment 3 provided with small teeth or tufts of spines. Penis with no inner fold. Penis segment 2 with elevation. Male cercus curved inward like a forceps. Ovipositor reaching posteriorly about the level of hind border of S10.

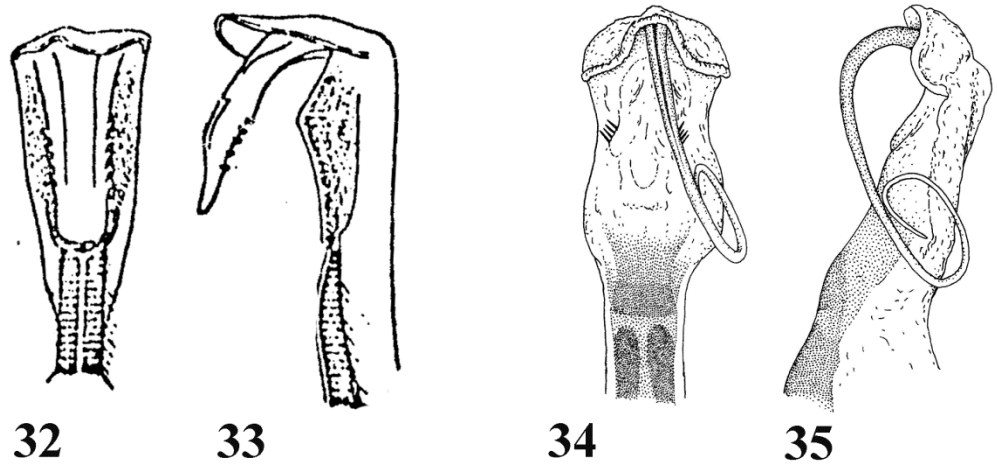


FIGURES 30–31. Wings of *Platystigma astictum* female, from Itatiaia, Rio de Janeiro. Fw (30) and Hw (31).

Remarks

The characters distinguishing *Platystigma* from the other five genera of Pseudostigmatidae, i.e. *Anomisma*, *Mecistogaster*, *Megaloprepus*, *Microstigma* and *Pseudostigma*, are: penis structure, supplementary tooth of tarsal claws absent or vestigial, and small to medium body size (Hw 32–48, abdomen 48–65) (except for *Anomisma*, is also small). The penis of *Platystigma* differs from those of other Pseudostigmatidae genera by having a plate-like segment 3 (Figs. 32–33), provided with small teeth or tufts of spines. In the other genera of Pseudostigmatidae this segment is represented by a filamentous flagellum (Figs. 34–35).

In *Mecistogaster ornata* Rambur, 1842, however, segment 3 is not a true flagellum, but a very narrow plate-like structure without teeth or spines. In all other characters it is a *Mecistogaster*. According to Kennedy (1920), *M. ornata* belongs to another genus, *Xanthostigma*, synonimized with *Mecistogaster* by Garrison *et al.* (2010). We maintain it in *Mecistogaster* until new studies define its generic status.



FIGURES 32–35. Penis of holotype of *Platystigma jocaste*, drawn by Kennedy, in ectal (32) and lateral (33) views. Penis of *Mecistogaster linearis* in ectal (34) and lateral (35) views.

According to Bechly (1996), Rehn (2003), and Garrison *et al*. (2010) the presence of a penis segment 3 modified as a flagellum is a family character of Pseudostigmatidae. However, this view could be questioned, as in *Platystigma* it is plate-like and in *Mecistogaster ornata* it is not a true flagellum, but a very narrow plate-like structure. Decision about this question requires a phylogenetic study of the Pseudostigmatidae.

P. astictum is the only species of *Platystigma* whose larva is known (Lencioni 2006). According to him, the larva of that species differs from that of *Mecistogaster ornata* Rambur, 1842, *Mecistogaster modesta* Selys, 1860, *Megaloprepus caerulatus* (Drury, 1782), and *Pseudostigma aberrans* Selys, 1860, by the presence of only two setae on the labial palp, whereas this number is six to seven in the other four species. It seems, therefore, that this may be a generic character of *Platystigma*.

When described by Kennedy (1919, 1920), *Platystigma* contained a single species, *P. jocaste.* We are including in this genus two species that occur in the Atlantic Forest, previously regarded as *Mecistogaster*, *P. astictum* (Selys, 1860) and *P. pronoti* (Sjöstedt, 1918), and they are redescribed. In addition, there are 5 species and 3 new species that are discussed in Machado & Soldati (2017).

Regarding its geographic distribution, *Mecistogaster* is a Central and South American genus, whereas *Platystigma* has been found only in South America. As in figure 7, *P. astictum* and *P. pronoti* has distribution in the Atlantic Forest of Southeastern and South

Brazil. The keys to males and females of *Platystigma* are attached to this study in Machado & Soldati (2017).

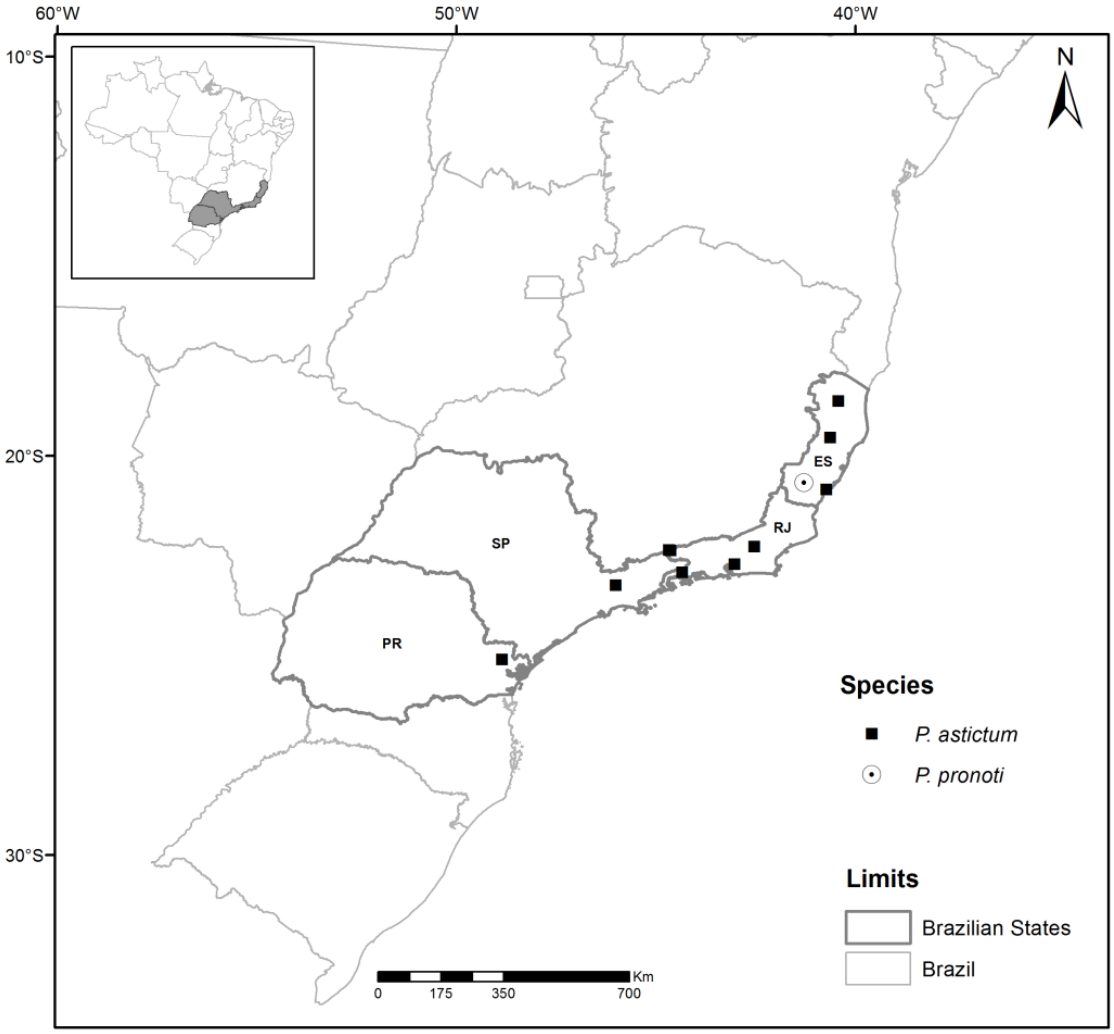


FIGURE 36. Map of species distribution of *Platystigma* in the Brazilian Atlantic Forest Domain. Abbreviations for Brazilian states: Espírito Santo (ES), Rio de Janeiro (RJ), São Paulo (SP), Paraná (PR).

***Platystigma astictum* (Selys, 1860) n. comb.**

Figures 37–49

Selys (1860: 15); McLachlan (1877: 88); Davies & Tobin (1984: 58); Machado (1985: 35); Selys (1886: 21); Bridges (1994: VII–21); Machado (1998: 507); Tsuda (2000: 57); Lencioni (2005: 152, 2006: 295); Heckman (2008: 206); Garrison, von Ellenrieder & Louton (2010: 391); Garrison & von Ellenrieder (2016: 20); Schorr & Paulson (2016).

Material examined:

1♂, 1♀: Brazil, Espírito Santo State, Colatina, Córrego do Gavião, XI.1930, X.1936, Rosa leg. (MNRJ). 1♂, 1♀: Brazil, Rio de Janeiro, Tinguá (Res. Florestal, 9.IV.1971, 20.I.1972, N. Santos leg. (MNRJ). 1♂: Brazil, Rio de Janeiro, Parque Nacional do Itatiaia, 2.I.1973, O. Mielke leg. (ABMM). Brazil, Rio de Janeiro State, Nova Friburgo (1.100m), II.2001, E. Grossi leg. (ABMM). 1♀: Brazil, São Paulo State, Jacareí, Fazenda Santana do Rio Abaixo, 12.IV.2003, F.A.A. Lencioni leg. (FAAL). Paraná, Ribeirão Vermelho, Campina Grande do Sul, 1.III.2003, Mielke leg. (ABMM).

Diagnosis

Hind prothoracic lobe of male with median and lateral portions separated by very slight depression, median portion with border straight (Fig. 37); in female median and lateral portions not distinguishable and border of median portion slightly convex. Pterothorax with antehumeral pale stripe reaching about ¾ length of pterothorax (Fig. 38). Venter pale with large black median stripe (Fig. 39). Anterior hamuli with ear-like basal plate, with posteromedial angle sclerotized. Distal portion of batilliform lamina curved ventrally with sclerotized apex. Posterior hamuli curved anteriorly (Fig. 40). Penis segment 3 in ectal view (Fig. 41) rectangular with no visible spines; in lateral view (Fig. 42) with small median row of very short spines. Female cercus in dorsal view (Fig. 43) about as long as S10, parallel, conical, and pilose. Dorsoposterior portion of S10 V-shaped (Fig. 43). Ovipositor reaching about level of hind border of S10 posteriorly (Fig. 44). Lateral valve with 9–10 minute, equal-sized teeth, except distal one larger (Fig. 45). Female similar to male, except for presence of pale apical area in Hw and for border with no elevation.

Male Fw hyaline, without pale apical area, pseudostigma distinct. Hw hyaline, pseudostigma gray with 7 cells (Fig. 46), becoming orange-yellow at high saturation (Fig. 47). Border of Hw of male with elevation at level of pseudostigma. Female with white apical area reaching level of RP2 in both wings, with no distinct pseudostigma (Fig. 48). At high saturation white area of Hw becomes light-blue with yellow venation, costal vein orange, and the pseudostigma becomes distinct with 11 cells (Fig. 49).

Measurements (mm): ♂ Hw 41–42, abdomen 59–61; ♀ Hw 42–51, abdomen 57–61.

Remarks

The male of *P. astictum* can be easily identified by having the border of hindwing with a subapical elevation and no pale apical area. The female with a white area in both wings and no distinct pseudostigma. *P. astictum* is the species with the largest geographical distribution in the genus, occurring in southeastern Brazil and extending southward to the state of Paraná (Fig. 37). The biology of adults and larvae of *P. astictum* has been studied by Lencioni (2006) with special emphasis on oviposition behavior.

***Platystigma pronoti* (Sjöstedt, 1918) n. comb.**

Figures 50–55

Sjöstedt (1918: 31); Davies & Tobin (1984: 57); Machado (1992: 19); Bridges (1994: 39); Tsuda (2000: 58); von Ellenrieder & Paulson (2006); Heckman (2008: 205); Machado, Drummond & Paglia (2008: 460); Garrison, von Ellenrieder & Louton (2010: 391); Garrison & von Ellenrieder (2016: 20); Machado & Lacerda (2016: 63); Schorr & Paulson (2016).

Material examined:

Holotype ♀. Brazil, Espírito Santo State (no further information available). Deposited in the NHMS.

Diagnosis

Head with dorsum black and orange-white spots anteriorly and another medially to antennae bases. Pronotum dark brown with pair of pale-yellow stripes anteriorly and laterally to middle lobe. Border of medial and apex of lateral portions of hind prothoracic lobe pale yellow. Median portion straight, separated from lateral portions by deep incision at each side (Fig. 50); lateral portions with apex rounded (Fig. 50). Mesepisternum (Fig. 51) black with antehumeral grayish-yellow stripe occupying whole extension of sclerite. Mesepimeron dark brown with grayish-yellow stripe not reaching lower part of sclerite. Metapleuron (Fig. 51) whitish yellow with black stripe adjacent to metapleural suture occupying dorsal ¾ of sclerite. Venter of pterothorax whitish yellow, with narrow middle dark stripe occupying its anterior

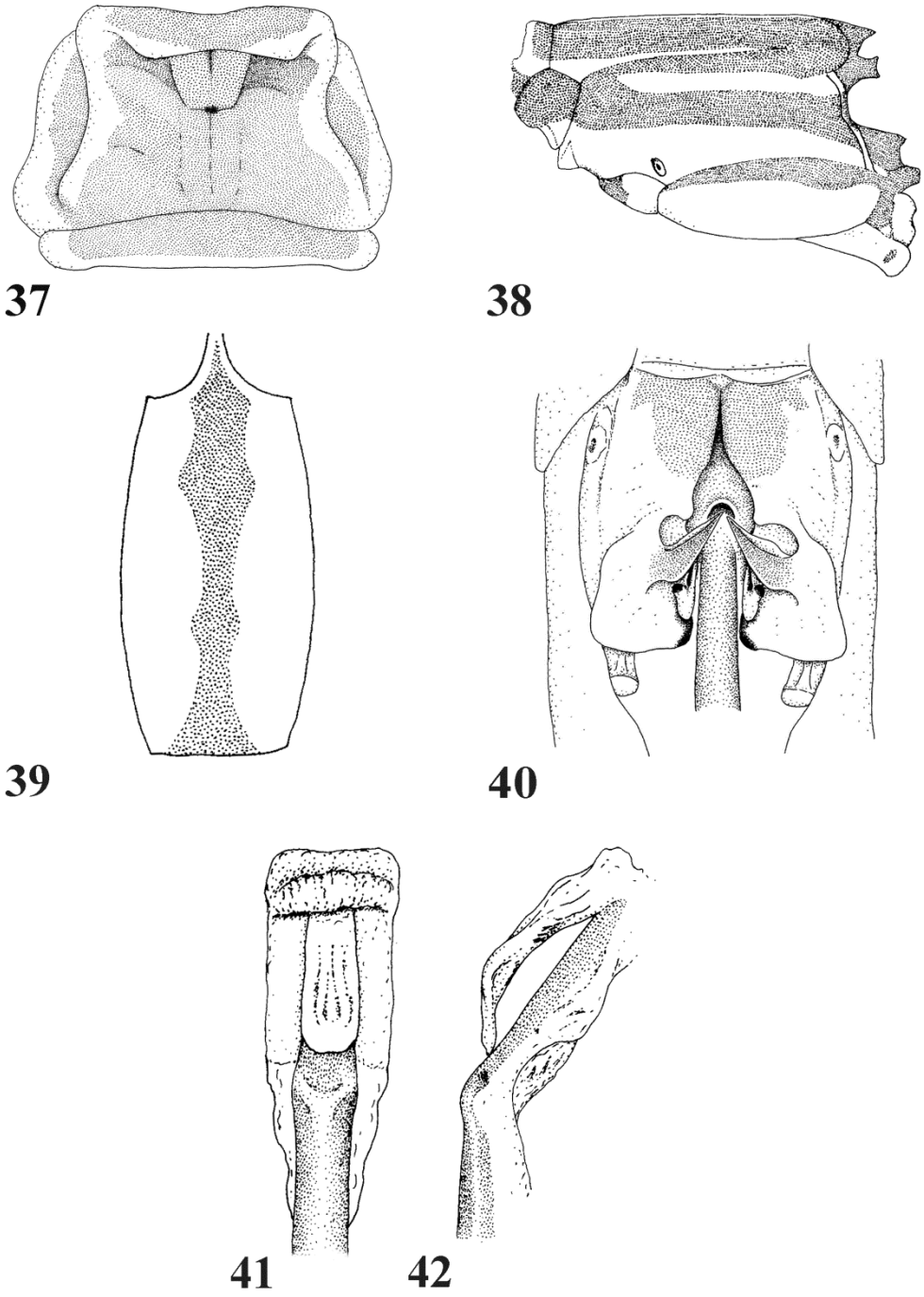
half. It is impossible to know whether this stripe reaches the posterior part of venter, because it is damaged. Supplementary tooth of tarsal claws absent. Wings dominantly hyaline with apical area milky-white reaching a row of cells posterior to RP1. Pseudostigma in both wings weakly indicated pale yellow color (Figs. 52, 54). At high saturation the color of apical area changes; the white color becomes pale blue and the pseudostigma appears very evident, yellow, with 6 cells in Fw and 8 in Hw (Figs. 53, 55). Costal vein becomes orange and RA to RP1 yellow (Figs. 53, 55). Abdomen dominantly brown. Cercus dark, with apex rounded. Ovipositor (stylus lacking) reaching posteriorly about level of hind border of S10.

Measurements (mm): Hw 40, abdomen 54.

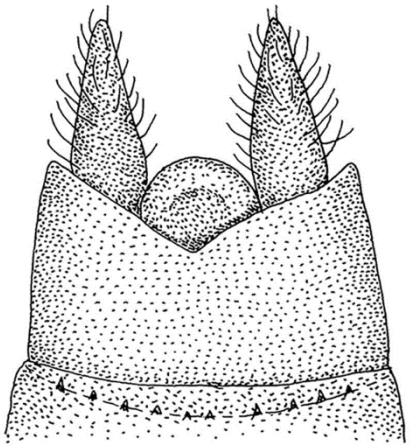
Male: unknown.

Remarks

Mecistogaster pronoti was transferred to *Platystigma* by Machado & Soldati (2017) based on its small size, absence of supplementary tooth of tarsal claw and presence of pale apical area on the wings. The species was described by Sjöstedt (1918) based on a single female specimen from the state of Espírito Santo, Brazil and has never been found again. According to Heckman (2008), "*M. pronoti* is a rare or unrecognized species." Its holotype has been recently redescribed and illustrated by Machado & Lacerda (2016), thus allowing its easy identification. The main character separating *P. pronoti* from the other *Platystigma* species is the peculiar form of the hind prothoracic lobe, whose median portion is clearly separated from the lateral ones by a deep incision. *P. pronoti* has been listed as Critically Endangered in Brazil in von Ellenrieder & Paulson (2006) and Portarias MMA n^{o} 444/445 (2014), and a strategy for its conservation has been proposed by Machado & Lacerda (2016).



FIGURES 37–42. *P. astictum*. Prothorax in dorsal view (37); pterothorax in lateral view (38); venter (39): males, Itatiaia, Rio de Janeiro. Genitalia of second segment (40); penis in ectal (41) and lateral (42) views: Tinguá, Rio de Janeiro.



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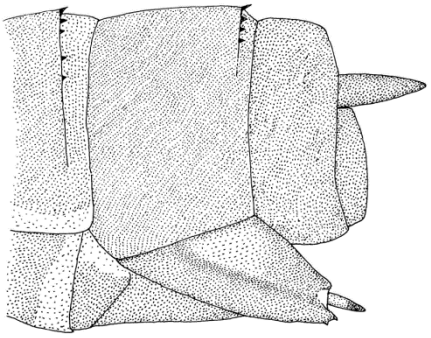

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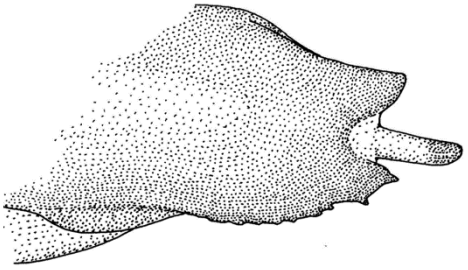

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FIGURES 43–45. *P. astictum*. Female cercus in dorsal view (43): Rio de Janeiro, Tinguá. Abdomen S8–10 in lateral view (44): São Paulo, Jacareí. Ovipositor in lateral view (45): Rio de Janeiro, Tinguá.

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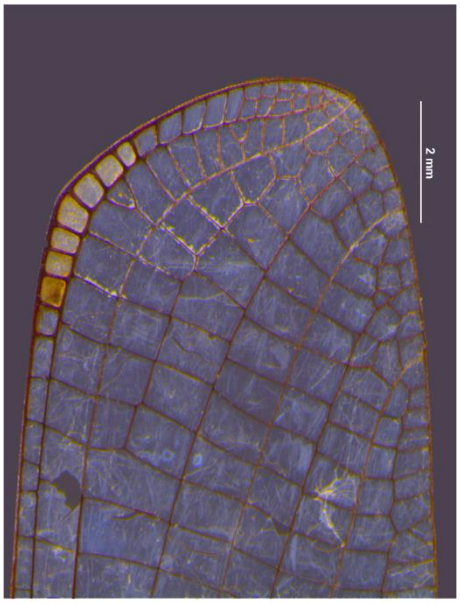

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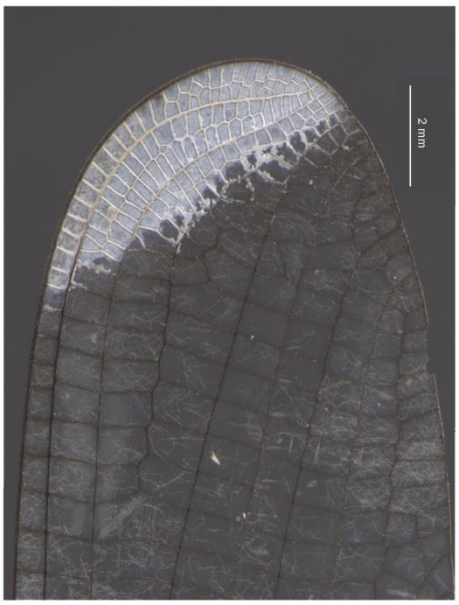

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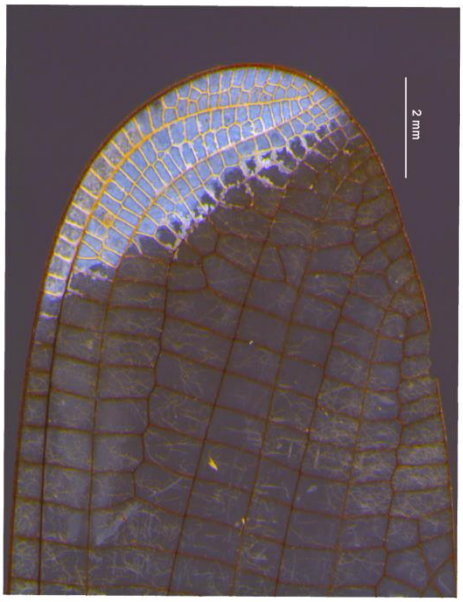

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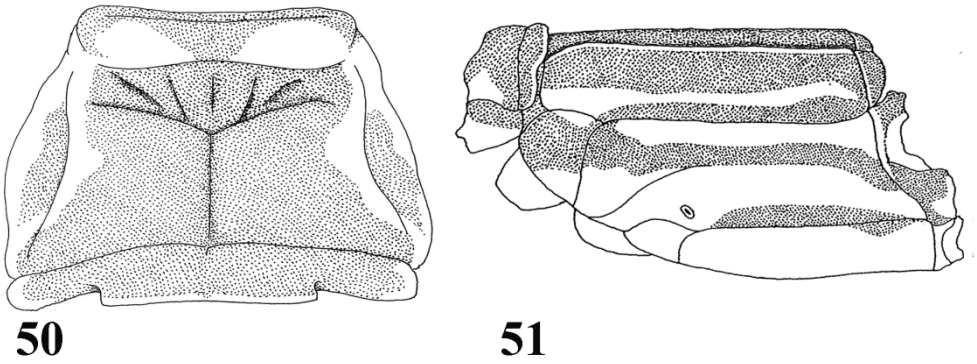
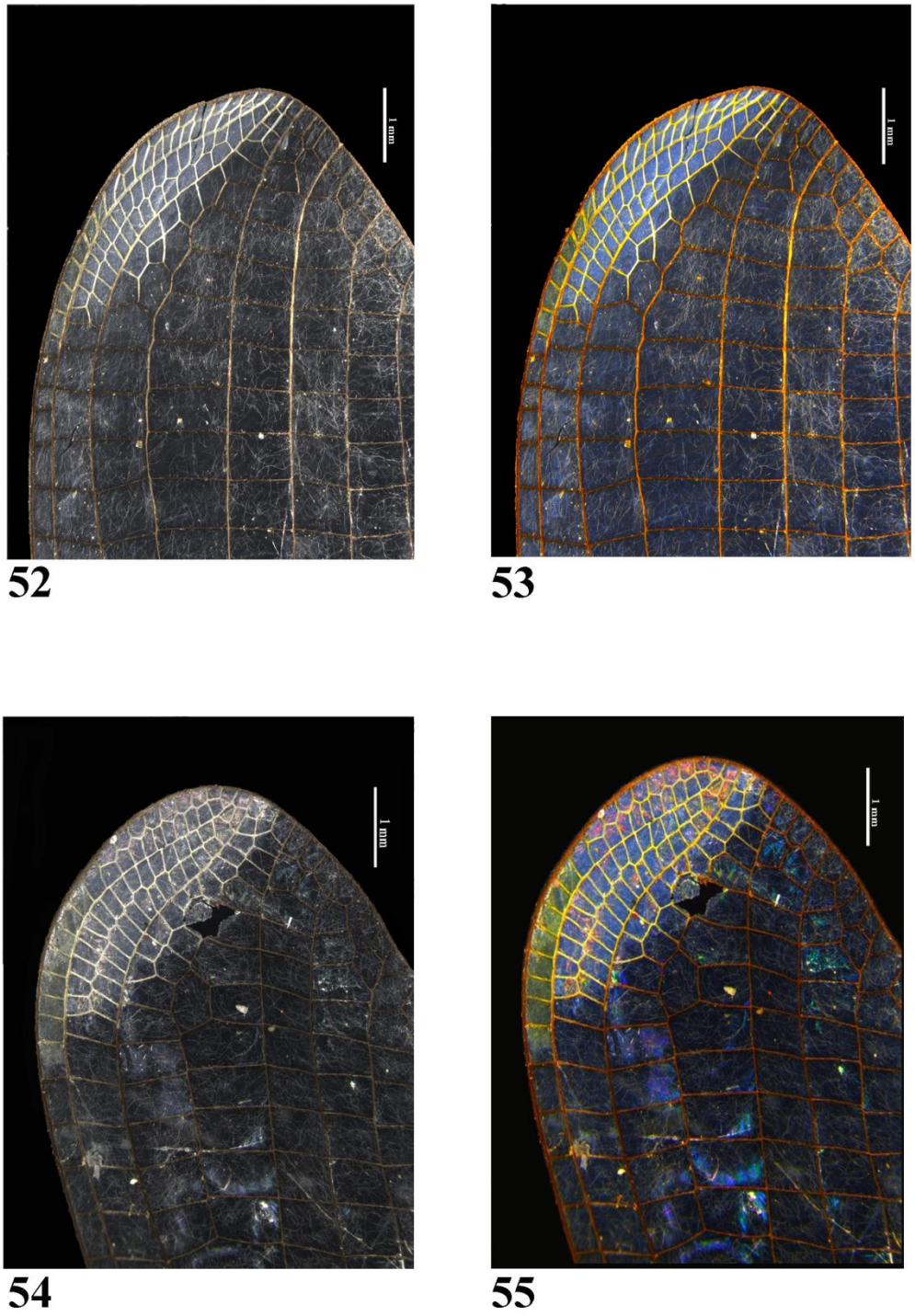
FIGURES 46–49. Wings in *P. astictum*. Male: Espírito Santo, Hw non saturated (46), saturated (47); female: Itatiaia, Rio de Janeiro, Hw non saturated (48) saturated (49).



FIGURES 50–51. *P. pronoti*. Female holotype: Prothorax in dorsal view (50); pterothorax in lateral view (51).



FIGURES 52–55. Wings in *P. pronoti* reproduced from Machado & Lacerda (2016). Female holotype: Fw non saturated (52), saturated (53); Hw non saturated (54), saturated (55).

Part III – Oviposition in Pseudostigmatidae with emphasis in *Platystigma*

Oviposition in Pseudostigmatidae with emphasis in *Platystigma*

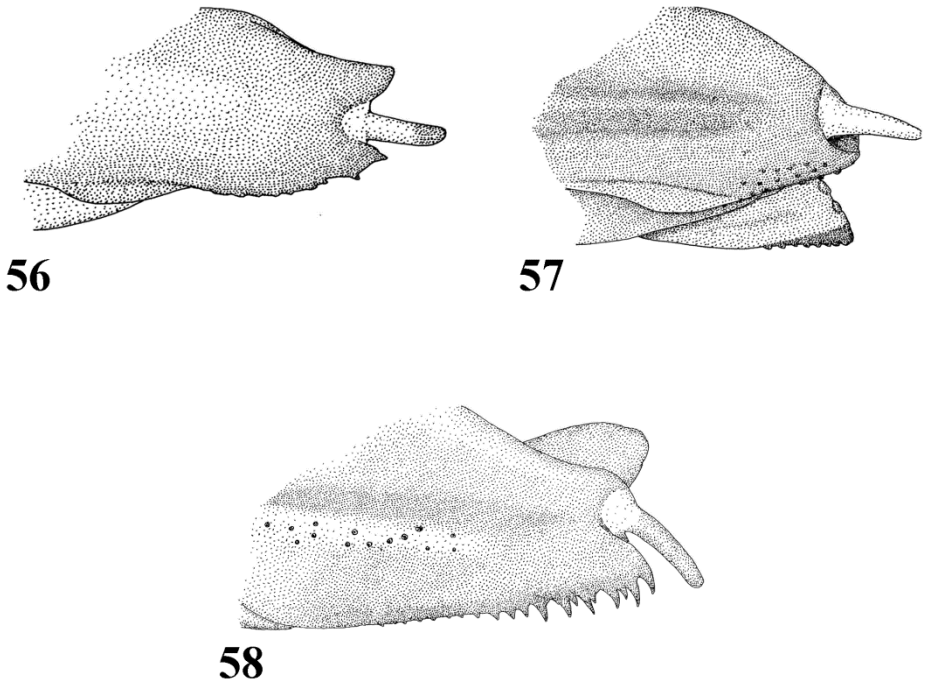
There is an enormous bibliography on the oviposition behavior of Odonata (see Corbet 2004), but we are going to treat this subject only for Pseudostigmatidae, with emphasis on *Platystigma*. Since Calvert (1911), it is known that the larvae of *Mecistogaster modesta* Selys, 1860, live in tank bromeliads, indicating that it oviposits there. Further studies (Fincke 1984, Machado 1985b) revealed that *Mecistogaster linearis* (Fabricius, 1776), *Mecistogaster ornata* Rambur, 1842, *Mecistogaster amalia* (Burmeister, 1839), *Pseudostigma* sp., and *Megaloprepus coerulatus* (Drury, 1782) also breed in phytotelmata (treeholes). *Microstigma anomalum* Rambur, 1842, oviposits in fallen fruits or nut husks (Santos 1981).

It seems, therefore, that in all Pseudostigmatidae oviposition is in phytotelmata (Garrison *et al.* 2010). In *Platystigma*, oviposition behavior has been observed only in *P. astictum* (Selys, 1860) by Lencioni (2006) and *P. martinezi* (Machado, 1985) by Machado & Martinez (1982). The oviposition of *P. martinezi* was observed by the entomologist Antonio Martinez (Machado & Martinez 1982). He stood motionless by a water-containing tree hole staring at the water surface in an attempt to detect mosquito larvae, when all of a sudden, a large flying damselfly appeared and remained hovering in the air close to his eyes. It curved its abdomen and scattered eggs individually on the water surface, through a series of jerking abdominal movements without touching the water with its abdomen. The eggs were not simply dropped into the water, but struck the water surface obliquely, drifted horizontally for a short distance, and floated. The specimen was collected and at first misidentified as *M. jocaste* and later described as a new species, *M. martinezi* Machado, 1985. This type of oviposition corresponds to "non-contact flying oviposition", as defined by Eda (1962). In this case, however, the eggs are dropped, not thrown on the water surface as in *P. martinezi*. Martinez's observation was made in such a favorable situation that there is no reason to consider it "likely in error", as did Garrison *et al.* (2010). Indeed the egg-throwing behavior of *P. martinezi* is now recognized by most authors (Silsby 2001, Corbet 1992, 2004, Heckman 2008). According to Corbet (2004), the oviposition by egg-throwing observed in *P. martinezi* is unique in Zygoptera but occurs also in some species of mosquitoes.

The larvae of *P. astictum* are found in water inside bamboo internodes as shown by Lencioni (2006), who described its oviposition behavior as follows: "The female flying slowly and while rising inspected the whole extension of the bamboo to locate a suitable hole. With a very slow forward flight, she approached the bamboo, landed above the hole while maintaining the wings half-open, and curved the abdomen only touching the hole with the tip

of her abdomen. She remained in this position for several seconds, usually walking a little above the hole; she then straightened her abdomen and flew to other bamboo stalks looking for new holes." Louton *et al*. (1996) saw an unidentified small *Mecistogaster* (most probably a *Platystigma*) that also oviposited in bamboo but inserted most of its abdomen in the lumen.

In the observations of Lencioni (2006) and Louton *et al*. (1996) it was not ascertained whether the eggs were laid directly on the water surface or in the substrate close to it. It is probable that other species of *Platystigma*, such as *P. minimum* collected in a bamboo-rich area in the state of Acre, also oviposit in bamboo phytotelmata. Despite the lack of direct evidence, it is probable that egg flotation, as observed for *P. martinezi*, also occurs in *P. astictum*. This is probable because in these two species, unlike in five species of *Mecistogaster*, the egg-shell shows a unique structure in Scanning Electro Microscopy (SEM) (Machado 1985b) represented by a great number of pores connected to a meshwork, which may function as an air-containing plastron. This structure is probably responsible for the floating ability of the eggs, as suggested for the eggs of *P. astictum* and demonstrated for the eggs of *P. martinezi* (Machado 1985b). The air-containing chorionic meshwork contributes to egg buoyancy that allows better conditions for egg development than the poorly oxygenated water in the bottom of tree holes.



FIGURES 56–58. Valve of ovipositor in lateral view: in *P. astictum* (56), *P. martinezi* (57), and unidentified *Platystigma* (58).

In an attempt to find a morphological correlate to the special type of oviposition of *P. astictum* and *P. martinezi,* we studied the morphology of their ovipositor in comparison to some other species of *Platystigma*. In the lateral valve of ovipositor of three unidentified species of *Platystigma* from the Brazilian states of Rondônia, Amazonas and Pará, the ventral border of the valve is provided with a row of large teeth that become larger distally (Fig. 58). In *P. astictum* (Fig. 56) and *P. martinezi* (Fig. 57), however, this border has a row of minute, equal-sized teeth with only the two distal ones larger in *P. martinezi* (Fig. 57). The number of teeth is also larger in an unidentified *Platystigma* (20) than in *P. astictum* and *P. martinezi* (9–10).

According to Matushkina & Lambret (2011), the row of teeth forms a bearing edge which functions to hold the female abdomen on the plant surface during oviposition. It is, therefore, important in endophytic species but not in exophytic ones like *P. martinezi* and possibly *P. astictum* that probably also lay their eggs in the water. This fact may explain why in *P. martinezi* and *P. astictum* the bearing ridge of the lateral valve has such small teeth as compared to those of three unidentified *Platystigma* that probably oviposit endophytically, as the other Zygoptera. The study of three undetermined species of the *jocaste* group in the ABMM Collection revealed that their ovipositors also have small teeth and no valve process. This suggests that they also may have exophytic oviposition, although this has not been demonstrated. Another difference between the morphology of the lateral valve of ovipositor of *P. martinezi* and *P. astictum*, and those of the other three species is the presence of a lateral valve process in these species (Fig. 58) and its absence in *P. astictum* and *P. martinezi* (Figs. 56, 57). The significance of these differences is difficult to ascertain without knowing the function of this process, but it is tempting to suppose that it might be related to endophytic oviposition, since it is present in endophytic Zygoptera such as the four species studied by Matushkina (2004). A detailed study of the ovipositor of *P. martinezi* and other *Platystigma* employing the technique used by Matushkina and Lambret (2011) in *Lestes macrostigma* is highly desirable.

Conclusão geral

Os resultados desta dissertação proveram que houve um grande aumento do conhecimento da biodiversidade de pseudostigmatídeos na Mata Atlântica do Brasil. O número de espécies de Pseudostigmatidae da Mata Atlântica aumentou de três para sete espécies: *Mecistogaster amalia, M. eustaquioi, M. jacatinga, M. kesselring, M. mielkei, Platystigma asticum* e *P. pronoti*. Assim, tornou-se mais urgente a implantação de medidas para proteção de seus remanescentes que somam hoje apenas 8.5% da área original (SOS Mata Atlantica).

Sabe-se que a dificuldade em relacionar o macho de uma espécie e sua respectiva fêmea é um desafio para muitos grupos de insetos e no presente estudo não foi diferente. Foi possível somente identificar a fêmea de *Mecistogaster kesselring*, encontrada em cópula e descrita.

Segundo Paulson (2006) a maior biodiversidade dos odonatos ocorre nas florestas tropicais e os resultados desta dissertação confirmam este fato. Os pseudostigmatídeos, mais que qualquer outra família, dependem diretamente da floresta para a oviposição em fitotelmata e para o forrageamento. Portanto, a destruição das floretas leva à extinção de espécies e não se pode descartar a hipótese de que nestes últimos 517 anos já tenha havido extinção de espécies de Pseudostigmatidae. Isto já pode ter ocorrido com *Mecistogaster pronoti*, classificada como criticamente em perigo e cuja área de ocorrência é apenas o estado do Espírito Santo (Machado & Lacerda, 2016).

Cabe agora uma avaliação do *status* de conservação das espécies de Pseudostigmatidae da Mata Atlântica como subsídio para a próxima revisão da Lista da Fauna Brasileira Ameaçada de Extinção. Esta avaliação tem como base os critérios definidos pela IUCN (2012) e discutidos em Machado, Drummond & Paglia (2008). Desses critérios o mais utilizado é a extensão de ocorrência da espécie, ou seja, a área na qual ela realmente ocupa hoje.

Com base neste critério os mapas de distribuição de *Mecistogaster* (Fig. 1) e *Platystigma* (Fig. 36) mostram que, além de *P. pronoti*, que já está na lista oficial das espécies da fauna brasileira ameaçada de extinção, *M. eustaquioi* tem extensão muito pequena, limitada aos estados do Pernambuco, Paraíba e Alagoas. Esta espécie é possível candidata a entrar na lista como quase ameaçada, dependendo de um estudo mais minucioso de seus fatores de ameaça. As demais espécies do mapa (Fig. 1) não estão ameaçadas, pois ocorrem em áreas muito grandes, no caso de *M. mielkei*, extende-se por quase toda a Mata Atlântica.

Um aspecto interessante revelado pelo mapa (Fig. 1) é que a maior biodiversidade de *Mecistogaster* concentra-se no nordeste (Paraíba, Pernambuco e Alagoas) e no sul e sudeste, havendo apenas um registro entre Alagoas e o sul da Bahia. Esta falta de registros,

especialmente nos estados de Alagoas, Sergipe e Bahia, assim como no Paraná e Rio Grande do Sul pode ser devido a dois fatores, relacionados à deficiência de coleta ou à inexistência de áreas de floresta capazes de manter as populações de *Mecistogaster*. Isto é mais provável na região que se estende de Salvador a Sergipe na qual a destruição das florestas foi especialmente grave desde o início da colonização e devido à expansão da agricultura (Coimbra-Filho & Camara 2006, Tabarelli *et al.* 2010).

As principais medidas para proteção dos Pseudostigmatideos da Mata Atlântica são as definidas por Machado & Lacerda (2016) para *M. pronoti*, sendo a mais importante, a proteção dos remanescentes florestais.

Um importante resultado obtido nesta dissertação foi a descoberta de dois caracteres estruturais ainda não utilizados na taxonomia de Pseudostigmatidae: hâmulo anterior e epiprocto das fêmeas. No hâmulo, é importante a presença ou não de alulas e a forma da placa. Estudos preliminares realizados em várias espécies de *Mecistogaster* demonstraram o valor taxonômico da estrutura do epiprocto das fêmeas.

Quanto ao pênis, foram observados dois tipos: com segmento 3 em forma de flagelo, característico do gênero *Mecistogaster*, ou em forma de placa, característico do gênero *Platystigma* (Corbet, 2004). Em um trabalho pioneiro, Waage (1979) demonstrou que, nos zigópteros, o pênis tem duas funções: injetar esperma e retirar o esperma depositado em cópula anterior. Este achado foi amplamente confirmado, tanto em zigópteros, como em anisópteros, existindo uma vasta literatura sobre o assunto (Corbert 2004). Verificou-se também em Waage (1986) que a forma do pênis está relacionada com a maneira como a retirada do esperma é feita. Nos zigópteros existem quatro tipos morfológicos de pênis (Corbet, 2004).

Os resultados desta dissertação mostram que o pênis de *Mecistogaster* enquadra-se no tipo 3 e o de *Platystigma* é do tipo 2, sugerindo diferentes mecanismos de retirada de esperma. Essas considerações indicam que o principal caráter taxonômico que separa *Mecistogaster* de *Platystigma*, ou seja, o pênis tem não só uma base morfológica, mas também funcional. Os resultados morfológicos obtidos, em especial os novos caracteres descritos, abrem caminho para estudos futuros da taxonomia e filogenia da família Pseudostigmatidae.

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Anexo 1

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Redescription of the holotype of *Mecistogaster pronoti* Sjöstedt, 1918 (Zygoptera: Pseudostigmatidae)

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Mecistogaster pronoti Sjöstedt, 1918 was described based on a female holotype deposited in the Naturhistoriska Riksmuseet, Stockholm, collected in the state of Espírito Santo, Brazil. The original description has no illustrations, which makes its identification very difficult. Herewith we redescribe and illustrate this holotype. The species is red listed and considerations regarding its conservation are made.

Keywords: Odonata; damselfly; redescription; conservation; LED illumination

Introduction

Mecistogaster pronoti was described based on a single female specimen from the state of Espírito Santo, Brazil. The type locality is unknown but most probably it is situated in some area of Atlantic Forest, because all *Mecistogaster* species are forest dwellers and the state of Espírito Santo was almost entirely forested in the beginning of the 20th century.

In the 97 years following its description, the species has never been found again, in spite of the fact that the state of Espírito Santo is part of Southeastern Brazil, where the largest collecting effort for odonates is concentrated (De Marco & Vianna, 2005), including the genus *Mecistogaster*. Two collecting trips by the senior author in forests of western Espírito Santo in search of the species revealed no results, and no specimens of *M. pronoti* were found by the senior author in the collections of Selys-Longchamps, Brussels nor in the Museu Nacional, Rio de Janeiro and the Museu de Zoologia, São Paulo. This suggests that the species, if not extinct, is very rare. According to Heckman (2008), *M. pronoti* is a rare or unrecognized species whose redescription is imperative. We herewith redescribe the holotype of *M. pronoti* mainly as a means to provide illustrations that are completely lacking in the original description.

Materials and methods

We studied the holotype of *Mecistogaster pronoti*, loaned from the Naturhistoriska Riksmuseet, Stockholm. It arrived pinned in a small box. The body got loose from the pin and was much

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damaged, although almost complete, lacking only three legs. Five labels were attached to the pin, which can be described as follows (from top to bottom):

- Label 1: large, rectangular, white, handwritten with ink: *Mecistogaster* ♀ *pronoti* Sjöstedt, 1918.
- Label 2: small, rectangular, grayish red, printed: typus.
- Label 3: small, rectangular, white, printed: Espiritu Santo.
- Label 4: medium size, rectangular, dirty white, printed with faded letters: Rijksmuseum Stockholm.
- Label 5: very small, square, pale red, handwritten: 28/81.

To these labels we have added the following rectangular, white, handwritten label: Redescribed by Machado & Lacerda, 2016.

The meaning of the numbers in label 5 could not be ascertained, but it probably refers to some kind of register at the Museum.

The color characteristics of the apical pale area of the wings and pseudostigma were studied with a Leica M205A stereomicroscope (Leica Microsystems, Wetzlar, Germany) equipped with LED 5000-RL (Ring Light) illumination that, according to the manufacturer (website below), allows true color reproduction of the material indicating its natural color. The LED-RL provides the same distribution in wavelength and has the same incident angle of illuminating beam. The color temperature of LED is 5600 K. White balance, exposure, gain and gamma adjustments were based on QPCARD 101/V3 target applying to their reference values. The saturation range is from 0 to 3 and the indicated default is 1.7. Details and concepts of the procedure used can be obtained from Leica Microsystems (Switzerland) Ltd (2012) and http://www.leica-microsystems.com/products/stereo-microscopes-macroscopes/illumination/details/product/leica-led5000-rl/. Photos taken with low (0.55) saturation and high (2.7) saturation values were obtained and compared.

Abbreviations

Fw, forewing; Hw, hindwing; Px, postnodal; S1–S10, abdominal segments 1–10. Venation terminology after Riek and Kukalová-Peck (1984).

Redescription of *Mecistogaster pronoti* Sjöstedt, 1918

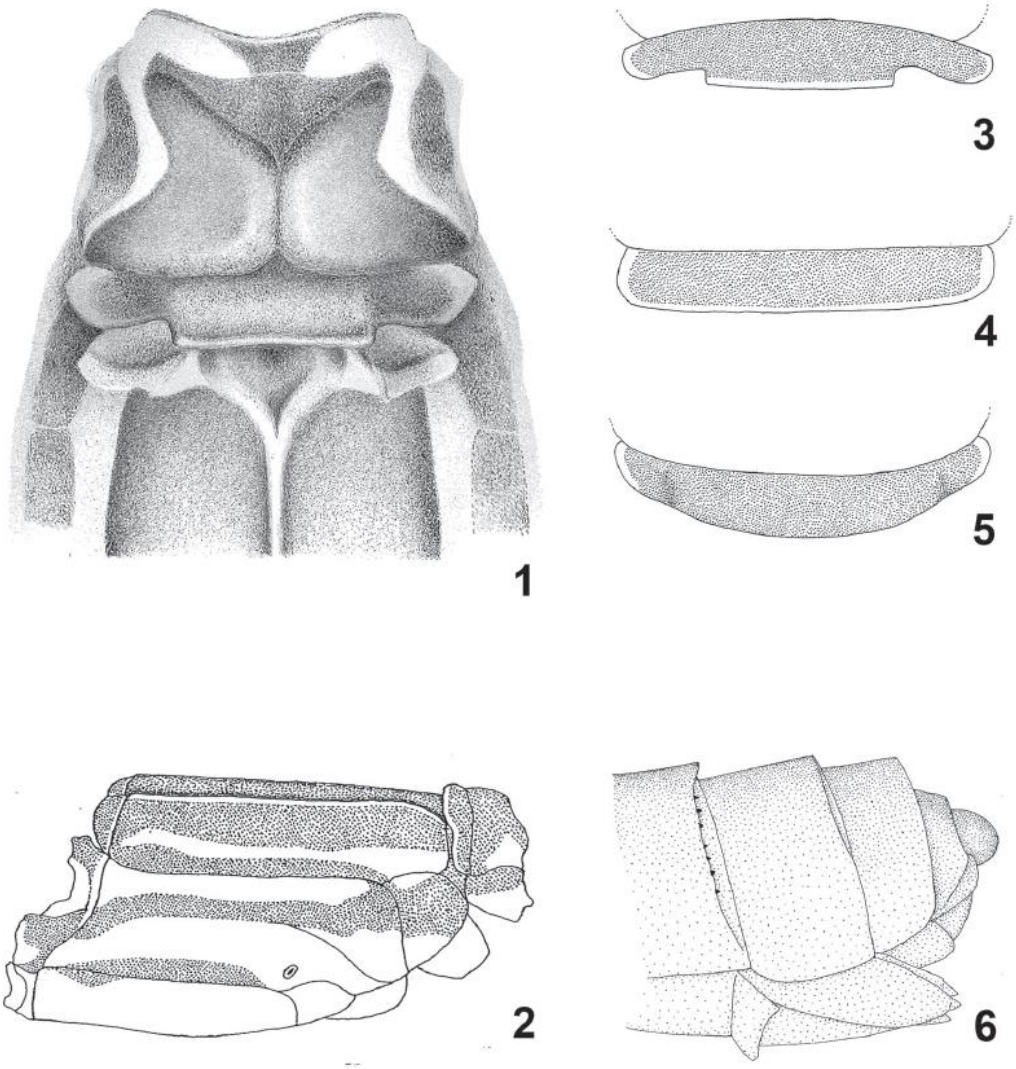
Material studied

Holotype. ♀. Brazil, Espírito Santo (no further information on the location), no further information on collectors and date (probably A. Roman, between July 1914 and July 1915), deposited in the Naturhistoriska Riksmuseet Stockholm.

Diagnosis

Head. Labium yellowish white, labrum grayish white with borders black and a central black stripe. Anteclypeus, genae and base of mandibles orange yellow, postclypeus black, antefrons orange yellow with a central black stripe. Dorsum of head black, with an orange and white spot anteriorly and another medially to the antennae base. Antennae with scape and pedicel black. Rear of head yellowish white.

Thorax. Prothorax (Figure 1): pronotum dark brown with a pair of pale yellow stripes anteriorly and laterally to the middle lobe. Hind prothorax lobe with the border of medial portion

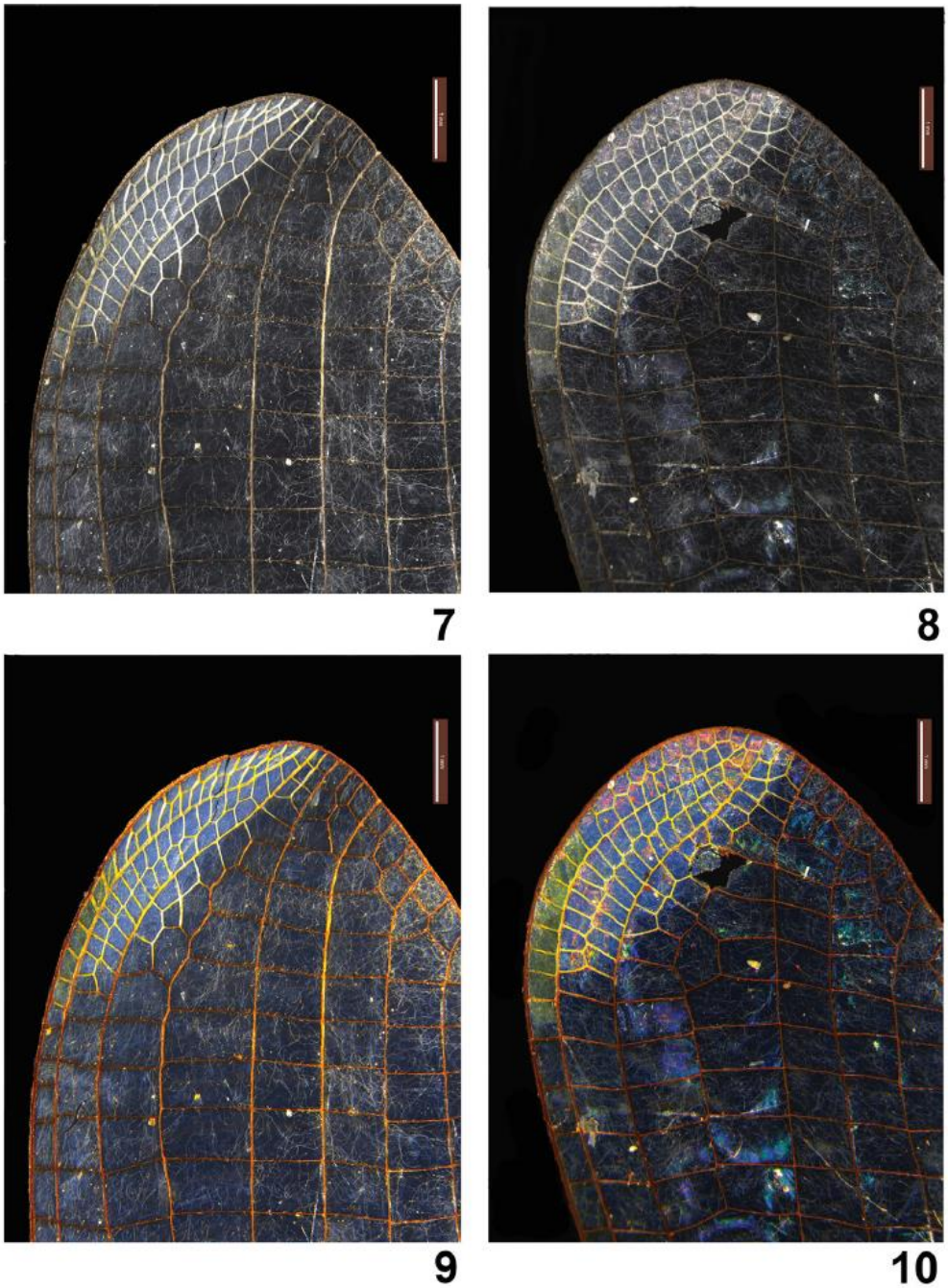


Figures 1–6. *Mecistogaster pronoti*, holotype ♀: (1) prothorax and anterior part of pterothorax in anterodorsal view; (2) pterothorax in lateral view; (3) hind prothoracic lobe in anterodorsal view; hind prothoracic lobes in anterodorsal view of females of (4) *Mecistogaster martinezi* and (5) *Mecistogaster asticta*; (6) abdominal segments 8–10 with ovipositor in lateral view.

and apex of lateral portions pale yellow. Propleuron pale yellow with a large dark brown spot. Pterothorax: Mesostigmal plates black with the margins yellow (Figure 1). Mesepisternum (Figure 2) black with an antehumeral grayish yellow stripe occupying the whole extension of the sclerite. Middorsal carina yellow (Figure 1), acrotergal area and antealar sinus brown. Mesepimeron dark brown with hardly noticeable bronze and a grayish yellow stripe not reaching the upper part of the sclerite. Mesinfraepisternum dark brown. Metapleuron (Figure 2) whitish yellow with a black stripe adjacent to the metapleural suture occupying the dorsal ¾ of the sclerite. Venter of pterothorax whitish yellow, with a narrow midventral dark stripe occupying the anterior ½ of the venter. It is impossible to know whether this stripe reaches the posterior part of the venter, because this part had been damaged.

Legs. Femora black with the flexor surface yellow. Tibiae whitish yellow, with flexural surface black. Tarsi black. Femora and tibiae spines black.

Wings. Dominantly hyaline with brown venation, except for the distal area between RA and RP1 and a row of cells posterior to RP1 that are milky white (saturation 0.55), including veins. Cells in the whitish area smaller than in the hyaline one. Pseudostigma at low saturation values (0.55) with a weakly indicated pale yellow color (Figures 7, 8). At saturation 2.7 the color of the apical part of wings changes completely and the pseudostigma becomes very evident, yellow, with six cells in Fw and eight in Hw (Figures 9, 10). Veins of the whitish area become yellow, with the cells pale blue. Venation: Px in Fw 35, in Hw 29, RP2 in Fw originating at Px 11, in



Figures 7–10. *Mecistogaster pronoti*, holotype ♀: photos with LED 5000-RL illumination. (7, 8) Saturation value 0.55 (natural color): (7) Fw; (8) Hw. (9, 10) Saturation value 2.7: (9) Fw; (10) Hw.

Hw at Px 9. Petiolation in Fw and Hw originating distal to CuP by a distance about the length of CuP.

Abdomen. S1 light brown, S2–S7 brown. S3 with a white narrow anterior ring interrupted in the middle. S8–S9 dark brown with a grayish yellow spot laterally, S10 dark brown proximally, dark distally. Cercus dark.

Structural characters: hind prothoracic lobe (Figure 1) with median portion straight, separated from the lateral portions by a deep incision at each side (Figures 1, 3). Lateral portions with the apex rounded (Figure 1). Supplementary tooth of tarsal claws absent.

Cercus (Figure 6) with the apex rounded, ovipositor (stylus lacking) reaching posteriorly about the level of S9–S10 border.

Discussion

As pointed out by Sjöstedt (1918), Heckman (2008) and Lencioni (2005) the main character separating *M. pronoti* from the other *Mecistogaster* species is the peculiar form of the hind prothoracic lobe. However, the description of this lobe made by Sjöstedt (1918) does not allow a precise visualization of its shape that is clearly shown in Figures 1 and 2.

A comparison of the hind prothoracic lobe of *M. pronoti* (Figure 1) with those of *M. asticta* Selys, 1860, *M. amalia* (Burmeister, 1839), *M. jocaste* Hagen, 1860, *M. linearis* (Fabricius, 1777), *M. lucretia* (Drury, 1773), *M. martinezi* Machado, 1985 and *M. ornata* Rambur, 1842 shows that whereas in these species the separation of the median and lateral portions of the hind lobe is not distinguishable, as in *M. martinezi* (Figure 4), or vaguely separated, as in *M. asticta* (Figure 5), in *M. pronoti* these portions are separated by a deep incision (Figure 3).

Sjöstedt (1918) stated that the claws of *M. pronoti* differ from those of *M. iphigenia* Selys, 1886 and probably also from *M. modestus* Selys, 1860 by lacking a tooth. This tooth is present not only in these two species but also in *M. amalia*, *M. linearis*, *M. lucretia* and *M. ornata*.

Remarks

The remarkable change of color in the pale apical area of the wings of *M. pronoti* using LED 5000 ring light system and at high saturation has not been reported previously. The phenomenon will be discussed in a forthcoming paper with four new species of *Mecistogaster* and also in the pale apical area of the wings of *M. amalia*, *M. hauxlari* (Selys, 1886), *M. lucretia*, *M. ornata* Rambur, 1842 and *Microstigma* sp. In all of these taxa there was change of color with high saturation values, different from what was found in *M. pronoti*. These differences support the view that changing saturation has taxonomic value in *Mecistogaster*, *Microstigma* and possibly in other genera of Pseudostigmatidae.

As regards conservation, *M. pronoti* has been listed as Critically Endangered in the red lists of Brazil, Portaria MMA n° 444/2014 and n° 445/2014, and IUCN (2006). As a main strategy for the conservation of the species, it has been recommended by Machado (2008) to intensify field collections in the state of Espírito Santo in search of the species followed by protections of its habitat. As shown in the map (Figure 11), collections of *Mecistogaster* species have been made predominantly throughout the central eastern part of the Espírito Santo State. Therefore, it seems reasonable to suggest that further collecting effort should prioritize undersampled forest habitats throughout the northern and southern part of this state. In *Mecistogaster asticta*, the closest species to *M. pronoti*, the larvae breeds in the water accumulated in bamboo internodes (Lencioni, 2005). Thus, for finding *M. pronoti*, further collections should be concentrated in bamboo rich forest habitats.

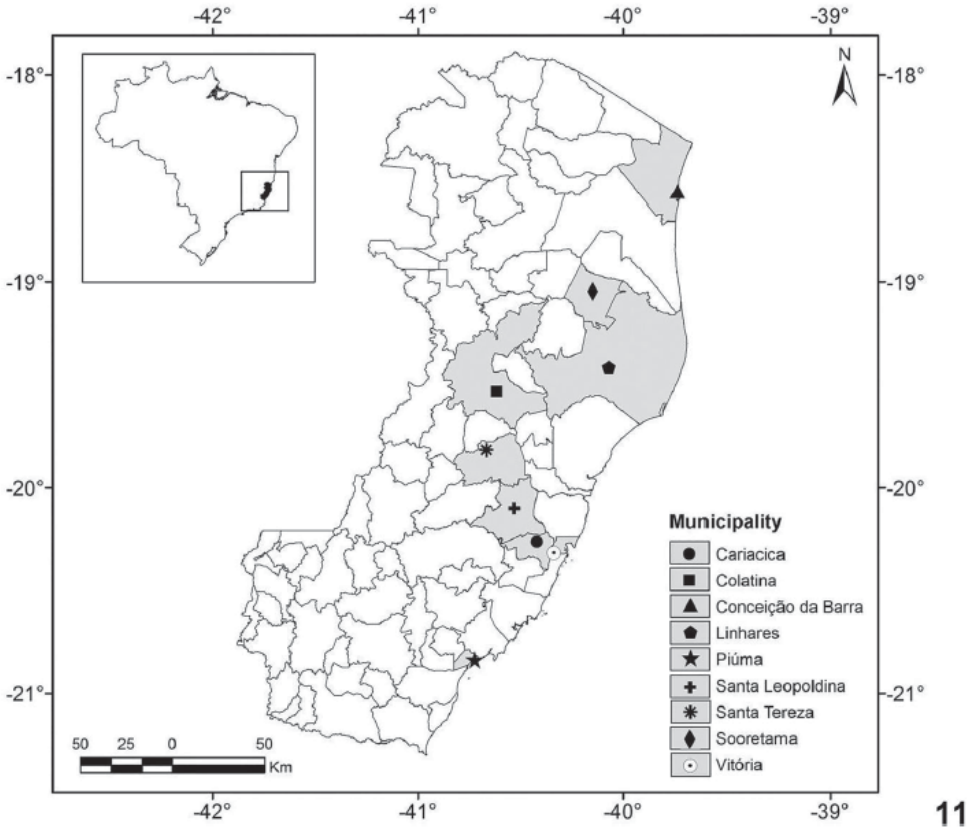


Figure 11. Municipalities in the State of Espírito Santo where specimens of *Mecistogaster* have been collected.

Acknowledgments

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Anexo 2

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Article

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Revalidation of *Platystigma* Kennedy, 1920, with a synopsis of the *quadratum* species group and the description of three new species (Odonata: Pseudostigmatidae)

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Abstract

The genus *Platystigma* Kennedy, 1920 is revalidated based mainly on the third segment of the penis that is plate-like, whereas in the other Pseudostigmatidae it is a flagellum. Dijkstra *et al* (2014) have merged this family into the Coenagrionidae. However, we prefer to maintain the long-used name Pseudostigmatidae until more detailed phylogenetic studies with more sampling are done. Eight species are here considered in the genus, three of which are described as new: *P. humaita, P. minimum* and *P. quadratum.* The genus is divided in two species group, *jocaste* and *quadratum,* the latter studied here. The hitherto unknown male of *P. martinezi* (Machado 1985) is described for the first time. Evidence for exophytic oviposition is presented in at least one species of the genus. A key is provided for the species of the *quadratum* group.

Key words: damselflies, exophytic, *Mecistogaster*, oviposition, South America, taxonomy

Introduction

Kennedy (1920) described 42 new genera of Zygoptera in a paper with no illustrations and very short descriptions. In the 96 years that elapsed since the publication of this paper, some of these genera have been synonymized. In that paper, *Mecistogaster* was divided into five genera: *Goniostigma*, *Haplostigma, Mecistogaster, Platystigma* and *Xanthostigma.* These new genera were regarded as subgenera by Davies & Tobin (1984) and synonymized with *Mecistogaster* by Garrison *et al.* (2010). Thus, the generic status of these four genera is controversial and reflects the fact that there are many taxonomic problems in *Mecistogaster*, a genus badly in need of a revision (Garrison *et al*. 2010). Here, *Platystigma* Kennedy is revalidated, and a taxonomic study of one of its species group is performed.

Material and methods

The specimens studied here were from Bolivia, Colombia, Ecuador, Peru, Venezuela, and from the Brazilian states of Acre, Amazonas, Rondônia, Pará, Espírito Santo, Rio de Janeiro, São Paulo, and Paraná. They are deposited in the following collections:

ABMM	Angelo B. M. Machado Collection, Department of Zoology, Federal University of Minas Gerais Federal de Minas Gerais, Belo Horizonte, Brazil.
FSCA	Florida State Collection of Arthropods, Gainesville, Florida, United States.
FAAL	Frederico A. A. Lencioni Collection, Jacareí, São Paulo, Brazil.
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge, United States.
MNRJ	Museu Nacional do Rio de Janeiro Collection, Universidade Federal do Rio de Janeiro, Brazil.
NHMS	Naturhistoriska Ricksmuseet, Stockholm, Sweden.

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The drawings were made with a camera lucida mounted on a Leica stereomicroscope. The pale apical areas of the wings were studied with a Leica M205 A stereomicroscope equipped with LED 5000RL (Ring Light) illumination. The use of high saturation turns natural color into more intense color. Details about this technique and its use can be obtained in Machado & Lacerda (2016). The anatomical terminology used for the hamuli is modified from that of Schmidt (1915). The internal plate was denominated simply *plate* and the outer plate *alula*. We believe this term, from Latin "small wing", represents better the shape of this structure in *Platystigma* and *Mecistogaster*. Measurements are given in millimeters. Abdomen length includes the caudal appendages. Venation terminology is according to Riek & Kukalova-Peck (1984) and penis terminology according to Kennedy (1916). Abbreviations: Fw, forewing; Hw, hindwing; S1–10, abdominal segments one to ten. Geographic records were represented on a map based on species studied here and on the literature. The geographic coordinates, when not provided in the specimen labels, were obtained in Google Earth and, if not found, searched in the speciesLink (http://www.splink.cria.org.br/geoloc).

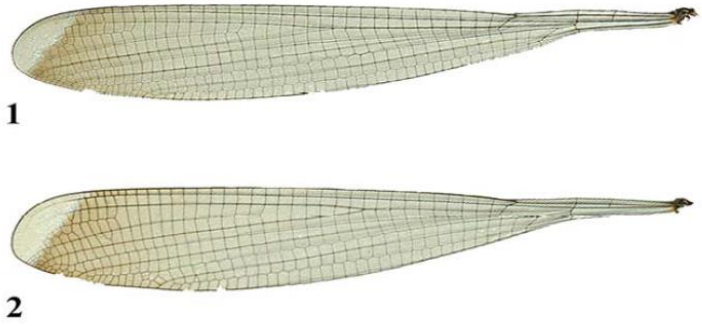
Revalidation of the genus *Platystigma*

The type species. The type species of *Platystigma* is *Mecistogaster jocaste* Hagen, 1869, as designated by Kennedy (1920). Unfortunately, this species is poorly known. The description of Hagen (1869) was based in a single male specimen from Bogotá, Colombia, deposited in the Museum of Comparative Zoology, Harvard University. It has no illustration and its main diagnostic character is the hindwing with apex whitish yellow preceded by a dark brown band. According to Hagen (1869), the species is notable for the color of the hindwing and was regarded by him as very beautiful. In spite of that, the species remains difficult to identify with certainty by lack of published drawings of the holotype penis. Fortunately, we had access to the unpublished manuscript of Kennedy's PhD thesis (1919) that has two drawings of the holotype penis made by himself. In the figure explanation, Kennedy (1919) wrote: *"Platystigma jocaste* (Hagen.); genotype. St. Fe de Bogota, Colombia, in coll. Hagen, M. C. Z." Therefore, the penis illustrated by Kennedy (1919) is that of the holotype of *P. jocaste*, and that illustrated by Garrison *et al.* (2010) as *M. jocaste* is actually a new species. The morphological organization of this penis is completely different from that of *Mecistogaster* and from the other four recognized genera of Pseudostigmatidae.

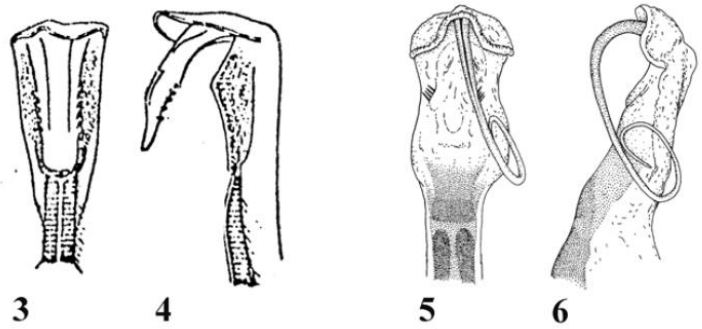
Generic characterization. Kennedy (1920) characterized the genus *Platystigma* as follows: "Penis with a broad, toothed terminal segment. Dense black part of stigma reduced to one cell in hind wing." The penis with broad toothed terminal segment (Figs. 3–4) is no doubt a good generic character, present not only in the type species *P. jocaste* but in all three species described here. However, none of these species has a reduced black "stigma" that we regard as a specific rather than a generic character. The decision to revalidate *Platystigma* was made possible by the examination of the illustration of the penis of the type species in Kennedy (1919). Without access to this illustration we would have maintained its synonymy with *Mecistogaster*, as proposed by Garrison *et al.* (2010). Based on the species studied here *Platystigma* can be characterized as follows: Small to medium-sized species of Pseudostigmatidae (Hw 32–48, abdomen 48–65). Face yellow or gray. Upper part of head predominantly black. Prothorax mainly black with pale markings. Mesopleuron black with antehumeral and posthumeral oblique stripe. Metapleuron pale with oblique black stripe along metapleural suture. Wings with distal pale areas at least in hindwings (Figs. 1–2) of males and females (except males of *Platystigma astictum* (Selys, 1804) that has no pale area in any wing). Venation: only one cell row between CuA and wing border along most of its extension. Wings stalked well before nodus. RP2 branching from RP at less than half distance from subnodus to tip of wing. Supplementary tooth of tarsal claws absent or vestigial. Abdomen dominantly black with metallic green reflections. Penis with well-developed plate-like segment 3 provided with small teeth or tufts of spines. Penis with no inner fold. Penis segment 2 with dorsal elevation (except in *P. astictum*). Male cercus curved inward like a forceps. Ovipositor reaching posteriorly about the level of the hind border of S10.

Remarks. The characters distinguishing *Platystigma* from the other five genera of Pseudostigmatidae, i.e. *Anomisma, Mecistogaster, Megaloprepus, Microstigma* and *Pseudostigma* are: penis structure, supplementary tooth of tarsal claws absent or vestigial, and small to medium body size (Hw 32–48, abdomen 48–65) (except for *Anomisma*, which is also small). The penis of *Platystigma* differs from those of other Pseudostigmatidae genera by having a plate-like segment 3 (Figs. 3–4), provided with small teeth or tufts of spines. In the other genera of Pseudostigmatidae this segment is represented by a flagellum (Figs. 5–6).

In *Mecistogaster ornata* Rambur, 1842, however, segment 3 is not a true flagellum, but a very narrow plate-like structure without teeth or spines. In all other characters it is a *Mecistogaster*. According to Kennedy (1920), *M. ornata* belongs to another genus, *Xanthostigma*, synonimized with *Mecistogaster* by Garrison *et al.* (2010). We maintain it in *Mecistogaster* until new studies define its generic status.



FIGURES 1–2. Wings of *Platystigma astictum* female, from Itatiaia, Rio de Janeiro. Fw (1) and Hw (2).



FIGURES 3–6. Penis of holotype of *Platystigma jocaste*, drawn by Kennedy, in ectal (3) and lateral (4) views. Penis of *Mecistogaster linearis* in ectal (5) and lateral (6) views.

According to Bechly (1996), Rehn (2003) and Garrison *et al.* (2010), the presence of a penis segment 3 modified as a flagellum is a family character of Pseudostigmatidae. However, this view could be questioned, as in *Platystigma* it is plate-like and in *Mecistogaster ornata* it is not a true flagellum, but a very narrow plate-like structure. Decision about this question requires a phylogenetic study of Pseudostigmatidae.

P. astictum is the only species of *Platystigma* the larva of which is known (Lencioni 2006). According to him, the larva of this species differs from that of *Mecistogaster ornata*, *Mecistogaster modesta* Selys, 1860, *Megaloprepus caerulatus* (Drury, 1782), and *Pseudostigma aberrans* Selys, 1860 by the presence of only two setae on the labial palp, whereas this number is six to seven in the other four species. It seems, therefore, that this may be a generic character of *Platystigma*.

When described by Kennedy (1919, 1920), *Platystigma* contained a single species, *P. jocaste*. We are now including in it the following species and subspecies previously regarded as *Mecistogaster*: *P. astictum* (Selys 1860), *P. buckleyi* (McLachlan 1881), *P. jocaste jocaste* (Hagen 1869), *P. jocaste sincerus* (McLachlan 1877), *P. jocaste vicentius* (Ris 1918), *P. martinezi* (Machado 1985), and *P. pronoti* (Sjöstedt 1918). To these we add *P. humaita* **sp. nov.**, *P. minimum* **sp. nov.**, and *P. quadratum* **sp. nov.**, making a total of 8 species, number almost equal to that of *Mecistogaster* (9 species). The species number of *Platystigma* is underestimated as there are at least two new species in the A.B.M. Machado Collection not described yet because they are represented by single

specimens in bad conservation conditions. Also there are three possibly new species of *Platystigma* that are represented only by female specimens and thus not safely identifiable. Regarding their geographic distribution, *Mecistogaster* is a Central and South American genus, whereas *Platystigma* has been found only in South America (Brazil, Bolivia, Colombia, Ecuador, Peru and Venezuela) (Fig. 7).

We propose the division of *Platystigma* into two species groups, the *quadratum* group and the *jocaste* group, based on hindwing color. In the *jocaste* group, there is a black or dark brown band just before the pale apical area that is lacking in the *quadratum* group. The latter group comprises, in addition to *P. quadratum*, the following species: *P. astictum, P. buckleyi, P. martinezi, P. minimum*, and *P. pronoti*. The *jocaste* group comprises only the nominal species with its three subspecies: *P. jocaste jocaste, P. jocaste sincerus* and *P. jocaste vicentius*. The species of the *quadratum* group occur throughout Northern and Southeastern Brazil, Bolivia, Ecuador and Peru, whereas those of the *jocaste* group are known only for Colombia, Peru and Venezuela.

As shown in figure 7, *Platystigma* has a disjunct distribution in Brazil, with most of its species in the Amazon region and a smaller number in the Atlantic Forest of Southeastern and South Brazil.

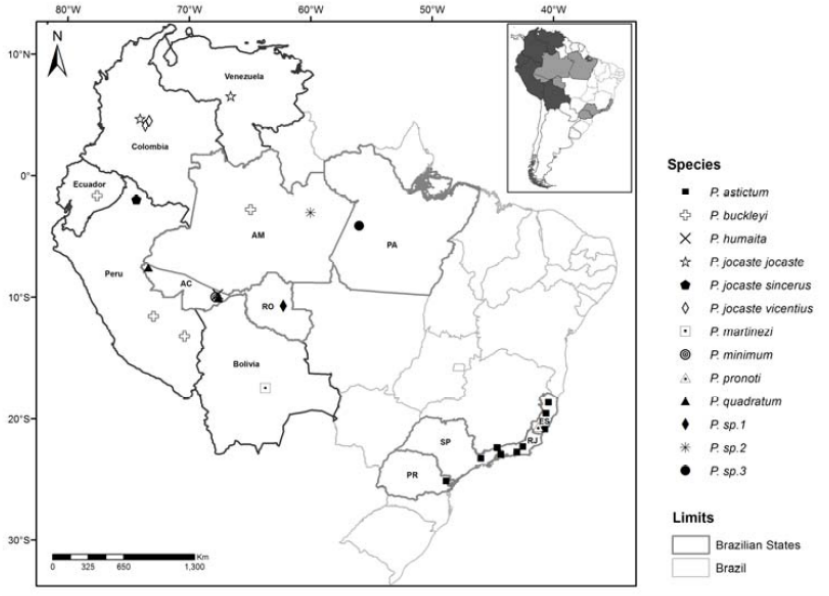


FIGURE 7. Map of species distribution of *Platystigma* in South America. Brazilian States: Amazonas (AM), Pará (PA), Rondônia (RO), Acre (AC), Espírito Santo (ES), Rio de Janeiro (RJ), São Paulo (SP), Paraná (PR).

Key to males of *Platystigma*

(male of *P. pronoti* unknown)

1 Hw with black or dark brown band. Species known only from Colombia, Peru and Venezuela . . . . . *jocaste* group
- Hw without black or dark brown band. Species of Northern and Southeastern Brazil, Bolivia, Ecuador and Peru (Figs. 25, 27, 31, 32, 35) . . . . . *quadratum* group ...2
2 Border of Hw with subapical elevation (Fig. 25) 3
- Border of Hw without subapical elevation (Figs. 27, 31, 32, 35) 5
3 Fw with pale apical area . . . . . *P. martinezi*
- Fw without pale apical area 4
4 Hw with pale apical area . . . . . *P. buckleyi*
- Hw without pale apical area (Fig. 25) . . . . . *P. astictum*
5 Small species (Hw 32, abdomen 48). Cleft of anterior lamina with elongated medial border sclerotized apically (Fig. 40). Penis segment 3 subrectangular (Fig. 48) . . . . . *P. minimum*
- Larger species (Hw 40–48, abdomen 52–65). Cleft of anterior lamina without elongated medial border. Penis segment 3 subquadrate (Figs. 46, 50) 6

6 Pale apical area present in Fw and Hw (Fig. 31) ..... *P. humaita*
- Pale apical area present only in Hw (Fig. 32) ..... *P. quadratum*

Key to females of *Platystigma*
(females of *P. buckleyi, P. humaita*, *P. minimum* and *P. quadratum* unknown)

1 Hw with black or dark brown band. Species known only from Colombia, Peru and Venezuela ..... *jocaste* group
- Hw without black or dark brown band. Species of Northern and Southeastern Brazil, Bolivia, Ecuador and Peru (Figs. 27, 35) ..... *quadratum* group... 2
2 Posterior prothoracic lobe with lateral and median portions clearly separated by deep incision (Fig. 12) ..... *P. pronoti*
- Posterior prothoracic lobe with lateral and median portions not clearly separated (Fig. 9) 3
3 Ventral border of lateral valve of ovipositor with a row of well-developed teeth increasing in size distad (Fig. 65) ..... *P. sp.*
- Ventral border of lateral valve of ovipositor with a row of very small denticles of equal sizes 4
4 Row of denticles originating directly from ventral border of lateral valve of ovipositor (Fig. 63) ..... *P. astictum*
- Row of denticles originating from small, narrow, sclerotized plate on ventral border of lateral valve of ovipositor (Fig. 64) ..... *P. martinezi*

***Platystigma astictum* (Selys, 1860) n. comb.**
Figures 8, 14, 20, 25–28, 37, 42, 43, 52, 62, 63

Selys (1860: 15); McLachlan (1877: 88); Davies & Tobin (1984: 58); Machado (1985: 35); Selys (1886: 21); Garrison & Ellenrieder (2016: 20); Bridges (1994: VII–21); Machado (1998: 507); Tsuda (2000: 57); Lencioni (2005: 152, 2006: 295); Heckman (2008: 206); Garrison, Ellenrieder & Louton (2010: 391); Schorr & Paulson (2016).

Material examined. Brazil, Espírito Santo State, Colatina, Córrego do Gavião, 1♂ 1♀, XI.1930, X.1936, Rosa leg. (MNRJ). Rio de Janeiro, Tinguá, (Res. Florestal), 1♂ 1♀, 9.IV.1971, 20.I.1972, N. Santos leg. (MNRJ). 1♂, Rio de Janeiro, Parque Nacional do Itatiaia, 2.I.1973, O. Mielke leg. (ABMM). 1♀, Nova Friburgo (1.100m), II.2001, E. Grossi leg. (ABMM). 1♀, São Paulo, Jacareí, Fazenda Santana do Rio Abaixo, 12.IV.2003, F.A.A. Lencioni leg. (FAAL). 1♀, Paraná, Ribeirão Vermelho, Campina Grande do Sul, 1.III.2003, Mielke leg. (ABMM).

Diagnosis. Posterior prothoracic lobe of male with median and lateral portions separated by very slight incision, median portion with border straight (Fig. 8); in female median and lateral portions not distinguishable and border of median portion slightly convex. Pterothorax with antehumeral pale stripe reaching about ¾ length of pterothorax (Fig. 14). Venter pale with large black median stripe (Fig. 20). Male Fw hyaline, without pale apical area, pseudostigma distinct. Hw hyaline, pseudostigma gray with seven cells (Fig. 25), becoming orange-yellow at high saturation (Fig. 26). Border of Hw of male with elevation at level of pseudostigma. Female with white apical area reaching level of RP2 in both wings, with no distinct pseudostigma (Fig. 27). At high saturation white area of Hw becomes light-blue with yellow venation, costal vein orange, and the pseudostigma becomes distinct with 11 cells (Fig. 28). Anterior hamuli with ear-like basal plate, with posteromedial angle sclerotized. Distal portion of batilliform lamina curved ventrally with sclerotized apex. Posterior hamuli curved anteriorly (Fig. 37). Penis segment 3 in ectal view (Fig. 42) rectangular with no visible spines; in lateral view (Fig. 43) with small median row of very short spines. Female cercus in dorsal view (Fig. 52) about as long as S10, parallel, conical, and pilose. Dorsoposterior portion of S10 V-shaped (Fig. 52). Ovipositor reaching about level of hind border of S10 posteriorly (Fig. 62). Lateral valve with 9–10 minute, equal-sized teeth, except distal one larger (Fig. 63). Female similar to male, except for presence of pale apical area in Hw and for border with no elevation.

Measurements (mm): ♂ Hw 41–42, abdomen 59–61; ♀ Hw 42–51, abdomen 57–61.

Remarks. Male and female of *P. astictum* can be easily identified by the characters given in the keys, the most important being the border of male Hw with subapical elevation. *P. astictum* is the species with the largest geographical distribution in the genus, occurring in Southeastern Brazil and extending southward to the state of Paraná (Fig. 7). The biology of adults and larvae of *P. astictum* have been studied by Lencioni (2006) with special emphasis on oviposition behavior. A comparison of the oviposition of *P. astictum* with that of *P. martinezi* is made at the end of this paper.

***Platystigma buckleyi* (McLachlan, 1881) n. comb.**

P. garleppi (Föster, 1903)
P. amazonica (Sjösted, 1918)

Kimmins (1970:103); McLachlan (1881:32); Davies & Tobin (1984: 58); Garrison & Ellenrieder (2016: 20); Bridges (1994: VII–39); Tsuda (2000: 57); Lencioni (2005: 153); Heckman (2008: 208); Garrison, Ellenrieder & Louton (2010: 391); Schorr & Paulson (2016).

Material examined: none.

Description. Description based on McLachlan (1881), who described two males from the district of Bobonaza, Ecuador.

Head. In one specimen the labrum is yellow, the anteclypeus, postclypeus and antefrons greenish. In another specimen the labrum is dark olive with narrow yellow anterior border, anteclypeus and postclypeus black. Upper part of head black.

Thorax. Prothorax: black with very narrow pale yellow border. Pterothorax: black with two greenish yellow humeral lines originating in opposite directions, the anterior very short and scarcely overlapping the posterior one. Venter yellowish, with black middle line, and small anterior and posterior spots.

Legs. Black with yellow line externally on femora and internally on tibiae.

Wings. Fw hyaline, without pale apical area, pseudostigma dark brown. Hw with small (4 mm broad) milky-white (or yellowish) pale apical area on which the border is slightly elevated.

Measurements (mm): Hw 44–48, abdomen 58–65.

Remarks. According to McLachlan (1881), the male *P. buckleyi* is perhaps most nearly allied to *P. astictum*, from which it differs especially because its Hw has the apical area pale, whereas *P. astictum* has no pale apical area; and the Fw in *P. astictum* has a scarcely indicated pseudostigma, while *P. buckleyi* has visible pseudostigma. It is not certain that the female described by McLachlan (1881) as *P. buckleyi* is conspecific with the male lectotype. The identity of *P. buckleyi* will remain uncertain until the penis of the lectotype in the British Museum is studied. The paralectotype may be a new species, as its color is slightly different from that of the lectotype (McLachlan 1881).

Platystigma amazonica (Sjösted, 1918) from the Brazilian State of Amazonas and *P. garleppi* (Förster, 1903) from Ecuador have been regarded as junior synonyms of *P. buckleyi* by Lencioni (2005) and Garrison *et al.* (2010), respectively. It is possible that they will prove to be good species after their penes are studied.

***Platystigma humaita* sp. nov.**

Figures 10, 16, 22, 31, 39, 46, 47, 56, 57

Material examined. Holotype ♂: Brazil, Acre State, Porto Acre (09º 45' 19"S, 67° 40' 18"W), Reserva Florestal de Humaitá, 28–31.VII.2008, Mielke & Casagrande leg. Type deposited in the ABMM Collection.

Etymology. Humaita, noun in apposition. A reference to the fact that the type was collected in the Forest Reserve of Humaita.

Description of the male holotype. *Head*. Labium yellow, face pale blue with pair of small black rounded spots at the lateral part of the labral-clypeal suture. Upper part of head black, with a narrow yellow transverse occipital stripe.

Thorax. Prothorax: pronotum (Fig. 10) black with S-shaped grayish yellow lateral stripe connected with oblong yellow transverse marking on anterior lobe. Posterior lobe bordered with yellow. Propleuron yellowish white with dorsal oblong black spot (Fig. 10). Pterothorax: mesepisternum (Fig. 16) black with middorsal carina yellow. Antehumeral yellow stripe reduced to small subtriangular marking. Posthumeral yellow stripe not reaching lower part of sclerite. Mesepimeron black, metapleuron yellow with black stripe along metapleural suture. Venter with posterior and anterior triangular black spot, latter continued in black midline (Fig. 22).

Wings. Both Fw and Hw with pale apical areas, with venation white reaching level of RP3 (Fig. 31). Area of Fw bluish white with space posterior to RA blue, and that of Hw bluish white. Pseudostigma in both wings blue with nine cells in Fw and in Hw. At high saturation, both pale area and pseudostigma becomes more intense blue.

Venation: Px in Fw 33, in Hw 29. RP2 in Fw arising at level of Px 8, in Hw at Px 9. IR1 arising near Px 13 in Fw, Px 14 in Hw. RP2 both wings branching from RP at less than half distance from subnodus to tip of wing. In Fw and Hw petiolation distal to CuP by a distance about 5X the length of CuP.

Legs. Femora flexural surface yellow, extensor surface brown; tibiae flexural surface brown, extensor surface yellow. Tarsi black.

Abdomen. S1–7 dorsally black, laterally yellow. S8–9 blue, S10 dorsally blue, laterally brownish yellow. Cercus black.

Structural characters. Median and lateral portions of posterior prothoracic lobe not separated and posterior border slightly convex (Fig. 10). Supplementary tooth of tarsal claw absent. Cleft of anterior lamina shaped as ogival Gothic arch (Fig. 39). Anterior hamuli with ear-like basal plate. End of batilliform lamina hardly visible. Posterior hamuli with apex sclerotized and curved anteromedially (Fig. 39). Penis segment 3 in ectal view subquadrate with small tongue-like apical lobe and distolateral tuft of spines (Fig. 46); in lateral view with distal and proximal tuft of spines (Fig. 47). Penis segment 2 with tuft of spines near the commissure (Figs. 46–47).

Abdomen. S10 slightly elevated dorsally (Figs. 56–57), hind border with medial concavity (Fig. 56). Cerci in dorsal view convergent distally (Fig. 56)

Measurement (mm): Hw 46, abdomen 65.

Female: unknown.

Remarks. *P. humaita* differs from all known species of *Platystigma,* except *P. martinezi* and *P. minimum*, by having pale apical area in both Fw and Hw. It differs from those species by having the penis with segment 3 subquadrate, and the border of male Hw without subapical elevation.

***Platystigma martinezi* (Machado, 1985) n. comb.**

Figures 9, 15, 21, 38, 44, 45, 53–55

Mecistogaster martinezi Machado (1985: 35, 854); Davies & Tobin (1984: 59); Garrison & Ellenrieder (2016: 20), Bridges (1994: VII–147); Tsuda (2000: 58); Corbet (2004: 44, 46, 146, 593, 596, 619); Heckman (2008: 207); Garrison, Ellenrieder & Louton (2010: 391); Schorr & Paulson (2016); Pinto (2016: 21).

Material examined. Holotype ♀ and two paratypes ♀: Bolivia. Department of Santa Cruz, Buena Vista, Ichilo Province (17° 27' 32" S, 63° 44' 07" W), Tacu Pallido, II.1951, A. Martinez leg. Additional ♂: Department of Santa Cruz, 450 m, February–April, no year. Types deposited in the ABMM Collection. Male deposited in FSCA.

Redescription of the female holotype. *Head*: Labrum laterally yellow with large black spot occupying its middle 1/3. Anteclypeus brown, whitish yellow medially. Postclypeus black; base of mandible and genae yellow. Antefrons yellow with median black spot. Upper part of head black, antennal scape black surrounded with yellow at base. Area between vertex and eye with pair of yellow streaks. Rear of head yellow bordered with black posteriorly.

Thorax. Prothorax: Pronotum (Fig. 9) black surrounded by reddish-yellow stripe interrupted at anterior lobe. Posterior prothoracic lobe bordered with yellow. Propleuron reddish yellow ventrally, black dorsally. Pterothorax: Middorsal carina yellowish brown. Antehumeral pale stripe subtriangular, reaching up to 1/3 of mesepisternum (Fig. 15). Venter yellowish with anterior and posterior black spots (Fig. 21).

Wings. Both wings with apical milky-white area reaching level of IR1 in Fw and IR2 in Hw. At high saturation, white areas become pale blue. Pseudostigma poorly indicated in both wings with eight pale yellow cells in Fw and 13 in Hw, more intensely yellow at high saturation. Venation: Px in Fw 31, in Hw 29, RP2 arising at Px 12 in Fw, at Px 10 in Hw. IR1 arising at Px 18 in Fw, at Px 15 in Hw. RP2 branching from RP at less than half distance from subnodus to tip of wing in both wings. Petiolation in Fw originating distally to CuP by a distance about the length of CuP; in Hw about 1½ time this length.

Legs. Fore legs missing. Middle and hind legs with extensor surface of femora light brown, black distally. Tibiae with extensor surface yellowish brown, flexural surface black. Tarsi black.

Abdomen. S1–9 dorsally black, laterally brownish yellow, S10 and cerci black. Ovipositor mainly brownish yellow, lateral valve black.

Structural characters. Median and lateral portions of posterior prothoracic lobe not separated and its posterior border almost straight (Fig. 9). Supplementary tooth of tarsal claws absent. Cerci shorter than S10 in

dorsal view (Fig. 53), parallel, conical, with many white hairs. Ovipositor short, extending posteriorlly to level of hind border of S10. Ventral border of lateral valve with sclerotized triangular plate provided with row of very small denticles of equal sizes.

Measurements (mm): Hw 46, abdomen 54.

Description of the male. *Head*. Lacking.

Thorax. Prothorax: as in female. Pterothorax with pale and black markings as described for female (Fig. 15). Antehumeral pale stripe subtriangular, limited to lower ¼ of sclerite. Venter yellowish white with anterior and posterior small black spots.

Wings. Border of wings with subapical elevation. Fw and Hw hyaline with pale apical area milky-white, including venation. Pseudostigma grayish white with crossveins brown and six cells. At high saturation, apical white area becomes light-blue and pseudostigma more evident. Venation: Px in Fw 30, in Hw 28, RP2 in Fw arising near Px 11, in Hw at Px 9. IR2 arising at level of Px 16 in Fw Px, 14 in Hw. IR1 arising near Px 17 in Fw, at Px 14 in Hw. RP branching from RP1 at less than half distance from subnodus to tip of wing. Petiolation distal to CuP by a distance about the length of CuP in Fw and Hw.

Legs. Femora with flexural surface light-brown, extensor surface black.

Abdomen. S1–9 dorsally black, laterally yellow. S10 and cerci black.

Structural characters. Posterior prothoracic lobe with no separation between median and lateral portions, posterior border slightly convex. Cleft of anterior lamina shaped as ogival Gothic arch (Fig. 38). Anterior hamuli with ear-like basal plate, and posteromedial angle slightly sclerotized. Distal portion of batilliform lamina curved ventrally with sclerotized apex. Posterior hamuli curved anteromedially (Fig. 38). Penis segment 3 in ectal view subrectangular, slightly narrowed medially (Fig. 44); in lateral view with median row of spines (Fig. 45). Penis segment 2 with row of spines near commissure (Fig. 44). Hind border of S10 with small concavity (Fig. 54). Cerci shorter than S10, subcylindrical and tapering distally, in lateral view (Fig. 55), with convergent apex (Fig. 54), in dorsal view (Fig. 54).

Measurements (mm): Hw 44, abdomen 52.

Remarks. The male described here is a specimen borrowed from the Florida State Collection of Arthropods, where it had been identified by M. J. Westfall, Jr., as *Mecistogaster martinezi*. Inside the glassine envelope there is a label written: "it corresponds to the description of the female. Det S. W. Dunkle 1989." This identification, which we believe to be correct is corroborated by the fact that this specimen was collected in the same Department (Santa Cruz) of Bolivia as the holotype. *Platystigma martinezi* belongs to the group of species in which the border of Hw of the male has a subapical elevation, and which also includes *P. astictum* and *P. buckleyi*. It differs from these species mainly by the presence of a pale apical area in both wings of male and female. Although close to *P. astictum, P. martinezi* differs from it by the presence of a row of spines in the penis segment 3 that lack in *P. astictum*. The female cerci of *P. martinezi* had not been described previously. It is remarkably similar to that of *P. astictum*, especially in the presence of much hair. The oviposition of *P. martinezi* (misidentified as *jocaste*) has been observed by Machado & Martinez (1982) and will be compared with that of *P. astictum* at the end of this paper.

***Platystigma minimum* sp. nov.**

Figures 11, 17, 23, 29, 30, 40, 48, 49, 58, 59

Material examined. Holotype ♂: Brazil, Acre State, Rio Branco (09° 58' 13"S, 67° 48' 00"W), 4.VII.1989, collected in Taboca (area rich in bamboo). L. Bedê leg. Type deposited in ABMM Collection.

Etymology. From Latin, *minimus – a – um*, the smallest. A reference to its very small size.

Description of the male holotype. *Head*. Labium yellow, labrum black with pair of large yellow rounded spots. Base of mandible and genae yellow, anteclypeus yellow, postclypeus black, antefrons yellow. Upper part of head with yellow marking posteromedially to antennae bases and smaller yellow marking between it and each lateral ocellus. Rear of head yellow.

Thorax. Prothorax (Fig. 11): anterior lobe yellow bordered with dark brown, with pair of oblong yellow spots disposed transversally. Middle lobe reddish brown with elongated yellow stripe dilated posteriorly. Posterior lobe brown with border yellow. Propleuron dorsally reddish brown and ventrally yellow. Pterothorax: mesepisternum

(Fig. 17) black with antehumeral pale stripe occupying whole extension of sclerite. Posthumeral pale stripe not reaching lower part of sclerite. Venter pale with middle narrow black stripe dilated anteriorly, and posteriorly forming triangular spot (Fig. 23).

Legs. Femora and tibiae brown with flexural surface yellow. Tarsi black.

Wings. Fw and Hw slightly infuscated ante-apically, with large light-yellow apical area and medial border oblique, reaching the level of RP2 (Fig. 29). Pseudostigma hardly distinguishable from yellow area posterior to RA. At high saturation the yellow color becomes more intense (Fig. 30). Venation: Px 30 in Fw; in Hw 28, RP2 arising near Px 8 in Fw, at Px 9 in Hw. IR1 arising at Px 16 in Fw, at Px 17 in Hw, RP2 in both wings branching from RP by less than half distance from subnodus to tip of wing. Petiolation originated distal to CuP by a distance about 1.5X the length of CuP in both wings.

Abdomen. S1–2 dorsally dark brown, laterally yellow. S3–8 dorsally black, ventrolaterally yellow. S9 black with pair of ventrolateral yellow streaks adjacent to intersegmental sutures. S10 and cerci black.

Structural characters. Median and lateral portions of posterior prothoracic lobe not separated and its posterior border slightly convex (Fig. 11). Border of Hw without subapical elevation. Anterior hamuli with ear-like basal plate, alula very slightly sclerotized, except at ventral border (Fig. 40). Anterior lamina with a medial elongated elevation, with apex sclerotized (Fig. 40) and provided with a comb-like column of spines visible only in medial view (Fig. 40). Cleft of anterior lamina shaped as ogival Gothic arch. Distal portion of batilliform lamina well visible, curved ventrally, with sclerotized apex. Posterior hamuli not sclerotized, curved anteromedially. Penis segment 3 in ectal view (Fig. 48) subrectangular with a comb-like row of lateral spines (Figs. 48–49). Cerci in lateral view (Fig. 59) about same length as S10, subcylindrical and tapering distally. In dorsal view with apex convergent (Fig. 58).

Measurements (mm). Hw 32, abdomen 48.

Female: unknown.

Remarks. *Platystigma minimum* is the smallest species of the family Pseudostigmatidae, a position previously occupied by *Anomisma abnorme* McLachlan, 1877. It can be readily identified by its small size, large apical light yellow area in both wings and anterior lamina with a medial elongated elevation, with apex sclerotized and provided with a comb-like column of spines.

Platystigma pronoti (Sjöstedt, 1918) n. comb.

Figures 12, 18, 33–36

Sjöstedt (1918: 31); Davies & Tobin (1984: 57); Garrison & Ellenrieder (2016: 20); Machado (1992: 19); Bridges (1994: 39); Tsuda (2000: 58); Machado, Drummond & Martins (2005: 96); Heckman (2008: 205); Garrison, Ellenrieder & Louton (2010: 391); Schorr & Paulson (2016); Machado & Lacerda (2016: 63).

Material examined. Holotype ♀: Brazil, Espírito Santo (no further information available). Holotype deposited in the NHMS.

Diagnosis. Head with dorsum black and orange-white spots anteriorly and another medially to antennae base. Pronotum dark brown with pair of pale yellow stripes anteriorly and laterally to middle lobe. Border of medial and apex of lateral portions of posterior prothorax lobe pale yellow. Median portion straight, separated from lateral portions by deep incision at each side (Fig. 12); lateral portions with apex rounded (Fig. 12). Mesepisternum (Fig. 18) black with antehumeral grayish-yellow stripe occupying whole extension of sclerite. Mesepimeron dark brown with grayish-yellow stripe not reaching lower part of sclerite. Metapleuron (Fig. 18) whitish yellow with black stripe adjacent to metapleural suture occupying dorsal ¾ of sclerite. Venter of pterothorax whitish yellow, with narrow middle dark stripe occupying its anterior ½. It is impossible to know whether this stripe reaches the posterior part of the venter, because it is damaged. Supplementary tooth of tarsal claws absent. Wings dominantly hyaline with apical area milky-white reaching a row of cells posterior to RP1. Pseudostigma in both wings weakly indicate pale yellow color (Figs. 33, 35). At high saturation, the color of apical area changes; the white color becomes pale blue and the pseudostigma appears very evident, yellow, with six cells in Fw and eight in Hw (Figs. 34, 36). Costal vein becomes orange and RA to RP1 yellow (Figs. 34, 36). Abdomen dominantly brown. Cercus dark, with apex rounded. Ovipositor (stylus lacking) reaching posteriorly about level of hind border of S10.

Measurements (mm): Hw 40. Abdomen 54.

Male: unknown.

Remarks. *Mecistogaster pronoti* is transferred here to *Platystigma* based on its small size, absence of supplementary tooth of tarsal claw and presence of pale apical areas on the wings. The species was described by Sjöstedt (1918) based on a single female specimen from the state of Espírito Santo, Brazil, and has never been found again. According to Heckman (2008), "*M. pronoti* is a rare or unrecognized species." The holotype of *P. pronoti* has been recently redescribed and illustrated by Machado & Lacerda (2016), thus allowing its easy identification. The main character separating *P. pronoti* from the other *Platystigma* species is the peculiar form of the hind prothoracic lobe, whose median portion is clearly separated from the lateral ones. *P. pronoti* has been listed as Critically Endangered in Brazil's, Portarias MMA nº 444/445 (2014) and IUCN (2006) red list, and a strategy for its conservation has been proposed by Machado & Lacerda (2016).

***Platystigma quadratum* sp. nov.**

Figures 13, 19, 24, 32, 41, 50, 51, 60, 61

Material examined. Holotype ♂: Brazil, Acre State, Senador Guiomard, Reserva Catuaba (10° 03' 60"S, 67° 35' 59"W), IX–2003, Mielke & Casagrande leg. (ABMM).Two ♂ paratypes with same data as holotype.

Etymology. From Latin *quadratum-a-um*, quadrate, an allusion to the shape of its penis segment 3 in ectal view.

Description of the male holotype. *Head*. Labium whitish yellow, base of mandible and genae bluish yellow, anteclypeus and postclypeus grayish blue, antefrons brownish. Upper part of head black with metallic green luster. Postocular lobe and occipital crest yellow. Rear of head whitish yellow.

Thorax. Prothorax: pronotum black . Anterior lobe with pair of pale oblong transverse spots. Middle lobe with large pale marking dilated posteriorly (Fig. 13). Posterior lobe bordered with yellow (Fig. 13). Propleuron yellow with black markings (Fig. 13). Pterothorax: mesepisternum (Fig. 19) black with middorsal carina yellow, antehumeral yellow stripe reduced to triangular marking at about 1/3 of sclerite. Posthumeral yellow stripe not reaching lower part of sclerite. Mesepimeron black. Metapleuron yellow with black stripe along metapleural suture. Venter with anterior triangular and posterior subcylindrical black spots (Fig. 24).

Wings. Fw hyaline with light brown pseudostigma, with six cells. Hw with large apical area bluish white reaching RP2; pseudostigma blue with eight cells (Fig. 32). At high saturation, bluish white area becomes whitish blue, surrounded by blue and pseudostigma more intensely blue. Venation: Px in Fw 31, in Hw 33, RP2 in Fw and in Hw originating at Px 11. IR1 originating at Px 16 in Fw, at Px 14 in Hw. RP2 branching from RP at about half distance from subnodus to tip of wing. Petiolation originates distal to CuP by two times length of CuP in Fw and three times in Hw.

Legs. Femora with proximal 1/3 yellow, distally black on extensor surface and yellow on flexural surface. Tibiae with extensor surface yellow and flexural surface black. Tarsi black.

Abdomen. S1–10 dorsally black, laterally yellow. Cerci black.

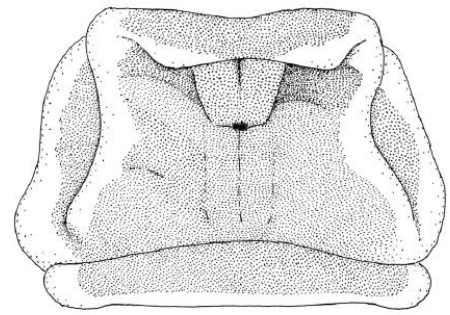
Structural characters. Median and lateral portions of posterior prothoracic lobe not separated. Posterior border slightly convex (Fig. 13). Cleft of anterior lamina shaped as ogival Gothic arch (Fig. 41). Anterior hamuli with ear-like basal plate. Posterior hamuli with apex curved anteromedially (Fig. 41). Distal portion of batilliform lamina very small, apex sclerotized (Fig. 41). Penis segment 3 in ectal view subquadrate with small tongue-like apical lobe and tuft of spines at anterolateral angle (Fig. 50); in lateral view with medial and distal tuft of spines (Fig. 51). Penis segment 2 with large tuft of spines near commissure (Figs. 50–51). Hind border of S10 in dorsal view with medial concavity (Fig. 60); in lateral view with distal ½ elevated (Fig. 61). Cerci in lateral view cylindrical, with distal 1/3 tapering and directed ventrally (Fig. 61). In dorsal view, distally convergent (Fig. 60).

Measurements (mm): Hw 47, abdomen 60.

Variations in paratypes. In one of the paratypes the tuft of spines at the anterolateral angle of penis segment 3 is hardly visible.

Female: unknown.

Remarks. *P. quadratum* shares with *P. humaita* the penis segment 3 subquadrate, with a small tongue-like apical lobe. It differs from it by having a pale apical area only in Hw (in both wings in *P. humaita*).



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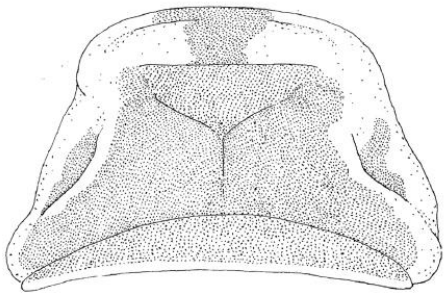

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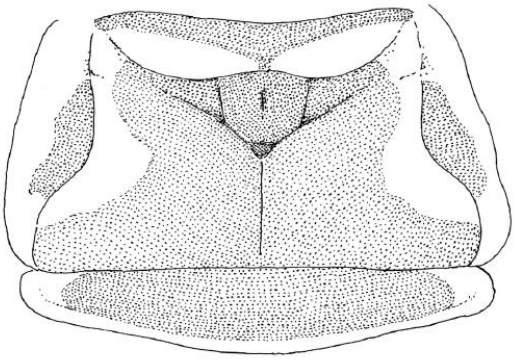

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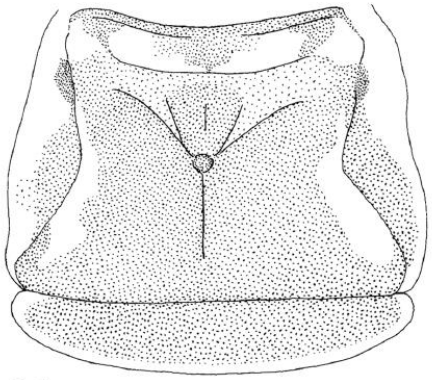

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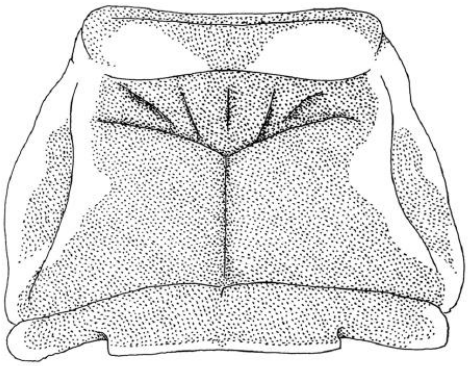

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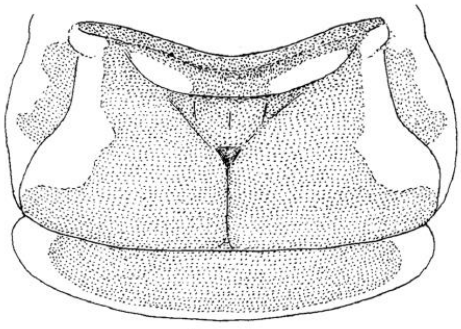

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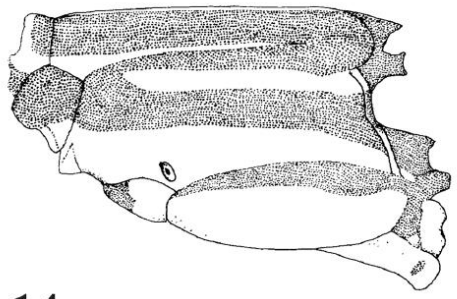
FIGURES 8–13. Prothorax in dorsal view: in *P. astictum* male, Itatiaia, Rio de Janeiro (8); *P. martinezi* female, holotype, Bolívia, Santa Cruz (9); *P. humaita* **sp. nov.** male, holotype, Porto Acre (10); *P. minimum* **sp. nov.** male, holotype (11); *P. pronoti* female, holotype (12); *P. quadratum* **sp. nov.** male, holotype (13).



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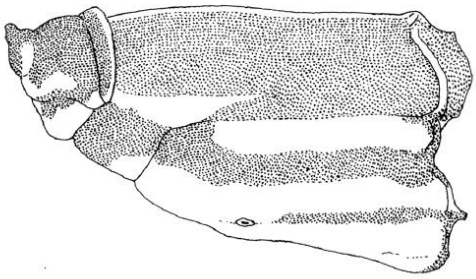

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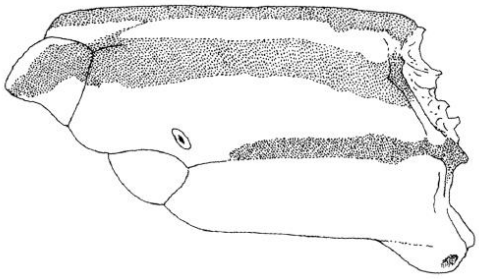

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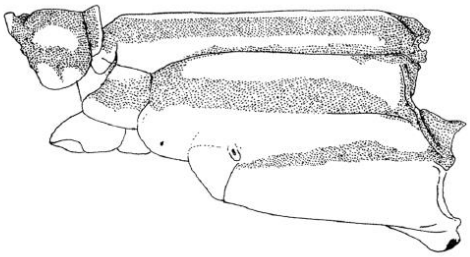

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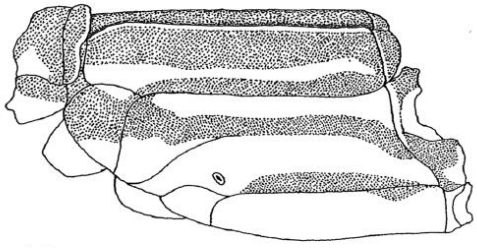

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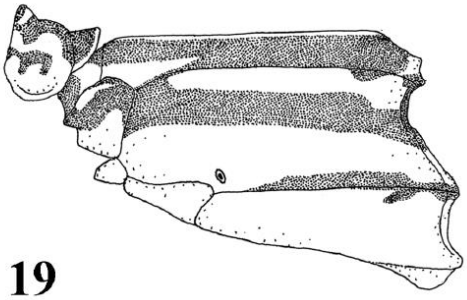

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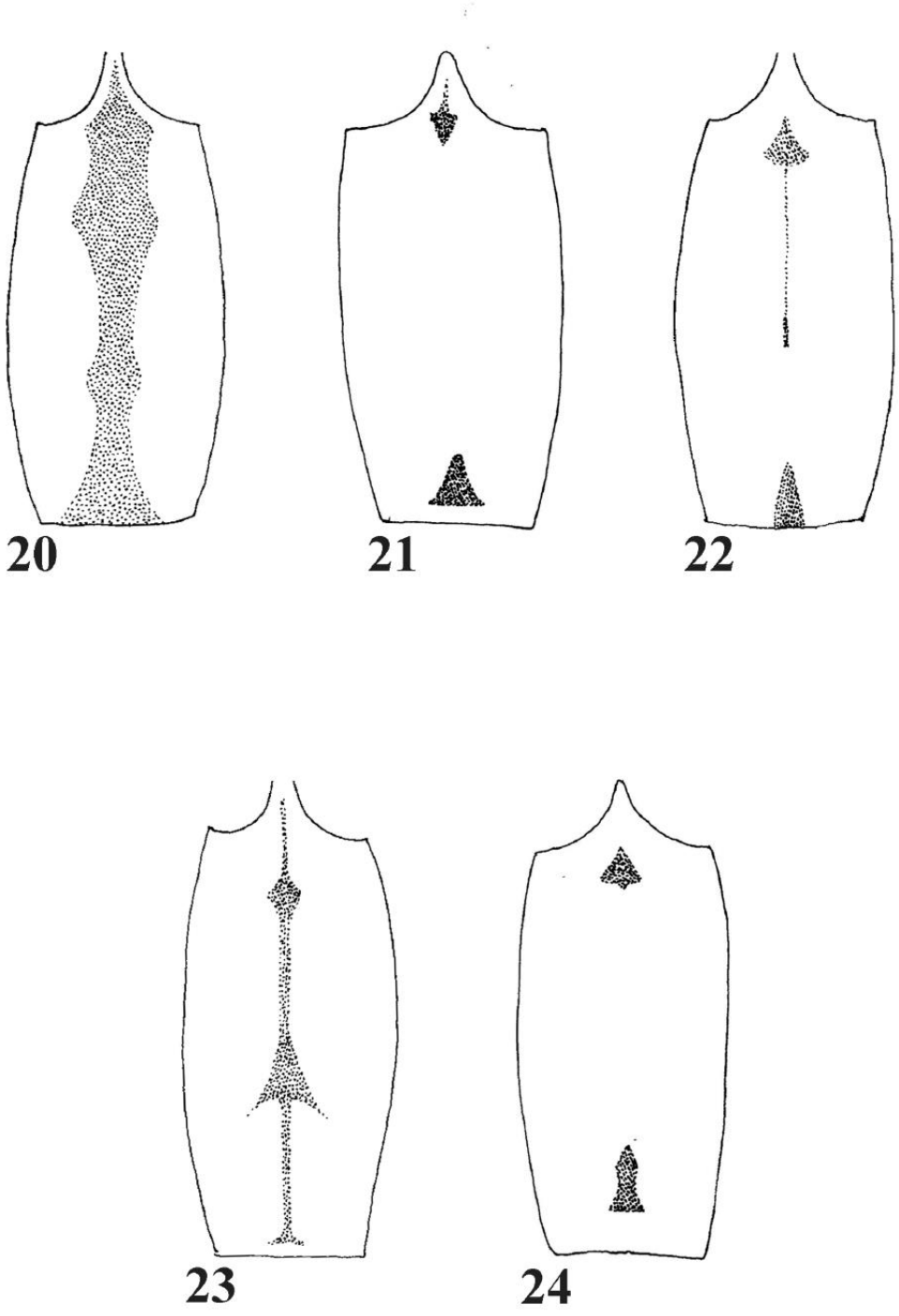
FIGURES 14–19. Pterothorax in lateral view: in *P. astictum* male, Itatiaia, Rio de Janeiro (14); *P. martinezi* female, holotype (15); *P. humaita* **sp. nov.** male, holotype (16); *P. minimum* **sp. nov.** male, holotype (17); *P. pronoti* female, holotype (18); *P. quadratum* male, holotype (19).



FIGURES 20–24. Venter in *P. astictum* male, Itatiaia, Rio de Janeiro (20); *P. martinezi* female, holotype (21); *P. humaita* **sp. nov.** male, holotype (22). *P. minimum* **sp. nov.** male, holotype (23); *P. quadratum* **sp. nov.** male, holotype (24).

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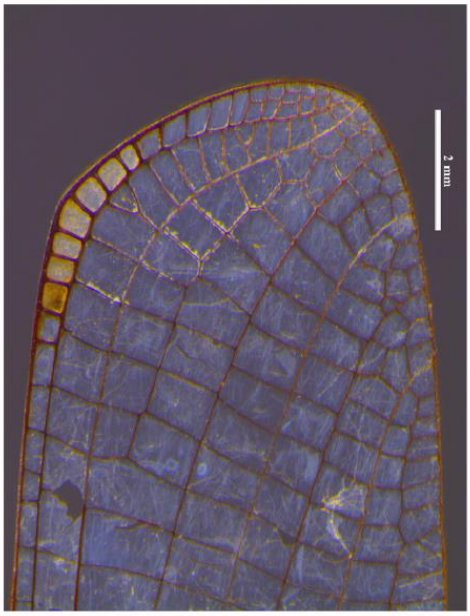

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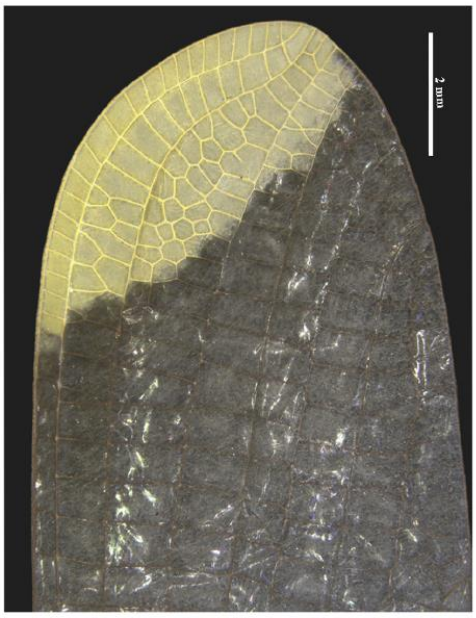
FIGURES 25–28. Wings in *P. astictum* male, Espírito Santo, Hw non saturated (25), saturated (26); female, Itatiaia, Rio de Janeiro, Hw non saturated (27) saturated (28).



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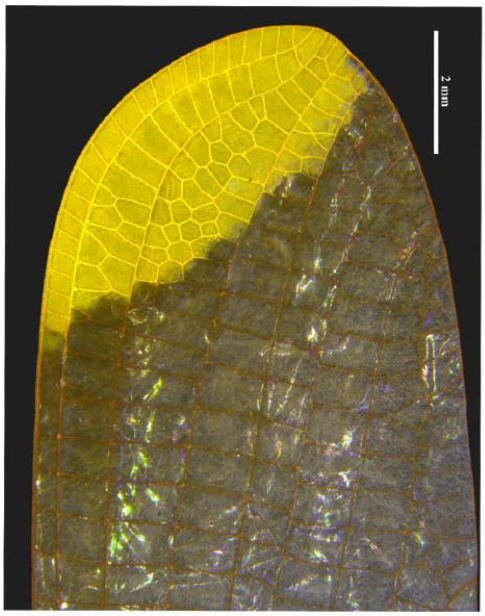

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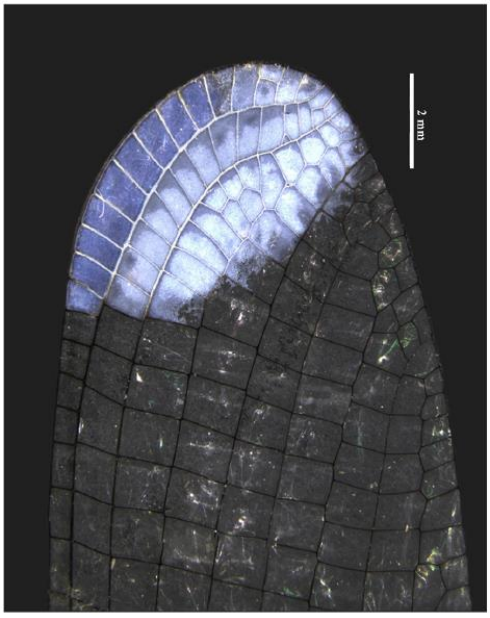

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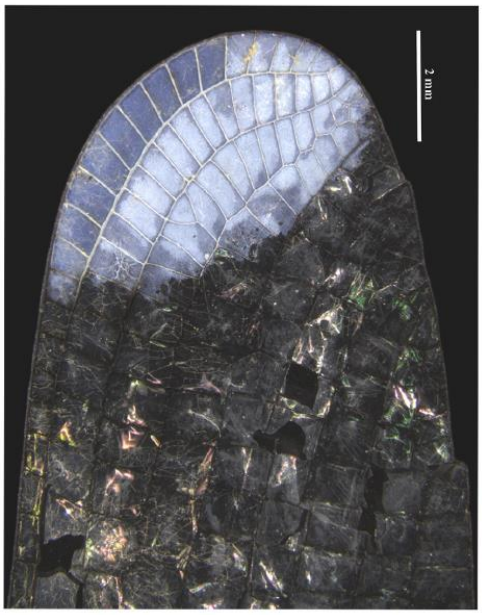

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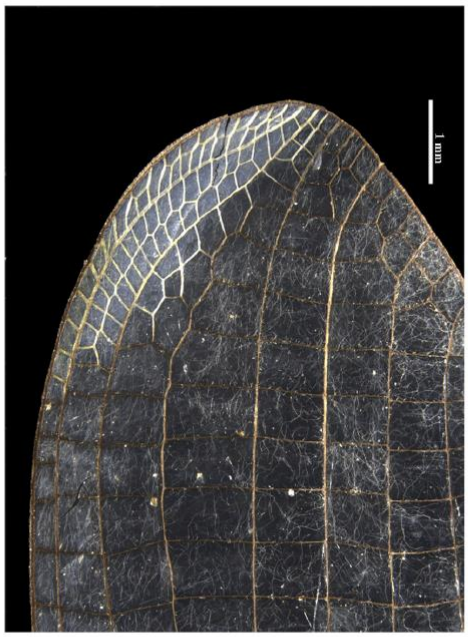
FIGURES 29–32. *P. minimum*, **sp. nov.** male, holotype, Fw non saturated (29), saturated (30). *P. humaita* **sp. nov.** male, holotype, Hw non saturated (31). *P. quadratum* **sp. nov.** male, holotype, Hw non saturated (32).



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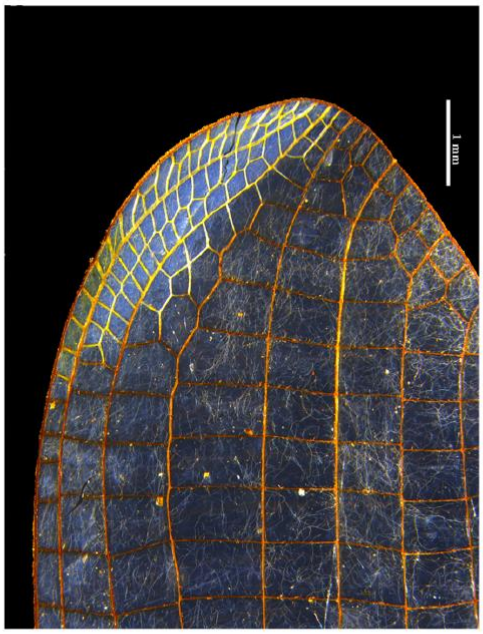

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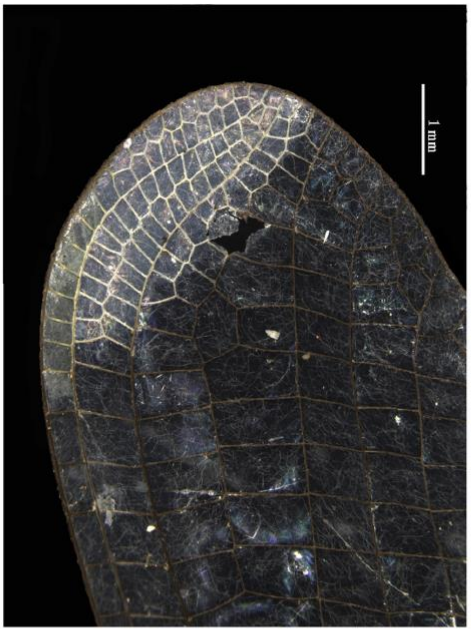

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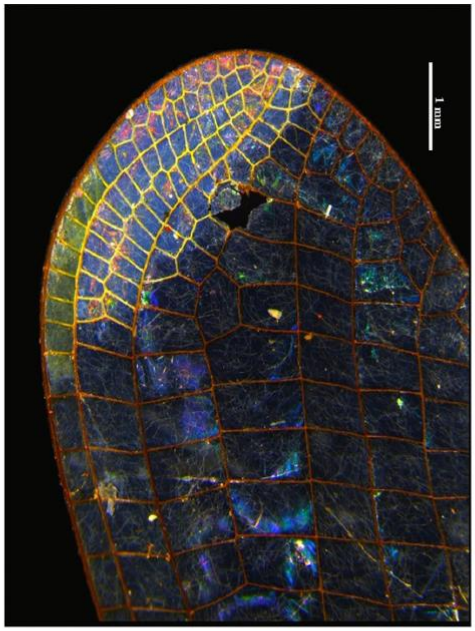

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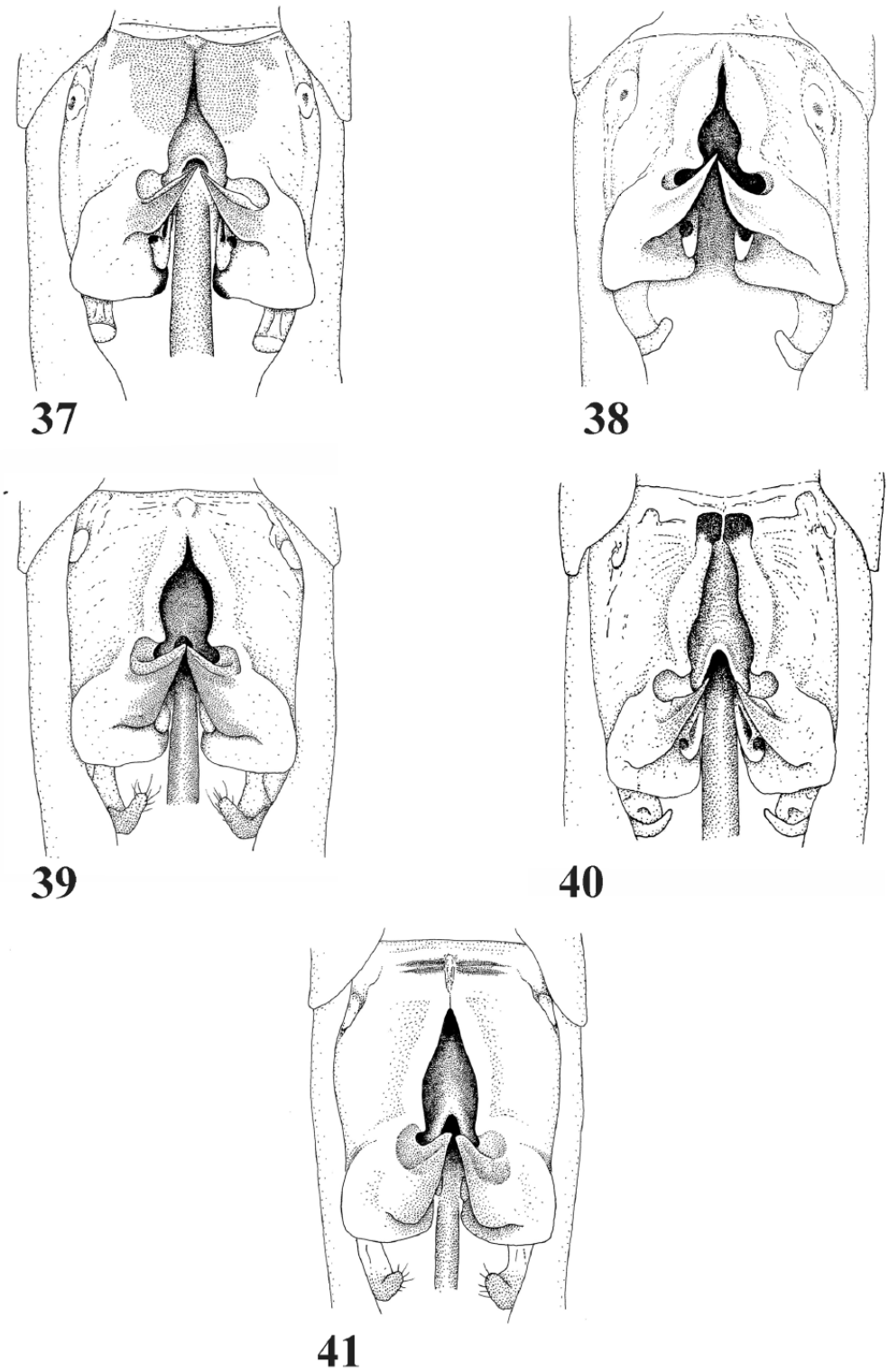
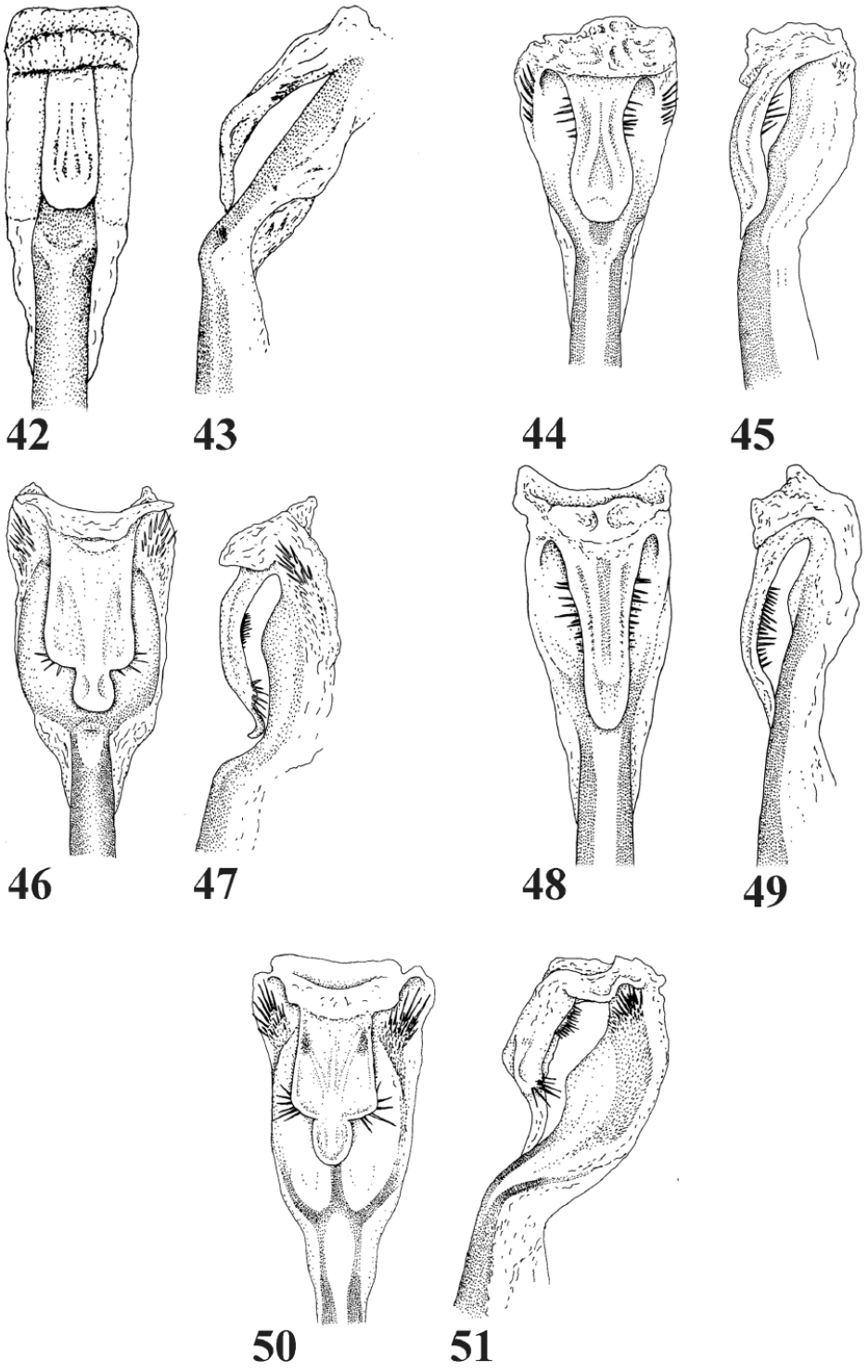
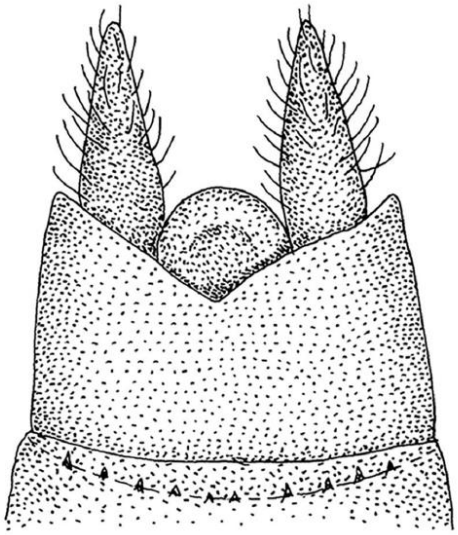
FIGURES 33–36. *P. pronoti* reproduced from Machado & Lacerda (2016), female holotype, Fw non saturated (33), saturated (34), Hw non saturated (35), saturated (36).



FIGURES 37–41. Genitalia of second segment in *P. astictum*, Tinguá, Rio de Janeiro (37); *P. martinezi*, Bolívia, Santa Cruz (38); *P. humaita* **sp. nov.**, holotype (39); *P. minimum* **sp. nov.**, holotype (40); *P. quadratum* **sp. nov.**, holotype (41).



FIGURES 42–51. Penis of *P. astictum*, Tinguá, Rio de Janeiro, in ectal (42) and lateral (43) views; *P. martinezi*, Bolívia, Santa Cruz, in ectal (44) and lateral (45) views. *P. humaita* **sp. nov.** in ectal (46) and lateral (47) views; *P. minimum* **sp. nov.** in ectal (48) and lateral (49) views; *P. quadratum* **sp. nov.** in ectal (50) and lateral views (51).



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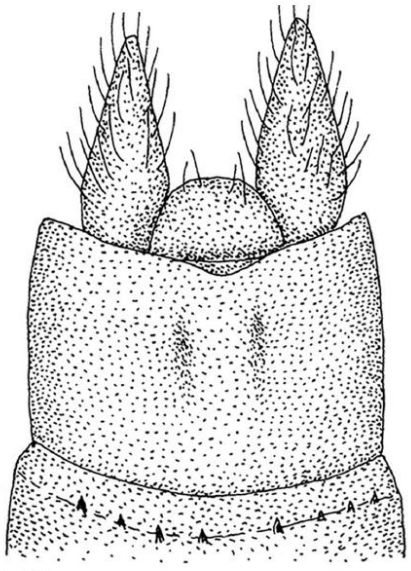

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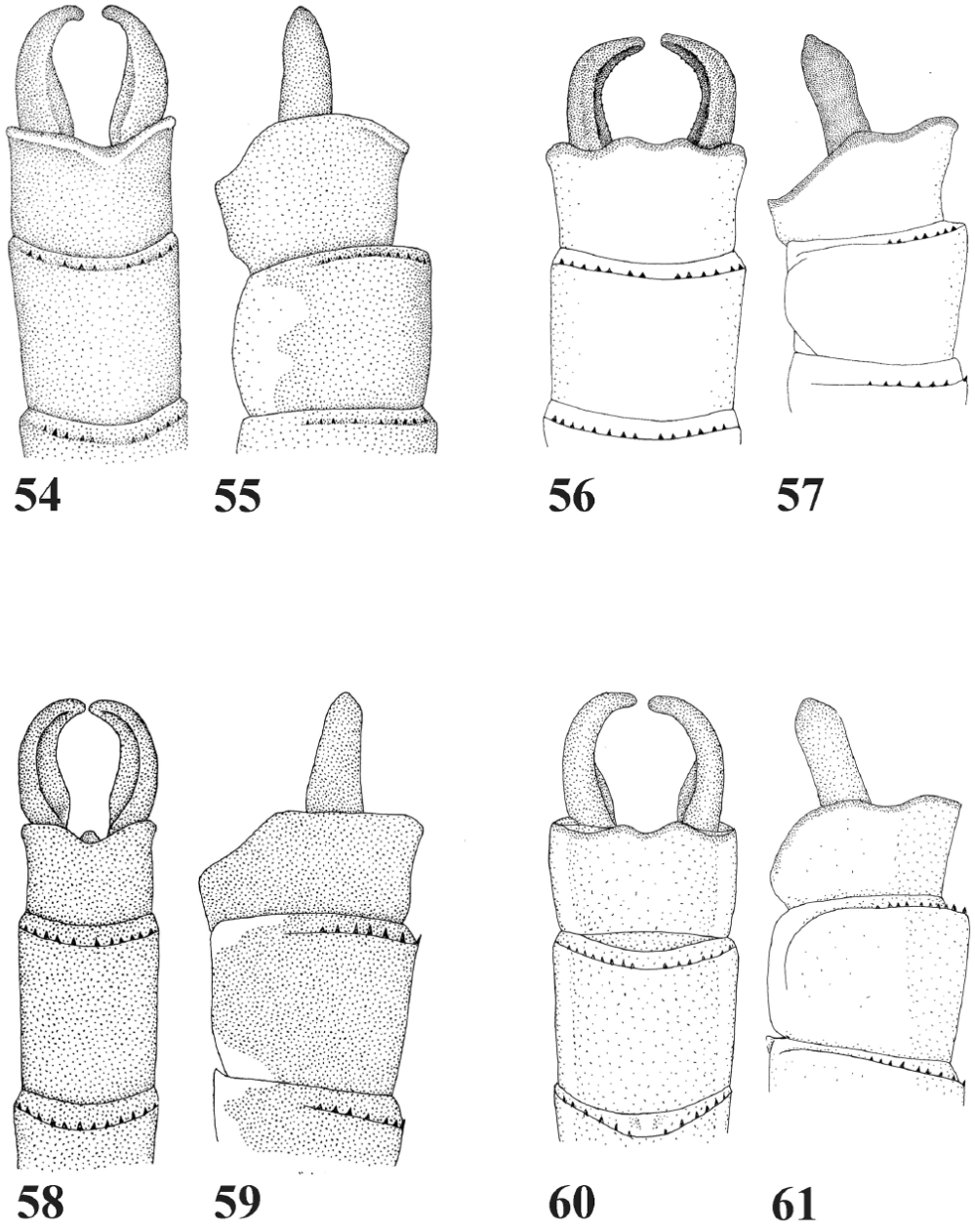
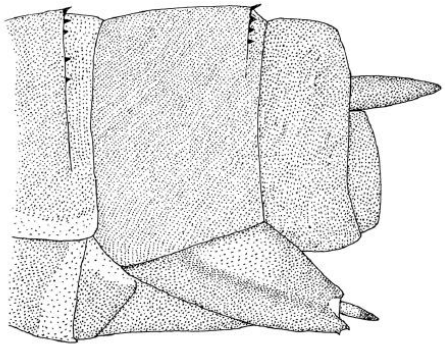
FIGURES 52–53. Female cercus in dorsal view: in *P. astictum*, Rio de Janeiro, Tinguá (52); *P. martinezi*, allotype (53).



FIGURES 54–61. Male cercus in *P. martinezi*, Bolívia, Santa Cruz, in dorsal (54) and lateral (55) views; *P. humaita* **sp. nov.**, holotype, in dorsal (56) and lateral (57) views; *P. minimum* **sp. nov.** in dorsal (58) and lateral (59) views; *P. quadratum* **sp. nov.** in dorsal (60) and lateral (61) views.



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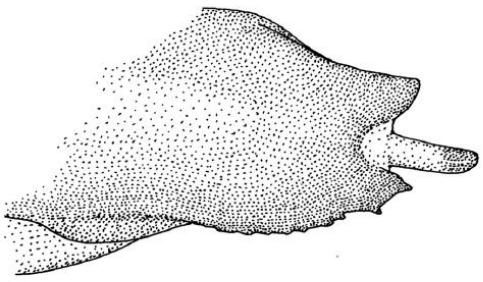

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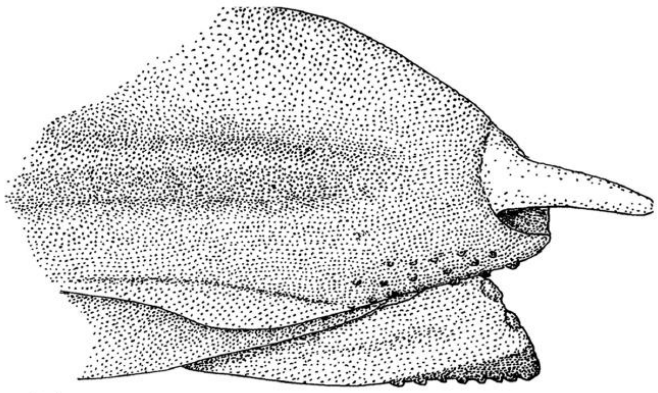

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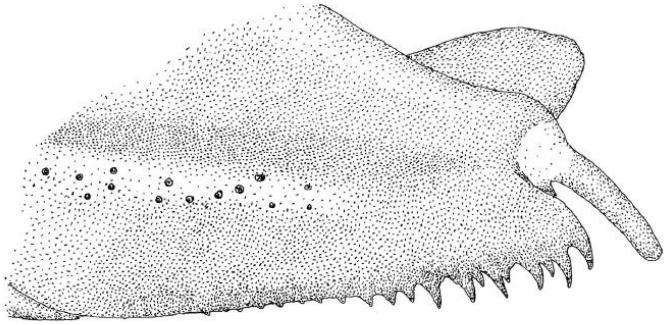

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FIGURES 62–65. Abdomen S8–10 in lateral view: in *P. astictum*, São Paulo, Jacareí (62). Ovipositor in lateral view: in *P. astictum*, Rio de Janeiro, Tinguá (63); *P. martinezi*, holotype (64); *P.* sp. (65).

Oviposition behavior in *Platystigma*

There is an enormous bibliography on oviposition behavior of Odonata (see Corbet 2004), but we are going to treat this subject only for Pseudostigmatidae, with emphasis on *Platystigma*. Since Calvert (1911), it is known that the larvae of *Mecistogaster modesta* live in tank bromeliads, indicating that it oviposits there. Further studies (Fincke 1984, Machado 1985b) revealed that *Mecistogaster linearis* Fabricius, 1776, *Mecistogaster ornata*, *Mecistogaster amalia* (Burmeister, 1839), *Pseudostigma* sp., and *Megaloprepus caerulatus* also breed in phytotelmata (treeholes). *Microstigma anomalum* Rambur, 1842, oviposits in fallen fruits or nut husks (Santos 1981).

It seems, therefore, that in all Pseudostigmatidae oviposition is in phytotelmata (Garrison *et al.* 2010). In *Platystigma*, oviposition behavior has been observed only in *P. astictum* (Selys, 1860) by Lencioni (2006) and *P. martinezi* (Machado, 1985) by Machado & Martinez (1982). The oviposition of *P. martinezi* was observed by the entomologist Antonio Martinez (Machado & Martinez, 1982). He stood motionless by a water-containing tree hole staring at the water surface in an attempt to detect mosquito larvae, when all of a sudden, a large flying damselfly appeared and remained hovering in the air close to his eyes. It curved its abdomen and scattered eggs individually on the water surface, through a series of jerking abdominal movements without touching the water with its abdomen. The eggs were not simply dropped into the water, but struck the water surface obliquely, drifted horizontally for a short distance, and floated. The specimen was collected and at first misidentified as *M. jocaste* and later described as a new species, *M. martinezi* Machado, 1985. This type of oviposition corresponds to "non-contact flying oviposition", as defined by Eda (1962). However, in oviposition described by Eda (1962) the eggs are simply dropped, not thrown obliquely on the water surface as in *P. martinezi*. Martinez's observation was made in such a favorable situation that there is no reason to consider it "likely in error", as did Garrison *et al.* (2010). Indeed the egg-throwing behavior of *P. martinezi* is now recognized by most authors (Silsby 2001, Corbet 1992, 2004, Heckman 2008). According to Corbet (2004), the oviposition by egg-throwing observed in *P. martinezi* is unique in Zygoptera but occurs also in some species of mosquitoes.

The larvae of *P. astictum* are found in water inside bamboo internodes as shown by Lencioni (2006), who described its oviposition behavior as follows: "The female flying slowly and while rising inspected the whole extension of the bamboo to locate a suitable hole. With a very slow forward flight, she approached the bamboo, landed above the hole while maintaining the wings half-open, and curved the abdomen only touching the hole with the tip of her abdomen. She remained in this position for several seconds, usually walking a little above the hole; she then straightened her abdomen and flew to other bamboo stalks looking for new holes." Louton *et al.* (1996) saw an unidentified small *Mecistogaster* (most probably a *Platystigma*) that also oviposited in bamboo but inserted most of its abdomen in the lumen.

In the observations of Lencioni (2006) and Louton *et al.* (1996) it was not ascertained whether the eggs were laid directly on the water surface or in the substrate close to it. It is presumable that other species of *Platystigma,* such as *P. minimum* collected in bamboo-rich area in the state of Acre, also oviposits in bamboo phytotelmata. Despite the lack of direct evidence, it is probable that egg flotation, as observed for *P. martinezi,* also occurs in *P. astictum*. This is probable because in these two species, unlike in five species of *Mecistogaster*, the egg-shell shows a unique structure in Scanning Electro Microscopy (SEM) (Machado 1985b) represented by a great number of pores connected to a meshwork, which may function as an air-containing plastron. This structure is probably responsible for the floating ability of the eggs, as suggested for the eggs of *P. astictum* and demonstrated for the eggs of *P. martinezi* (Machado 1985b). The air-containing chorionic meshwork contributes to egg buoyancy that allows better conditions for egg development than the poorly oxygenated water in the bottom of tree holes.

In attempt to find a morphological correlate to the special type of oviposition of *P. astictum* and *P. martinezi,* we studied the morphology of their ovipositor in comparison to some other species of *Platystigma*. In the lateral valve of three unidentified species of *Platystigma* from the Brazilian states of Rondônia, Amazonas and Pará, the ventral border of the valve is provided with a row of large teeth that become larger distally (Fig. 65). In *P. astictum* (Fig. 63) and *P. martinezi* (Fig. 64), however, this border has a row of minute, equal-sized teeth with only the two distal ones larger in *P. martinezi* (Fig. 64). The number of teeth is also larger in an unidentified *Platystigma* (20) than in *P. astictum* and *P. martinezi* (9–10). According to Matushkina & Lambret (2011), this row of teeth forms a bearing edge which functions to hold the female abdomen on the plant surface during oviposition. It is, therefore, important in endophytic species but not in exophytic ones like *P. martinezi* and possibly *P. astictum* that probably also lay their eggs in the water. This fact may explain why in *P. martinezi* and *P. astictum* the bearing ridge of the

lateral valve has such small teeth, compared to those of three unidentified *Platystigma* that probably oviposit endophytically, as the other Zygoptera. The study of three undetermined species of *jocaste* group in ABMM Collection revealed that their ovipositors also have small teeth and no valve process. This suggests that they also may have exophytic oviposition, although this has not been demonstrated. Another difference between the morphology of the lateral ovipositor valve of *P. martinezi* and *P. astictum* and those of the other three species is the presence of a lateral valve process in these species (Fig. 65) and its absence in *P. astictum* and *P. martinezi* (Figs. 63–64). The significance of these differences is difficult to ascertain without knowing the function of this process, but it is tempting to suppose that it might be related to endophytic oviposition, since it is present in endophytic Zygoptera, such as the four species studied by Matushkina (2004). A detailed study of the ovipositor of *P. martinezi* and other *Platystigma* employing the technique used by Matushkina and Lambret (2011) in *Lestes macrostigma* (Eversmann, 1836) is highly desirable.

Acknowledgments

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