JÚLIO CÉSAR DO CARMO VAZ SANTOS

TAXONOMIA E REPORTES ECOLOGICOS PARA CIXIIDAE SPINOLA, 1839 (HEMIPTERA: AUCHENORRHYNCHA: FULGOROIDEA) DE CAVERNAS BRASILEIRAS

LAVRAS – MG
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Dissertação apresentada à Universidade Federal de Lavras, como parte dos requisitos necessários do Programa de Pós-graduação em Ecologia Aplicada, área de concentração Ecologia e Conservação de Recursos em Paisagens Fragmentadas e Agrossistemas para a obtenção do título de mestre

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APROVADO em 22 de junho de 2022

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2022

Dedico esta Dissertação a todos que de alguma forma auxiliaram na sua construção, mesmo que de forma indireta, toda experiência compartilhada até aqui foi de imenso valor.

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“Escrever é bom. Pensar é melhor. A inteligência é boa. A paciência é melhor”

Sidarta – Hermann Hesse

RESUMO

A presente dissertação foi construída em quatro partes e três capítulos, sendo que o capítulo I "*Hemiptera: Auchenorrhyncha*", fará parte do livro a "*Fauna cavernícola do Brasil*", elaborado como material de compensação ambiental pela empresa Vale S. A. Neste capítulo, fornecemos informações sobre ecologia e habitat dos principais grupos cigarrinhas que ocorrem em cavernas do Brasil, bem como propomos uma chave de identificação para os principais grupos encontrados em habitats subterrâneos brasileiros. Além disso, discutimos as principais ameaças para as espécies de Fulgoroidea troglóbias descritas para o Brasil, e propomos caminhos para a conservação. No capítulo II (Artigo I), fornecemos uma revisão preliminar da taxonomia do gênero *Pintalia* Stål, 1862 para o Brasil, onde redescrevemos as nove espécies da série tipo proposta por Stål (1862). Além disso, descrevemos doze novas espécies e a alocamos em três subgêneros, os primeiros criados para *Pintalia* Stål, 1862. Informações sobre ecologia, habitat, distribuição, e uma chave de identificação para as novas espécies e subgêneros também são fornecidas. No capítulo III (Artigo II), reportamos o primeiro caso de Mudanças Adaptativas em cigarrinhas de cavernas do Brasil. Descremos duas novas espécies troglóbias e a primeira espécie epígea referente ao gênero *Ferricixius* Hoch e Ferreira, 2012. Discutimos a especiação de cigarrinhas em cavernas do Brasil e, os principais desafios para a conservação. No entanto, antes dos três capítulos é fornecido uma introdução geral aos principais temas contemplados nesta dissertação.

Palavras-chave: Invertebrados; Caverna; Taxonomia; Ecologia; Mudanças adaptativas.

ABSTRACT

The present dissertation was built in four parts and three chapters, the chapter I "*Hemiptera: Auchenorrhyncha*", will be part of the book "*Fauna cavernícola do Brasil*", prepared as material for environmental compensation by the company Vale SA In this chapter, we provided information on ecology and habitat of the main groups of planthoppers that occur in caves in Brazil. Additionally, we propose an identification key for the main groups occurring in the Brazilian subterranean habitats. In addition, we discuss the main threats to the troglobitic Fulgoroidea species described for Brazil and propose ways for conservation. In Chapter II (Article I), we provide a preliminary review of the taxonomy of the genus *Pintalia* Stål, 1862 for Brazil, where we redescribe the nine species of the type series proposed by Stål (1862). In addition, we describe twelve new species and allocate them into three subgenera, the first to be created for *Pintalia* Stål, 1862. Information on ecology, habitat, distribution, and an identification key for the new species and subgenera are also provided. In Chapter III (Article II), we report the first case of Adaptive Shifts in Brazilian cave planthoppers. We describe two new troglobitic species and the first epigean species referring to the genus *Ferricixius* Hoch and Ferreira, 2012. We discuss the speciation of leafhoppers in caves in Brazil and the main challenges for conservation. However, before the three chapters, a general introduction to the main topics covered in this dissertation is provided.

Keywords: Invertebrates; Cave; Taxonomy; Ecology; Adaptive Shifts.

SUMÁRIO

APRESENTAÇÃO

A presente dissertação foi erigida em três capítulos. O primeiro capítulo foi elaborado em formato de livro, o segundo e o terceiro capítulo em formato de artigos. No entanto, antes dos capítulos apresentados fornecemos uma breve introdução aos temas que serão contemplados nestes trabalhos.

PRIMEIRA PARTE

Introdução geral

1. Introdução aos Fulgoromorpha (Hemiptera; Auchenorrhyncha) com ênfase para o Brasil

Os hemípteros constituem a maior e mais diversa ordem entre os Paraneopteras (GRIMALDI et al., 2005; KJER et al., 2006; JOHSON et al., 2018). O nome tem origem do grego (*hemi* = metade e *pteron* = asa) e se refere a asas metade membranosas e metade tipo coriácea (GRAZIA et al., 2012). Tais organismos possuem corpo que varia de 0,5 a 15cm, e são caracterizados pelo aparelho bucal em forma de rostro, formado por um lábio segmentado com estiletes perfurantes e pela ausência de palpos maxilares e labiais (HENNIG, 1969-1981; COBBEN, 1978; KRISTENSEN, 1991; FORERO, 2008; SZWEDO, 2016). O aparelho bucal sugador confere hábitos alimentares diversos em Hemiptera, que incluem de fitofagia à predação (ectoparasitismo e hematofagia) (SZWEDO, 2016).

Há muitas décadas os hemípteros são reconhecidos como um grupo monofilético (HENNIG, 1969; CARVER et al., 1991; BOURGOIN; CAMPBELL, 2002; FORERO, 2008; LI, HU et al., 2015; SONG et al., 2016; SZWEDO, 2016). No entanto, a origem da ordem não é bem estabelecida, e embora os fósseis mais antigos sejam datados do Carbonífero (ca. 330 Ma) (NEL et al., 2013; SZWEDO, 2016), análises moleculares recentes apontam ainda para o Devoniano (ca. 419-350 Ma) (JOHSON et al., 2018). O número total de espécies associadas aos hemípteros é incerto e possivelmente subestimado (SZWEDO, 2016). Para o Brasil estima-se cerca de 30 mil espécies (GRAZIA et al., 2012; CARVALHO et al., 2012), e em todo o mundo estima-se aproximadamente 100 mil espécies (ZHANG, 2011), embora alguns trabalhos indiquem até 193 mil espécies (SLATER, 1982; HODKINSON; CASSON, 1991; ARNETT, 2000). Atualmente a Ordem Hemíptera encontra-se subdividida em quatro subordens

(Auchenorrhyncha, Sternorrhyncha, Heteroptera e Coleorrhyncha) (JOHNSON et al., 2018), sendo que as três primeiras ocorrem no Brasil (GRAZIA et al., 2012).

O primeiro registro fóssil de um Auchenorrhyncha foi relatado por BRODIE (1845), com a ocorrência estimada para o Mesozóico da Inglaterra. No entanto, estima-se que a subordem Paleorrhyncha Carpenter, 1931 (Ordem Palaeohemiptera Handlirsch, 1908) (DMITRIEV, 2020), teria se diversificado e dado origem às duas linhagens, Sternorrhyncha e Auchenorrhyncha em meados do Permiano (ca. 270 Ma) (SHCHERBAKOV, 2002; SHCHERBAKOV, 2007; DIETRICH, 2009; BARLETT et al. 2018). Atualmente a subordem Auchenorrhyncha (do grego, *auchen* = pescoço e *rhyncos* = nariz), é reconhecida principalmente por um complexo sistema acústico no segmento abdominal I, flagelo antenal "aristóide", lábio surgindo próximo ao occipital com ausência de gula esclerótica interveniente, e capacidade de salto (possivelmente) (KRISTENSEN, 1975; CARVER et al., 1991; CRYAN; URBAN, 2012). Em relação à dieta, embora alguns autores apontem mudanças na exploração de Xilema para Floema nos grupos atuais (SHCHERBAKOV, 2002; DIETRICH, 2009), estima-se que todos os estágios da história dos Auchenorrhynchas coincidam com os estágios florais passados, visto que desde os grupos mais basais é inferido o hábito sugador de seiva (SHCHERBAKOV, 2002).

A classificação dos Auchenorrhynchas foi amplamente discutida nas últimas décadas, e após muitos conflitos e filogenias propostas (GOODCHILD, 1966; HAMILTON, 1981; BOURGOIN, 1986a-1986b; BOURGOIN; HUANG, 1990; BOURGOIN, 1993), tais organismos foram retirados dos antigos Homoptera. No entanto, com o avanço de abordagens moleculares, novas filogenias também indicam a monofilia do grupo, por exemplo Cryan e Urban (2012), LI Hu et al., (2017), Wang et al., (2017) e Johnson et al., (2018). Atualmente a subordem Auchenorrhyncha é subdividida em duas linhagens monofiléticas, que embora tenham sido indicadas como subordens provisórias de Hemiptera por Bourgoin e Campbell (2002) e mais recentemente por Szwedo (2016), na maior parte dos trabalhos são tratadas como Infraordens, sendo os Cicadomorpha (Cigarras verdadeiras) e os Fulgoromorpha (Cigarrinhas) (OSSIANNILSSON, 1978; BOURGOIN et al., 1997; WILSON, 2005a; CRYAN; URBAN, 2012; MOZAFFARIAN; KHARRAZI, 2014; JOHNSON et al., 2018; CHEN, 2021; GARGALIK, 2021).

A infraordem Fulgoromorpha é composta por duas superfamílias extintas Coleoscytoidea Martynov (1935) (Permiano Superior ca. 260-251 Ma) e Surijokocixioidea Shcherbakov (2000) (Permiano Superior e Triássico ca. 260-200 Ma), e apenas uma única superfamília com representantes atuais, os Fulgoroidea Latreille (1807), com registros que datam do Jurássico inferior (ca. 200-155 Ma) (SZWEDO, 2016). Atualmente os Fulgoroidea compreendem um grande grupo exclusivamente fitófago que soma mais de 14.000 espécies distribuídas em todo o mundo (BOURGOIN, 2021). Podem consumir angiospermas, gimnospermas, fungos, musgos, e algumas pteridófitas (O'BRIEN; WILSON, 1985; WILSON, 1994). Podem, ainda, em alguns casos, exibir alta especificidade com a planta hospedeira (KRAMER, 1977; LARIVIERE, 1999; NICKEL; REMANE, 2002; WILSON et al., 1994-2005). A relação dos Fulgoroidea com as plantas hospedeiras está além das necessidades para alimentação, tendo sido relatado também o uso para ovoposição, abrigo, comunicação, acasalamento e especiação (NAULT; RODRIGUEZ, 1985; DENNO; PERFECT, 1994; CLARIDGE, 1985; CLARIDGE; VRIJER, 1994). A morfologia completa dos Fulgoroidea foi avaliada por diferentes autores ao longo do tempo, sendo os principais autores e caracteres para a identificação informados no Capítulo I. Atualmente em todo o mundo a superfamília Fulgoroidea é composta por 14 famílias extintas e 21 ainda viventes.

Baptista (2006), com base em artigos publicados e indexados no Zoological Records, registrou 627 espécies, 205 gêneros, em 14 famílias ainda vivas distribuídas nos estados Brasileiros, também contabilizadas para o Brasil na base FLOW, mais †Lalacidae Hamilton, 1990, (BOURGOIN, 2021). Além destas famílias, Viegas (2019) apontou a ocorrência de oito novas espécies de *Bebaiotes* - Achilixiidae Muir, 1923 para a região norte do Brasil, somando 16 famílias descritas para o país. A monofilia dos Achilixiidae Muir, 1923 ainda é incerta, e uma pequena introdução é fornecida no capítulo I. Bourgoin (2021), contabiliza 394 espécies de Fulgoroidea para o Brasil, sendo que 130 destas espécies possuem como localidade tipo apenas “Brasil”. As regiões do Brasil com maior número de espécies de Fulgoroidea é a região Norte com 170 espécies (principalmente Amazonas e Pará), seguida pela região Sudeste com 122 espécies (principalmente Rio de Janeiro) e Sul com 49 espécies (principalmente Santa Catarina) (BOURGOIN 2021). As famílias com maior número de espécies descritas para o Brasil são Derbidae com 105 espécies, Fulgoridae com 41 espécies e os Cixiidae com 39 espécies (BOURGOIN 2021). No entanto, estes dados são subestimados, visto a ampla fauna

não descrita depositada em coleções de todo país, e publicações realizadas ainda no século XIX, que levam a descrições e ocorrências muito difíceis de serem reconhecidas ou averiguadas, como em Achilixiidae Muir, 1923, Delphacidae Leach, 1815, e Cixiidae Spinola, 1839.

Atualmente os Cixiidae compreendem a maior família entre os Fulgoroidea (BOURGOIN, 2021), e possuem o maior número de gêneros endêmicos de cavernas (16) ao redor do Globo (ver capítulo II). O primeiro registro fóssil de Cixiidae é datado para o Cretáceo (129,4 - 125 Ma) (Bourgoin 2021), muito embora alguns trabalhos apontem que a maioria dos Fulgomorpha que viveram durante o jurássico inferior já exibiam algumas características primitivas do tipo Cixiidae (SHCHERBAKOV, 2002). Holzinger et al., (2002) revisaram a família e forneceram informações sobre a morfologia, ecologia, importância econômica e dicas sobre as principais chaves para a identificação desta família. As fêmeas possuem o ovopositor bem definido, do tipo 'ortóptero' (ASCHE, 1988), caráter compartilhado em Fulgoroidea apenas com Delphacidae (HOLZINGER et al., 2002), muito embora a monofilia entre Cixiidae e Delphacidae não seja bem estabelecida (ASCHE, 1997; URBAN; CRYAN, 2007; CEOTTO et al., 2008; URBAN et al., 2010). Vários estudos publicados nas últimas décadas examinaram as relações filogenéticas dentro dos Cixiidae, com base em dados morfológicos (HOLZINGER et al., 2002; EMELJANOV, 2002; CEOTTO; BOURGOIN, 2008, e BROŻEK; BOURGOIN, 2013) e moleculares (URBAN; CRYAN, 2007; CEOTTO et al., 2008) e incluíram a tribo Pintaliini Metcalf, 1938.

Os Pintaliini Metcalf, 1938, são amplamente distribuídos no novo mundo (BOURGOIN, 2021), e atualmente correspondem a 8 gêneros ainda viventes (*Pintalia* Stål, 1862 gen. tipo*; Aulocorypha* Berg, 1879; *Cubana* Uhler, 1895; *Cubanella* Fennah, 1948; *Diastrocixius* Caldwell, 1944; *Monorachis* Uhler, 1901; *Muirolonia* Metcalf, 1936 e *Notocixius* Fennah, 1965) (BOURGOIN, 2021). Recentemente Szwedo, 2019 descreveu o gênero †*Worodbera* Szwedo, 2019, para alocar uma única espécie fóssil, †*Worodbera nimakka* Szwedo, 2019, datada do período Priaboniano no Eoceno (ca. 37,8 - 33,9 Ma) (SZWEDO et al., 2019; BOURGOIN, 2021). A maioria dos gêneros agrupados em Pintaliini Metcalf, 1938, foram descritos a muito tempo e são um desafio para a proposta de novas espécies, portanto devem ser revisados. Atualmente *Pintalia* Stål, 1862 exibe o maior número de espécies entre os Pintaliini Metcalf, 1938 (BOURGOIN, 2021). No entanto, *Pintalia* Stål, 1862 é definido por caracteres basais, e atualmente age como gênero do tipo "balde de lixo" agrupando uma grande

variedade de espécies que não puderam ser alocadas nos outros gêneros da tribo. Além disso, é o único gênero entre os Pintaliini Metcalf, 1938 com espécies descritas para o Brasil (BOURGOIN, 2021), e possivelmente o gênero de cigarrinhas mais abundante em cavernas Brasileiras (ver capítulo I).

1.1. Resumo histórico e taxonômico para *Pintalia* Stål, 1862.

O gênero *Pintalia* foi proposto por Stål, 1862 para agrupar nove espécies com distribuição ainda pouco clara. Stål (1862) informou apenas "Brasil" ou "Rio de Janeiro" para a localização das espécies propostas para erguer o gênero (*P. lateralis* Stål, 1862 - espécie de tipo, *P. consobrina* Stål, 1862, *P. fasciatipennis* Stål, 1862, *P. fraterna* Stål, 1862, *P. inornata* Stål, 1862, *P. obscuripennis* Stål, 1862, *P. pictipennis* Stål, 1862, *P. proxima* Stål, 1862 e *P. ustulata* Stål, 1862). O autor informou que caracteres da cabeça, tórax e tégminas compõem as principais características do gênero. No entanto, pouco se pode aproveitar das descrições originais, que não contam com figuras ou descrições das genitálias masculinas, sendo que as características morfológicas externas também são pouco nítidas. Mais tarde Stål (1869) transferiu *Flata variegata* Fabricius, (1803) para *Pintalia variegata* (Fabricius, 1803), somando dez espécies para gênero até aquela data.

Muir (1925a) identificou sinônimos de *Pintalia* Stål, 1862 com três gêneros: *Ciocixius* (Metcalf, 1923) (*Cixius dorsivittatus* Van Duzee, 1909-espécie-tipo); *Cotyleceps* (Uhler, 1895) (*Cotyleceps decorata* Uhler, 1895 - espécie-tipo; *Cotyleceps procellata* Uhler, 1901); *Metabrixia* **(**Fowler, 1904) (*Metabrixia delicata* Fowler, 1904-espécie-tipo; *Metabrixia aspersa* Fowler, 1904; *Metabrixia germana* Fowler, 1904; *Metabrixia maculata* Fowler, 1904). Mais tarde, Muir (1934) descreveu vinte e oito novas espécies para a América do Sul, sendo dez delas para o Brasil (*P. fuscispennis* Muir, 1934; *P. propria* Muir, 1934; *P. longispinis* Muir, 1934; *P. quadrispinosa* Muir, 1934; *P. infuscta* Muir, 1934; *P. fuscomaculata* Muir, 1934; *P. angustinotata* Muir, 1934; *P. albomarginata* Muir, 1934; *P. latinotata* Muir, 1934; *P. ornata* Muir, 1934), quinze para o Equador (*P. huigrensis* Muir, 1934; *P. furcata* Muir, 1934; *P. distincta* Muir, 1934; *fuscomaginata* Muir, 1934; *P. obscurata* Muir, 1934; *P. lentiginosa* Muir, 1934; *P. tunguraguensis* Muir, 1934; *P. brunnivenosa* Muir, 1934; *P. bicaudata* Muir, 1934; *P. obtorta* Muir, 1934; *P. ecuadoriensis* Muir, 1934; *P. maculinipennis* Muir, 1934, *P. puchella* Muir, 1934; *P. altamazonica* Muir, 1934; *P. discrepans* Muir, 1934), e três para a Guiana (*P. blairmontensis* Muir, 1934; *P. albolineata* Muir, 1934; *P. tumatumariensis* Muir, 1934). Muir

(1934) enfatizou a importância da ontogenia para o entendimento da homologia acerca das características do gênero com outros Fulgoroidea, assim como a importância do uso das genitálias masculinas na descrição de espécimes de Fulgoroidea.

Osborn (1935) descreveu quatro espécies para Porto Rico e Ilhas Virgens (*P. alta* Osborn, 1935; *P. insularis* Osborn, 1935; *P. infuscata* Osborn, 1935; *P. maculata* Osborn, 1935). Mais tarde, Caldwell (1944-1951) renomeou duas destas espécies, *P. infuscata* Osborn (1935), em razão de *P. infuscata* Muir (1934), *nomen novum P. martorelli* Caldwell (1951) e *P. maculata* Osborn (1935), em razão de *P. maculata* (Fowler, 1904), *nomen novum P. osborni* Caldwell (1944). O autor também forneceu redescrições e imagens para as quatro espécies propostas por Osborn (1935). Pouco mais tarde Metcalf (1936) oficializou os sinônimos propostos por Muir, 1925, entre *Ciocixius* (Metcalf, 1923), *Cotyleceps* (Uhler, 1895), *Metabrixia* (Fowler, 1904) e *Pintalia* Stål, 1862. Metcalf (1938) em "The Fulgorina of Barro Colorado and other parts of Panama", forneceu uma chave para as espécies descritas até aquela época, uma diagnose para o gênero e diagnose emendada para *P. germana* (Fowler 1904), *P. tacta* (Fowler 1904) e *P. maculata* (Fowler 1904). O autor também descreveu duas novas espécies para o Panamá (*P. fusca* Metcalf, 1938; *P. erecta* Metcalf, 1938).

Caldwell (1944 – 1951) se dedicou às espécies da América central principalmente, mas descreveu espécies da América do Sul e Norte, somando treze espécies descritas para seis países do novo mundo. Destas espécies, sete foram descritas para o México (*P. chromata* Caldwell, 1944; *P. geometra* Caldwell, 1944; *P. lineata* Caldwell, 1944; *P. marginata* Caldwell, 1944; *P. neoaspersa* Caldwell, 1944; *P. pseudomaculata* Caldwell, 1944; *P. punctata* Caldwell, 1944), duas espécies para os Estados Unidos (*P. nemaculata* Caldwell, 1951, *P. supralta* Caldwell, 1951), uma espécie para a Guatemala (*P. acarinata* Caldwell, 1944), uma espécie para a Guiana (*Pintalia stigmata* Caldwell, 1944), uma espécie para a Bolívia (*P. contra* Caldwell, 1944), e uma espécie para a Costa Rica (*P. fumata* Caldwell, 1944). Caldwell (1944) chamou atenção para a dificuldade de descrever novas espécies para o gênero devido às publicações antigas serem baseadas em manchas e cores. O autor também forneceu informações acerca da distribuição e morfologia de *P. aspersa* (Fowler, 1904), *P. dorsivittatus* (Van Duzee, 1909) e *P. delicata* (Fowler, 1904).

Fennah (1945-1971) se dedicou a fauna da América do Sul e América Central. No total descreveu doze espécies para nove territórios do novo mundo. Destas espécies três são para o

Equador (*P. daedala* Fennah, 1945a; *P. marmorata* Fennah, 1945a; *P. vomerifera* Fennah, 1945a) e duas para a Bolívia (*P. curvivitta* Fennah, 1945a; *P. quadrimaculata* Fennah 1945a = *Pintalia constellaris* (Walker, 1858) sin. por Fennah 1947: 12); Os demais territórios receberam uma única espécie cada: Ilhas Cayman (*P. damalis* Fennah, 1971); Dominica (*P. dominicana* Fennah, 1948); Guiana francesa (*P. falcata* Fennah, 1945a); Grenada (*P. grenadana* Fennah, 1948); Peru (*P. obliquivitta* Fennah, 1945a); Santa Lucia (*P. sanctae-luciae* Fennah, 1948); Trindade e Tobago (*P. straminea* Fennah, 1945b). Fennah 1945a informou que a morfologia do segmento anal masculino e estilos genitais são características mais estáveis entre os caracteres utilizados na identificação de *Pintalia* Stål, 1862. Fennah (1945a) também relacionou as seis novas espécies descritas por ele até aquela data, e espécies propostas por Muir (1934) em nove grupos: propria, ecuadoriensis, albolineata, infuscata, obtorta, ornata, huigrensis, bicaudata e vomerifera. Além disso, Fennah (1965) transferiu *Cixius fasciolaris* Blanchard, 1852, para *Pintalia fasciolaris* (Blanchard, 1852).

A última diagnose proposta para o gênero foi elaborada por Kramer (1983). No entanto, este autor teve acesso apenas a espécies que ocorrem nos Estados unidos, portanto pôde observar apenas uma pequena parte de uma grande variedade de espécies distribuídas no novo mundo. Além disso, Kramer (1983) descreveu duas novas espécies *P. vibex* Kramer, 1983 e *P. gurneryi* Kramer, 1983, e redescreveu *P. delicata* (Fowler 1904), além de fornecer figuras e informações para a distribuição das espécies que ocorrem no norte do México, forneceu uma chave para identificação destas espécies. Mais recentemente, O'brien (1987) em Correções e adições ao "The Fulgorina de Metcalf, Barro Colorado e outras partes do Panamá ", descreveu duas novas espécies (*P. metcalfi* O'Brien, 1987, *P. mettacta* O'Brien, 1987), e forneceu notas e imagens para *Pintalia germana* (Fowler 1904) e *Pintalia tacta* (Fowler 1904).

Desde que foi erigido, muitas espécies foram descritas e sinonimizadas em *Pintalia* Stål (1862). Atualmente o gênero é composto por oitenta e uma (80) espécies distribuídas no novo mundo (Bourgoin 2021). *Pintalia* Stål, 1862 exibe uma grande variedade de espécies que têm em comum as margens distais da tégmina que se tocam quando em repouso, e o vértice separado da fronte por uma carena apical transversal. Possivelmente *Pintalia* Stål, 1862 trata-se de um grupo polifilético e alguns sinônimos devem ser revistos. Portanto, é aconselhável que a proposta de novas espécies seja feita junto do erguimento de subgêneros afim de homogeneizar a informação para o gênero e facilitar trabalhos filogenéticos futuros. Além disso, informações

acerca da ecologia e biologia das espécies de *Pintalia* Stål, 1862 raramente foram informadas na literatura.

Kramer (1983) relatou o consumo de *Sagittaria latifolia* Willd (Alismatales, Alismataceae) por *Pintalia delicata* (Fowler, 1904), porém ainda não foi encontrado nenhuma especificidade na alimentação de *Pintalia* Stål, 1862, portanto as espécies do gênero são classificadas como polifágas (MAZZONI, 2005). Em geral espécies de *Pintalia* Stål, 1862 estão associadas às partes verdes das plantas, tendo sido observados muitos espécimes em amostras de nebulização de dossel tropical (BARLLET, 2021). Muito embora a localização tipo (Disponível em literatura taxonômica) de muitas espécies esteja inserida em regiões cársticas, ou próximo de regiões com ocorrência de cavidades naturais em toda América do Sul (e.g. STÅL, 1862; MUIR, 1934; CALDWEL, 1944; FENNAH, 1945), apenas no Brasil são frequentes os registros de jovens e adultos em cavernas, alimentando-se de raízes oriundas da vegetação epígea (externo às cavidades).

No capítulo II, redescrevemos a serie tipo proposta por Stål, 1862. Descrevemos doze novas espécies encontradas em cavernas do estado de Minas Gerais para o Brasil, e as alocamos em três subgêneros aqui propostos: *Pintalia* (*Pictipennis*) **subgen. nov** (*P. pictipennis* Stål, 1862, *P. propria* Muir 1934, *P. minuta* **sp. nov**, *P. minima* **sp. nov**, *P. magnaepiprocti* **sp. nov**, *P. serratilis* **sp. nov**, *P. stali* **sp. nov**), *Pintalia* (*Ecuadorensis*) **subgen. nov** (*P. constellaris* (Walker,1858), *P. ecuadorensis* Muir, 1934, *P. ferratilis* **sp. nov**, *P. fennahi* **sp. nov**), *Pintalia* (*Caudata*) **subgen. nov** (*P. dorensis* **sp. nov**, *P. lundi* **sp. nov**, *P. painensis* **sp. nov**, *P. montalvaniensis* **sp. nov**, *P. muiri* **sp. nov**). Os subgêneros foram criados principalmente em razão da genitalia masculina, no entanto, outros caracteres podem ser úteis para identificação, como a carena apical transversal em vista frontal e dorsal, presença de setas finas ou platelas no segundo tarsomero da perna posterior, e padrão de células e veias da tégmina. Além disso, propomos um novo diagnóstico para *Pintalia* Stål, 1862, fornecemos um checklist para espécies descritas para o Brasil, e uma chave para as novas espécies e subgêneros propostos aqui. Informações sobre ecologia e habitat também são fornecidas.

1.2. Aspectos gerais, classificação, e especiação de Fulgoroidea(s) em cavernas.

Abaixo da superfície terrestre há espaços de variados tamanhos, que podem abrigar uma vasta fauna subterrânea (CULVER; PIPAN 2009; CULVER; PIPAN 2018). Comumente, estes

habitats são categorizados em grandes cavidades (cavernas), pequenas cavidades (habitats intersticiais) e mais recentemente espaços que conectam cavidades (habitats subterrâneos rasos) (CULVER; PIPAN 2018). Os habitats subterrâneos têm em comum médias anuais de temperatura que variam menos que no ambiente epígeo, alta umidade e ausência permanente de luz solar (GILBERT et al., 1994; CULVER; PIPAN 2014-2018). A ausência permanente de luz solar confere a estes ambientes carência de produtores autotróficos primários como plantas, algas e algumas bactérias, fazendo com que a maior parte da energia disponível nestes ambientes seja advinda do ambiente epígeo. No entanto, algumas vezes raízes provenientes da vegetação epígea adentram nestas cavidades, se tornando um importante recurso para o estabelecimento da fauna subterrânea (STONE et al., 2012).

Os Fulgoroidea são candidatos improváveis aos habitats subterrâneos, visto que são fitófagos, e a relação com as plantas hospedeiras é essencial para completar seu ciclo de vida (COBBEN, 1965; CLARIDGE, 1985; CLARIDGE; VRIJER, 1994). No entanto, as ninfas em algumas famílias de cigarrinhas são subterrâneas e se alimentam das raízes provenientes da vegetação epígea (Cixiidae Delphacidae, Kinnaridae, Meenoplidae e Hypochthonellidae) (HOCH 1994-2002, STONE et al., 2012). Hoch (2002) e Howarth (2019) apontaram essa pré-adaptação como um importante fator para o surgimento de espécies capazes de completar todo o ciclo de vida em ambientes subterrâneos. Atualmente mais de sessenta espécies foram registradas vivendo obrigatoriamente em ambientes subterrâneos em diferentes regiões do mundo (HOCH, 2002; BOURGOIN, 2021). No Brasil, até o momento, são reconhecidas três espécies Fulgoroidea obrigatoriamente cavernícolas *Ferricixius davidi* Hoch e Ferreira (2012), *Kinnapotiguara troglobia* (Hoch e Ferreira 2013) e *Iuiuia caeca* Hoch e Ferreira (2016) (ver Capítulo I e III). Espécies obrigatoriamente cavernícolas são reconhecidas como troglóbias.

Sket (2008) revisou o sistema de classificação ecológico e evolutivo das espécies de cavernas (SCHINER, 1854; RACOVIŢĂ, 1907; RUFFO, 1957; BARR 1968) e atualmente os fulgoroidea encontrados em cavernas podem ser classificados da seguinte forma:

- **Troglóbios**: Espécies estritamente subterrâneas que exibem modificações morfológicas, fisiológicas e ou comportamentais selecionadas para sobreviver em ambientes hipógeos (e.g. *Ferricixius Davidi* Hoch e Ferreira, 2012).

- **Eutroglófilos**: Espécies que podem estabelecer populações viáveis tanto dentro quanto fora de cavernas, eventualmente algumas populações podem exibir troglomorfismos incipientes (e.g *Sanghabenna florenciana* Hoch et al., 2017).

- **Subtroglófilos**: Espécies que podem estabelecer populações dentro de cavernas, mas que dependem do habitat epígeo em algum momento para completar o ciclo de vida, seja diariamente para alimentação ou eventualmente para a reprodução (e.g. *Trigonocranus emmeae* Fieber, 1876; HOCH et al., 2013).

- **Trogloxenos e acidentais**: Espécies que não são capazes de estabelecer populações viáveis e ou completar parte do ciclo de vida exclusivamente dentro das cavernas, mas que são encontrados explorando o ambiente por acidente ou como abrigo (e.g. *Oliarus kanoa* Kirkaldy, 1902; HOCH; HOWARTH, 1999; HOWARTH, 2019).

Possivelmente muitas espécies de *Pintalia* Stål, 1862, encontradas em cavernas do Brasil podem ser classificadas como Subtroglófilas em razão da riqueza e abundância de jovens e adultos observados alimentando-se dentro de cavidades de diferentes litologias. No Capítulo II, observamos possíveis troglomorfismos incipientes em populações de apenas uma única espécie, *Pintalia (P.) minima* **sp. nov** (espécie eutroglófila). Espécies com troglomorfismos intermediários ou avançados (espécies troglóbias) não foram encontrados. Howarth (2019), discutiu fatores intrínsecos e extrínsecos que podem influenciar a ocorrência de espécies de cavernas. *Pintalia* Stål, 1862 é um Cixiidae, e possui capacidade intrínseca à colonização de cavernas, fazendo parte de uma pequena porcentagem de grupos epígeos que podem completar todo ciclo de vida nestes ambientes. Muito embora, fatores extrínsecos, ou seja, aqueles impostos ao organismo pelo ambiente que o levam a migrar e realizar parte, ou todo o ciclo de vida dentro das cavidades ainda não foram explorados para o gênero. Duas hipotéses alternativas foram propostas para explicar o surgimento de espécies troglóbias, "*Hipótese dos Relictos Climáticos*" (CRH) (Barr PECK; FINSTON, 1993; RIVERA et. al., 2002) e *Mudanças adaptativas* (ASH) (Howarth 1981; 2019). Ambas as hipóteses consideram espécies troglófilas como personagens que quando isolados, iniciam o processo de especiação em cavernas.

Durante muito tempo, a Hipótese dos Relictos Climáticos-CRH foi a mais aceita para explicar a ocorrência de espécies obrigatoriamente cavernícolas em todo o mundo. Esta hipótese se dava principalmente em função de mudanças naturais drásticas geralmente

atribuídas ao clima, e acompanhadas da deterioração de condições externas adequadas para a sobrevivência das populações de superfície. Os ciclos de glaciação e principalmente o recuo glacial durante o pleistoceno teria extinguido populações epígeas e afugentado indivíduos para o interior de cavidades (CULVER, 1982; RIVERA et al., 2002). Nesta abordagem, caso conseguissem se estabelecer, as espécies evoluíam de forma totalmente isolada (alopatria). Muitas espécies foram associadas a esta hipótese, onde as cavernas funcionaram como refúgio durante períodos de extremos climáticos, por exemplo *Meenoplus roddenberryi* Hoch et al., 2012, *Tsingya clarkei* Hoch et al., 2014 e mais recentemente *Valenciolenda fadaforesta* Hoch et al., 2021. No entanto, nas últimas décadas um fenômeno inicialmente observado em espécies de cigarrinhas insulares, vêm ganhando força para explicar o surgimento de espécies troglóbias de diversos grupos no trópicos (HOWARTH 1981; HOWARTH 1987; HOWARTH; HOCH 2005; HOWARTH 2019).

Segundo Howarth (2019), as Mudanças Adaptativas-ASH iniciam-se quando indivíduos de uma população epígea ao explorar um novo recurso relacionado à dieta ou habitat, estabelecem diferentes populações ao longo de um gradiente subterrâneo. Caso esses indivíduos possam se alimentar, crescer e reproduzir, ao longo de muito tempo as novas populações podem divergir em aspectos comportamentais, fisiológicos e morfológicos (parapatria). Nesta abordagem o acasalamento seletivo, a seleção contra hibridização, e afastamento da zona hibrida, são apontados como incipientes para a manutenção da barreira de fluxo gênico, e consequente especiação dentro das cavidades. Além disso Howarth (2019) informa que as mudanças adaptativas podem ser verificadas sempre que para uma espécie com troglomorfismos avançados (adaptações selecionadas no ambiente subterrâneo) seja encontrado indivíduos com troglomorfismos intermediários e ou um correspondente epígeo. Atualmente gêneros de diversos grupos abrigam espécies associadas a hipótese de Mudanças adaptativas, em fulgoroidea temos como exemplo *Oliarus* Stål, 1862 (e.g *Oliarus polyphemus* Fennah, 1973 e *Oliarus makaiki* Hoch e Howarth, 1999) no Hawai, *Trirhacus* Fieber, 1875 (e.g Trirhacus *helenae* Hoch, 2013) na Croácia, e mais recentemente em *Ferricixius* Hoch e Ferreira, 2012 no Brasil (dados não publicados).

1.3. O gênero *Ferricixius* Hoch e Ferreira, 2012 em cavernas do Brasil

O gênero *Ferricixius* Hoch e Ferreira, 2012, foi proposto para alocar uma única espécie obrigatoriamente cavernícola, *Ferricixius Davidi* Hoch e Ferreira, 2012. *Ferricixius Davidi*

Hoch e Ferreira, 2012 foi o primeiro Fulgoroidea-Cixiidae estritamente subterrâneo descrito para o Brasil e apenas o quinto fulgoroidea troglóbio descrito para a região Neotropical (Hoch e Ferreira, 2012). No capítulo III, propomos três novas espécies pertencentes ao gênero *Ferricixius* Hoch e Ferreira, 2012, sendo duas espécies troglóbias (*Ferricixius goliathi* **sp. nov**; *Ferricixius michaeli* **sp. nov**) e a primeira espécie de superfície encontrada para um gênero de cigarrinha-das-cavernas no Brasil (*Ferricixius urieli* **sp. nov**). Após exaustivas buscas realizadas em cavernas próximas, e no ambiente epígeo ao redor da localização tipo do *Ferricixius Davidi* Hoch e Ferreira, 2012, os autores associaram a espécie à hipótese do Relicto Climático, embora não tenham descartado a hipótese da existência de um epígeo correspondente para a espécie. Pesquisas posteriores de material depositado na coleção do ISLA revelaram a ocorrência de um único espécime de superfície com genitália masculina muito semelhante, e localização tipo moderadamente próxima à de *Ferricixius Davidi* Hoch e Ferreira, 2012. Mais recentemente, dois novos espécimes do tipo de superfície foram coletados em diferentes localidades. Todos os três espécimes masculinos de superfície exibem pequenas variações morfológicas que supomos serem populacionais. As novas espécies que estamos propondo fornecem informações que suportam a hipótese de Mudanças adaptativas (Howarth. 2019) no gênero *Ferricixius* Hoch e Ferreira, 2012, encontrado em cavernas brasileiras.

Ferricixius Davidi Hoch e Ferreira, 2012 e *Ferricixius goliathi* sp. nov. e *Ferricixius urieli* **sp. nov.** apresentam localização apenas para as respectivas cavidades tipo no Quadrilátero Ferrífero em Minas Gerais. O Quadrilátero Ferrífero é caracterizado principalmente pela presença de rochas ferríferas, onde as cavidades apresentam alta conectividade que ocorre através de pequenos canalículos inseridos na rocha matriz. *Ferricixius michaeli* **sp. nov**. tem localidade tipo fora do Quadrilátero Ferrífero, e embora apenas um pouco mais ao norte da região ferrífera, é encontrada em uma única caverna de litologia carbonática. Todas as espécies troglóbias aqui relatadas são endêmicas e estão em áreas de interesse para mineração, portanto, devem ser consideradas ameaçadas.

Com as novas espécies de *Ferricixius* Hoch e Ferreira, 2012 descritas aqui soma-se para a região Neotropical, sete espécies de cixiidae obrigatoriamente cavernícolas distribuídas em quatro gêneros e em quatro países, *Cixius* Spinola, 1839: *Cixius orcus* Fennah, 1973, *Cixius actunus* Hoch, 1988 (Mexico); *Notolathrus*, Lenicov, 1992: *Notolathrus sensitivus* Lenicov, 1992 (Argentina); *Oliarus* Stål, 1862: *Oliarus hernandezi* Hoch e Izquierdo, 1996 (Galápagos);

Ferricixius Hoch e Ferreira, 2012: *Ferriciixius Davidi* Hoch e Ferreira, 2012, *Ferricixius goliathi* **sp. nov**., *Ferricixius michaeli* **sp. nov.** (Brasil).

REFERENCIAS

ARNETT, R. H. American insects: a handbook of the insects of America north of Mexico. CRC Press, **Boca Raton**, USA. 1.003 p. 2000.

ASCHE, M. Delphacidae from Côte d'Ivoire (Homoptera, Fulgoroidea). **Revue française d'entomologie (1979)**, v. 10, n. 2, p. 151-231, 1988.

ASCHE, Manfred. A review of the systematics of Hawaiian planthoppers (Hemiptera: Fulgoroidea). 1997.

BARTLETT, Charles R. et al. The diversity of the true hoppers (Hemiptera: Auchenorrhyncha). **Insect biodiversity: science and society**, v. 2, p. 501-590, 2018.

BOURGOIN T. FLOW (Fulgoromorpha Lists on The Web): a world knowledge base dedicated to Fulgoromorpha. 2021. Version 8, updated [date]. https://hemiptera-databases.org/flow/

BOURGOIN, T. Female genitalia in Hemiptera Fulgoromorpha, morphological and phylogenetic data. Annales de la Société Entomologique de France (Nouvelle série) 29 (3): 225-244. 1993.

BOURGOIN, T. Morphologie imaginale du tentorium des Hemiptera Fulgoromorpha. **International Journal of Insect Morphology & Embryology** 15 (4): 237-252. 1986a.

BOURGOIN, T. Valeur morphologique de la lame maxillaire chez les Hemiptera; remarques phylogénétiques. Annales de la Société Entomologique de France (Nouvelle série) 22 (4): 413- 422. 1986b.

BOURGOIN, T., JD Steffen-Campbell e BC Campbell. Filogenia molecular de Fulgoromorpha (Insecta, Hemiptera, Archaeorrhyncha). Os enigmáticos Tettigometridae: afiliações evolutivas e biogeografia histórica. Cladistics 13: 207-224. 1997.

BOURGOIN, T.; HUANG, J. Morphologie comparée des genitalia mâles des Trypertimorphini et remarques phylogénétiques (Hemiptera: Fulgoromoprha: Tropiduchidae). Annales de la Société Entomologique de France (N.S.) 26 (4): 555-564. 1990.

BOURGOIN, Thierry; CAMPBELL, B. C. **Inferring a phylogeny for Hemiptera: falling into the 'autapomorphic trap'**. na, 2002.

BOURGOIN, Thierry; CAMPBELL, B. C. **Inferring a phylogeny for Hemiptera: falling into the 'autapomorphic trap'**. na, 2002.

BRODIE, P. B. **A history of the fossil insects in the secondary rocks of England: accompanied by a particular account of the strata in which they occur, and of the circumstances connected with their preservation**. John Van Voorst, 1845.

BROŻEK, Jolanta; BOURGOIN, Thierry. Morphology and distribution of the external labial sensilla in Fulgoromorpha (Insecta: Hemiptera). **Zoomorphology**, v. 132, n. 1, p. 33-65, 2013.

CALDWELL, J. S. Pintalia Stål with special reference to Mexico (Homoptera, Cixiidae). Pintalia Stål con especial referencia a México (Homoptera, Cixiidae). **The Pan-Pacific Entomologist**., v. 20, n. 4, p. 154-160, 1944.

CALDWELL, John S.; MARTORELL, Luis F. Review of the auchenorynchous homoptera of Puerto Rico" part ii. The fulgoroidea except kinnaridae. **The Journal of Agriculture of the University of Puerto Rico**, v. 34, n. 2, p. 133-269, 1951.

CARVALHO, C. J. B. et al. Insetos do Brasil, Diversidade e Taxonomia. **Ribeirão Preto: Holos**, 2012.

CARVER, M., G.F. Gross & T.E. Woodward. 30- Hemiptera, p. 429-515, CSIRO. The insects of Australia. Cornell Univerity Press, Ithaca, New York, 542p. 1991.

CEOTTO, P.; BOURGOIN, T. Insights into the phylogenetic rela- tionships within Cixiidae (Hemiptera: Fulgoromorpha): cla- distic analysis of a morphological dataset. **Systematic Ento- mology**, [*s.l.*], v. 33, n. 3, p. 484-500, 2008.

CEOTTO, P.;KERGOAT, G. J.; RASPLUS, J. Y.; BOURGOIN, T. Molecular phylogenetics of cixiid planthoppers (Hemiptera: Fulgo- romorpha): new insights from combined analyses of mito- chondrial and nuclear genes. **Molecular Phylogenetics and Evolution**, [*s.l.*], v. 48, n. 2, p. 667-678, 2008.

CHEN, J. True hopper fossils (Fulgoromorpha and Cicadomorpha) in the Jurassic to Cretaceous of eastern Asia and their evolutionary implications. **Geological Society**, London, Special Publications, 521. 2021.

CLARIDGE, M. F. Acoustic signals in the Homoptera: behavior, taxonomy, and evolution. **Annual review of entomology**, v. 30, n. 1, p. 297-317, 1985.

CLARIDGE, Michael F.; DE VRIJER, Peter WF. Reproductive behavior: the role of acoustic signals in species recognition and speciation. In: **Planthoppers**. Springer, Boston, MA. p. 216-233, 1994.

COBBEN, R. H. Evolutionary trends in Heteroptera. Part 2. Mouthpart-structures and feeding strategies. Mededelingen Landbouwhogeschool 78-5. H. Veeman, Wageningen, the Netherlands. 407 p, 1978.

CRYAN, J. R.; URBAN, J. M. Higher-level phylogeny of the insect order Hemiptera: is Auchenorrhyncha really paraphyletic?. **Systematic entomology**, [*s.l.*], v. 37, n. 1, p. 7-21, 2012.

CULVER, D. C. Cave Life: Evolution and Ecology Harvard University Press. **Cambridge, Massachusetts**, 1982.

CULVER, D. C.; PIPAN, T. **Shallow subterranean habitats: ecology, evolution, and conservation**. Oxford University Press, USA, 2014.

CULVER, D; PIPAN, T. Shifting paradigms of the evolution of cave life. **Acta Carsologica**, v. 44, n. 3, 2015.

CULVER, David C.; PIPAN, Tanja. Insects in caves. **Insect Biodiversity: Science and Societ; Foottit, RG, Adler, PH, Eds**, p. 123-152, 2018.

DENNO RF, P. TJ. Planthoppers: their ecology and management. Chapman and Hall, New York. 1994.

DIETRICH, Christopher H. Auchenorrhyncha:(cicadas, spittlebugs, leafhoppers, treehoppers, and Planthoppers). In: **Encyclopedia of insects**. Academic press, 2009. p. 56-64.

DMITRIEV A. 2020. Nomenclatural changes in the suborders Auchenorrhyncha (Hemiptera) and Paleorrhyncha (Palaeohemiptera). **Zootaxa** 4881 (1): 25-53, DOI: https://doi.org/10.11646/zootaxa.4881.1.2

EMELJANOV, A. F. **Contribution to classification and phylogeny of the family Cixiidae (Hemiptera, Fulgoromorpha)**. na, 2002.

FENNAH, R G. The Fulgoroidea, or lanternflies, of Trinidad and adjacent parts of South America. Proceedings of the United States National Museum, 1945b.

FENNAH, R. G Fulgoroidea from Southern Chile (Hemiptera). Bulletin of the British Museum (Natural History). **Entomology**, v. 17, p. 231-272, 1965.

FENNAH, R. G. Fulgoroidea from the Cayman Islands and adjacent areas. **Journal of Natural History**, v. 5, n. 3, p. 299-342, 1971.

FENNAH, R. G. New lanternflies (Fulgoroidea) from South America. Proceedings of the United States National Museum 96: 95-105 [99], 1945a.

FENNAH, R. G. Notes on Neotropical Dictyopharidae and synonymy in two other groups. Smithsonian Miscellaneous Collections, 1947.

FENNAH, R. G. Three new cavernicolous species of Fulgoroidea (Homoptera) from Mexico and Western Australia. **Proceedings of the Biological Society of Washington**, 1973.

FENNAH, R. G. XXXIII.—New pintaliine Cixiidæ, Kinnaridæ and Tropiduchidæ from the Lesser Antilles (Homoptera: Fulgoroidea). Annals and Magazine of Natural History, v. 1, n. 6, p. 417-437, 1948.
FIEBER, F. X. **Les cicadines d'Europe: d'après les originaux et les publications les plus récentes**. pp. 288–416.1875.

FORERO, D. The systematics of the Hemiptera. **Revista Colombiana de Entomología**, v. 34, n. 1, p. 1-21, 2008.

FOWLER, W. W. Order Rhynchota. Suborder Hemiptera-Homoptera. (Continued). Biologia Centrali-Americana 1: 85-124, 1904.

GARGALIK, S. Ranissus Scytha (Oshanin, 1913) (Hemiptera, Fulgoromorpha, Dictyopharidae) in the fauna of the Republic of Moldova. In **Sustainable use and protection of animal world in the context of climate change** (pp. 212-214). 2021.

GILBERT, J., D. L. Danielpol & J.A. Stanford. Groundwater Ecology. New York: **Academic Press**, 571 p. 1994.

GOODCHILD, A. J. P. Evolution of the alimentary canal of the Hemiptera. Biological Review 41: 97-140. 1966.

GRAZIA, J.; CAVICHIOLI, R. R.; WOLF, V. R. S.; FERNANDES, J. A. M. & TAKIYA, D. M, Hemiptera. In: Rafael, J. A.; Melo, G. A. R.; Carvalho, C. J. B. de; Casari, S. A. & Constantino, R. (Eds). Insetos do Brasil: Diversidade e Taxonomia. Ribeirão Preto. Holos Editora. p. 347-406, 2012.

GRIMALDI, D. et al. **Evolution of the Insects**. Cambridge University Press, 2005.

HAMILTON, K. G. A. Morphology and evolution of the Rhynchotan head (Insecta: Hemiptera, Homoptera). The Canadian Entomologist 113 (11): 953-974. 1981.

HENNIG, W. Insect phylogeny. John Wiley & Sons, New York, USA. 514 p. 1981.

HENNIG, W. **Die stammesgeschichte der Insekten**. Kramer, 1969.

HOCH, H. et al. Acoustic communication in the subtroglophile planthopper Trigonocranus emmeae Fieber, 1876 (Hemiptera: Fulgoromorpha: Cixiidae: Oecleini). – **Acta Musei Moraviae, Scientiae biologicae** 98: 155-162, 2013.

HOCH, H. et al. Small giants from Madagascan caves: autapomorphic giantism in the new cave-dwelling planthopper Tsingya clarkei gen. nov., sp. nov.(Hemiptera: Fulgoroidea: Meenoplidae). **Journal of Natural History**, v. 48, n. 15-16, p. 919-935, 2014.

HOCH, H. Trirhacus helenae sp. n., a new cave-dwelling planthopper from Croatia (Hemiptera: Fulgoromorpha: Cixiidae). **Deutsche Entomologische Zeitschrift**, v. 60, n. 2, p. 155-161, 2013.

HOCH, H. **Hidden from the light of day: planthoppers in subterranean habitats (Hemiptera: Auchenorrhyncha: Fulgoromorpha)**. na, 2002.
HOCH, H., BOURGOIN, T., FAILLE, A., & SOULIER-PERKINS, A. A new species of Bennini (Hemiptera, Cixiidae) from granitic subterranean environment in Vietnam, an under-investigated biotope. In: **Annales Zoologici**. Museum and Institute of Zoology, Polish Academy of Sciences. p. 1-12, 2017.

HOCH, H.; FERREIRA, R. *Iuiuia caeca* gen. n., sp. n., a new troglobitic planthopper in the family Kinnaridae (Hemiptera, Fulgoromorpha) from Brazil. **Deutsche Entomologische Zeitschrift**, [*s.l.*], v. 63, p. 171, 2016.

HOCH, H.; FERREIRA, R. L. *Ferricixius davidi* gen. n., sp. n.–the first cavernicolous planthopper from Brazil (Hemiptera, Fulgoromorpha, Cixiidae). **Deutsche Entomologische Zeitschrift**, [*s.l.*], v. 59, n. 2, p. 201-206, 2012.

HOCH, H.; FERREIRA, R. L. *Potiguara troglobia* gen. n., sp. n.–first record of a troglobitic Kinnaridae from Brazil (Hemiptera: Fulgoromorpha). **Deutsche Entomologische Zeitschrift**, [*s.l.*], v. 60, n. 1, p. 33-40, 2013.

HOCH, H; HOWARTH, F. G. Multiple cave invasions by species of the planthopper genus Oliarus in Hawaii (Homoptera: Fulgoroidea: Cixiidae). **Zoological Journal of the Linnean Society**, v. 127, n. 4, p. 453-475, 1999.

HOCH, H; NARANJO, M; OROMÌ, P. Witness of a lost world: Meenoplus roddenberryi sp. nov., a new cavernicolous planthopper species (Hemiptera, Fulgoromorpha, Meenoplidae) from Gran Canaria. **Deutsche Entomologische Zeitschrift**, v. 59, n. 2, p. 207-215, 2012.

HODKINSON, J. D.; CASSON, D. A lesser predilection for bugs: Hemiptera (Insecta) diversity in tropical rain forests. Biological Journal of the Linnean Society 43: 101-109, 1991.

HOLZINGER, W. E.; EMELJANOV, A. F.; KAMMERLANDER, I. **The family Cixiidae Spinola 1839 (Hemiptera: Fulgoromorpha)-a Review**. na, 2002.

HOWARTH, F. G. & HOCH, H. Adaptive Shifts. In Culver, D. C. & White, W. B. (eds). Encyclopedia of Caves. **Elsevier Academic Press**, 654 pp.: pp. 17–24, 2005

HOWARTH, F. G. Adaptive shifts. *In*: **ENCYCLOPEDIA of caves**. [*S.l.*]: Academic Press, 2019. p. 47-55.

HOWARTH, F. G. Non-relictual terrestrial troglobites in the tropical Hawaiian caves. In: **Proceedings of the 8th International Congress of Speleology, Huntsville, AL (USA)**. p. 1,1981.
HOWARTH, F. G. The evolution of non-relictual tropical troglobites. **Int**. **J. Speleol.**, [*s.l.*], v. 16, p. 1-16, 1987.

HOWARTH, F. G. The zoogeography of specialized cave animals: a bioclimatic model. **Evolution**, [*s.l.*], v. 34, n. 2, p. 394-406, 1980.
JOHNSON, Kevin P. et al. Phylogenomics and the evolution of hemipteroid insects. **Proceedings of the National Academy of Sciences**, v. 115, n. 50, p. 12775-12780, 2018.

KIRKALDY, G. W. et al. Hemiptera. **Fauna Hawaiiensis, Vol. 3**, p. 93-174, 1902.

KJER, Karl M. et al. A molecular phylogeny of Hexapoda. **Arthropod Syst Phylogeny**, v. 64, n. 1, p. 35-44, 2006.

KRAMER, James P. Taxonomic study of the planthopper family Cixiidae in the United States (Homoptera: Fulgoroidea). **Transactions of the American Entomological Society**, p. 1-57, 1983.

KRAMER, James P. Taxonomic study of the planthopper genus Oecleus in the United States (Homoptera: Fulgoroidea: Cixiidae). Transactions of the American Entomological Society 1(1890-), v. 103, n. 2, p. 379-449, 1977.

KRISTENSEN, N. P. Chapter 5. Phylogeny of extant Hexapods. Pp. 125-140. In: CSIRO, Division of Entomology. Insects of Australia. 2nd edition, 2 volumes. Cornell University Press, Ithaca, USA. 1137 p, 1991.

LARIVIÈRE, M-C. Cixiidae (Insecta: Hemiptera: Auchenorrhyncha). **Fauna of New Zealand**, v. 40, 1999.

LI, Hu et al. Higher-level phylogeny of paraneopteran insects inferred from mitochondrial genome sequences. **Scientific Reports**, v. 5, n. 1, p. 1-10, 2015.

LI, Hu et al. Mitochondrial phylogenomics of Hemiptera reveals adaptive innovations driving the diversification of true bugs. **Proceedings of the Royal Society B: Biological Sciences**, v. 284, n. 1862, p. 20171223, 2017.

METCALF, Z. P. 1938. The Fulgorina of Barro Colorado and other parts of Panama. Bulletin of the Museum of Comparative Zoology at Harvard Collage 82: 277-423, 1938. [available from http://www.biodiversitylibrary.org]

METCALF, Z. P. A key to the Fulgoridae of Eastern North America with descriptions of new species**. Journal of the Elisha Mitchell Scientific Society.** 38: 139-230, 1923.

METCALF, Z. P. Cixiidae. **General Catalogue of the Hemiptera. Fascicle IV. Fulgoroidea. Pt**, v. 2, p. 1-269, 1936.

METCALF, Z. P. Homoptera. Fulgoroidea and Jassoidea of Guam. Bulletin Bernice P. Bishop Museum 189: 105-148, 1946.

MOZAFFARIAN, F., & Kharrazi, R. Faunistic study of planthoppers (Auchenorryhncha: Fulgoromorpha) of South Eastern Iran (Kerman and Sistan-Baluchestan provinces, region 9 of agricultural division. 2014.
MUIR, F. On the genera of Cixiidae, Meenoplidae and Kinnaridae (Fulgoroidea, Homoptera). **Pan-Pacific Entomologist**, v. 1, n. 3, p. 97-110, 1925.

MUIR, F. The genus Pintalia Stål (Homoptera, Cixiidae). **Transactions Of The Royal Entomological Society Of London**, v. 82, n. 2, p. 421-441, 1934.

NAULT, Lowell R.; RODRIGUEZ, Juan G**. The leafhoppers and planthoppers**. 1985.

NEL, A. et al. The earliest known holometabolous insects. **Nature**, v. 503, n. 7475, p. 257-261, 2013.

NICKEL, H; REMANE, R. Check list of the planthoppers and leafhoppers of Germany, with notes on food plants, diet width, life cycles, geographic range and conservation status (Hemiptera, Fulgoromorpha and Cicadomorpha). **Beiträge zur Zikadenkunde**, v. 5, p. 27-64, 2002.

O'BRIEN, L. B. Corrections, and additions to Metcalf's 'The Fulgorina of Barro Colorado and other parts of Panama' (Homoptera: Fulgoroidea). **Annals of the Entomological Society of America.** 80(3): 379-390, 1987.

O'BRIEN, L. B. et al. Planthopper systematics and external morphology. **The leafhoppers and planthoppers**, p. 61-102, 1985.

OSBORN, H. Survey of Porto Rico and the Virgin Islands Homoptera (excluding Sternorhynchi). **Scientific Survey of Porto Rico and the Virgin Islands** 14: 111-260, 1935.

OSSIANNILSSON, F. The Auchenorrhyncha (Homoptera) of Fennoscandia and Denmark. Part 1: Introduction, infraorder Fulgoromorpha. **Faun. ent. scand**., *7*, 1-222, 1978.

PECK, S. B.; FINSTON, Terrie L. Galapagos islands troglobites: the questions of tropical troglobites, parapatric distributions with eyed-sister-species, and their origin by parapatric speciation. **Mémoires de Biospéologie**, v. 20, p. 19-37, 1993.

RACOVITZA, E. G. Essaisur les problèmes biospéologiques. Biospéologica: I, Arch. **Zool. Exp. Gén., Sér**, v. 4, p. 371-488, 1907.

RIVERA, M. A. J. et al. (2002). Evolution in Hawaiian cave-adapted isopods (Oniscidea: Philosciidae): vicariant speciation or adaptive shifts?. **Molecular Phylogenetics and Evolution**, v. 25, n. 1, p. 1-9.

RUFFO, S. **Le attuali conoscenze sulla fauna cavernicola della regione pugliese**. 1955.

SCHINER, J. R. Fauna der Adelsberger. **LueggerM, und Magdalenen Grotte**, p. 231, 1854.

SHCHERBAKOV, D. E. Extinct four-winged precoccids and the ancestry of scale insects and aphids (Hemiptera). Russian Entomological Journal, v. 16, n. 1, p. 47-62, 2007.

SHCHERBAKOV, D. The 270 million year history of Auchenorrhyncha (Homoptera). na, 2002.

SKET, B. Can we agree on an ecological classification of subterranean animals?. **Journal of Natural History**, v. 42, n. 21-22, p. 1549-1563, 2008.

SLATER, J. A. Hemiptera, pp. 417-447. In: Parker, S. P. (ed.). Synopsis and classification of living organisms. McGraw Hill, New York, USA. 1119 p, 1982.

SONG, N. et al. Phylogenetic relationships of Hemiptera inferred from mitochondrial and nuclear genes. Mitochondrial DNA Part A, v. 27, n. 6, p. 4380-4389, 2016.

SPINOLA M. - Tribu IV.-Hipocefalocera. Gay's Historia fisica y politica de Chile 7: 238-305, 1852.

STÅL, C. Bidrag till Rio Janeiro-trakens Hemipt er fauna. II. Handl. *Svenska Vet. Akad*. 3 (6), l-75, 1862.

STÅL, C. **Hemiptera Fabriciana: Fabricianska hemipterarter, efter de i Köpenhamn och Kiel förvarade typexemplaren granskade och beskrifne**. PA Norstedt & söner, 1868.

STONE, F. D., F. G. Howarth, H. Hoch and M. Asche. Root communities in lava tubes. Pp. 659–664. In W. B. White and D. C. Culver (eds). Encyclopedia of Caves. Second edition. Elsevier/Academic Press, Amsterdam, Netherlands, 2012.

SZWEDO, J. et al. Aphids, true hoppers, jumping plant-lice, scale insects, true bugs and whiteflies (Insecta: Hemiptera) from the Insect Limestone (latest Eocene) of the Isle of Wight, UK. **Transactions of the Royal Society of Edinburgh. Earth and Environmental Science**, v. 110, n. 3-4, p. 331-396, 2019.

SZWEDO, J. The unity, diversity and conformity of bugs (Hemiptera) through time. **Earth and Environmental Science Transactions of the Royal Society of Edinburgh**, v. 107, n. 2-3, p. 109-128, 2016.

UHLER, P. R. Some new genera and species of North American Hemiptera. **Proceedings of the Entomological Society of Washington**, v. 4, p. 507-515, 1901.

UHLER, P. R. **An enumeration of the Hemiptera-Homoptera of the Island of St. Vincent, WI**. 1895.

URBAN, J. M.; BARTLETT, C. R.; CRYAN, J. R. Evolution of Delphacidae (Hemiptera: Fulgoroidea): Combined-evidence phylogenetics reveals importance of grass host shifts. **Systematic Entomol- ogy**, [*s.l.*], v. 35, p. 678-691, 2010.

URBAN, J. M.; CRYAN, Jason R. Evolution of the planthoppers (Insecta: hemiptera: Fulgoroidea). **Molecular Phylogenetics and Evolution**, v. 42, n. 2, p. 556-572, 2007.
WALKER, F. List of the specimens of Homopterous insects in the collection of the British Museum: Supplement. order of the Trustees, 1858.

WANG, Y-H. et al. When did the ancestor of true bugs become stinky? Disentangling the phylogenomics of Hemiptera–Heteroptera. **Cladistics**, v. 35, n. 1, p. 42-66, 2017.

WILSON, S. W. et al. Evolutionary patterns of host plant use by delphacid planthoppers and their relatives. In: **Planthoppers**. Springer, Boston, MA, p. 7-113. 1994.

WILSON, S. W. Keys to the families of Fulgoromorpha with emphasis on planthoppers of potential economic importance in the southeastern United States (Hemiptera: Auchenorrhyncha). **Florida Entomologist**, *88*(4), 464-481. 2005a.

ZHANG, Z-Q. Animal biodiversity: An outline of higher-level classification and survey of taxonomic richness. **Magnolia press**, 2011.

CAPÍTULO I

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Com. Pessoal

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Hemiptera: Auchenorrhyncha

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Introdução geral

A subordem Auchenorrhyncha foi extraída da antiga ordem Homoptera e, apesar de alguns conflitos, as últimas análises filogenéticas propostas (e.g., CRYAN; URBAN, 2012) sugerem a uniparentalidade (monofilia) desse grupo. A subordem Auchenorrhyncha subdivide-se em duas infraordens: Cicadomorpha e Fulgoromorpha, que é composta por uma única superfamília ainda existente (Fulgoroidea) e outras duas extintas (Coleoscytoidea, Surijokocixioidea) (BOURGOIN; SZWEDO, 2008). A infraordem Cicadomorpha é diversa e abriga três superfamílias (Cercopoidea, Cicadoidea e Membracoidea) (DIETRICH, 2005). No entanto, espécies capazes de completar todo o ciclo de vida em ambientes subterrâneos nunca foram relatadas para este grupo (HOCH, 2002). Portanto, neste capítulo iremos nos ater aos Fulgoroidea, visto que abrigam mais de 60 espécies obrigatoriamente cavernícolas, alocadas em 27 gêneros e distribuídos em 22 países distintos (Tabela 1). Atualmente, as espécies fulgoroidea capazes de estabelecer populações viáveis e completarem todo o ciclo de vida em cavidades naturais subterrâneas estão distribuídas em cinco famílias, Hypochthonellidae, Cixiidae, Delphacidae, Kinnaridae e Meenoplidae (HOCH, 2002) (Tabela 1).

Os Fulgoroidea comumente são reconhecidos (em inglês) como “planthoppers”, devido a seu hábito saltador, também observado em grilos e gafanhotos. No Brasil, são conhecidas como cigarras ou cigarrinhas. Diversos caracteres foram propostos para reconhecer os Fulgoroidea, sendo que, atualmente, eles podem ser identificados principalmente pelas seguintes características: cabeça com carenas elevadas separando a fronte e a gena; antenas abaixo dos olhos compostos e antenas segmentadas em três partes – escapo, pedicelo e flagelo –, sendo que o pedicelo é característico, maior que o escapo, globular ou cilíndrico/alongado e com sensilas elevadas; tégula na base da tégmina (na maioria dos táxons); asas com pares de veias anais formando conjunto de veias em Y na margem distal (na maioria dos táxons) (BAPTISTA, 2006; WILSON, 2005). A terminologia e forma da cabeça e sensilas das antenas foram estudadas por Bourgoin (1985) e Bourgoin e Deiss (1994), respectivamente. A terminologia das veias e células da tegmina dos fulgoromorpha foram revisadas recentemente por Bourgoin *et al.* (2015). Bourgoin *et al.* (2015) identificaram as principais regiões da tégmina utilizadas na descrição dos fulgoroidea (Figura 1C). Além disso, sugeriram que a posição e número de células são mais relevantes para a identificação do que o número e posição das veias, e propuseram a união das veias RP e MA – garfo (RP+ (MA)). A genitália masculina foi estudada por Fennah (1945a) e Bourgoin e Huang (1990), e a genitália feminina por Bourgoin (1993). O’Brien e Wilson (1985) e Carver *et al.* (1994) dedicaram-se à morfologia completa

dos fulgoromorpha. Uma figura com base nas terminologias mais recentes das estruturas da cabeça, do tórax e da tegmina associadas à fulgoroidea é fornecida na Figura 1.

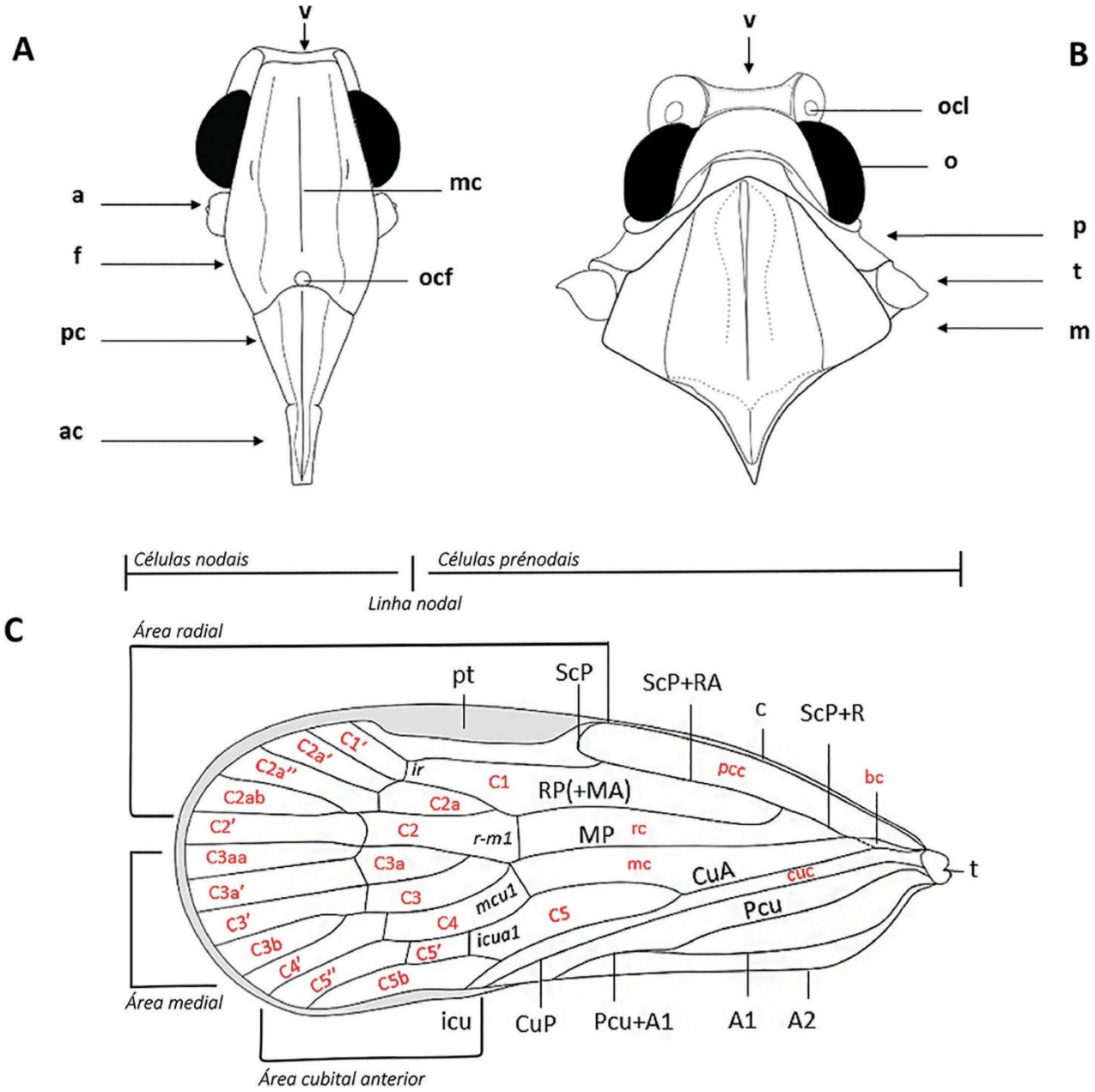

FIGURA 1: *Pintalia lateralis Stål, 1862. A) Cabeça em vista facial, v = vértice; mc = carena mediana; a = antenas; f = fronte; ocf = ocelo frontal (ausente em algumas famílias); pc = pósclipeo; ac = anteclípeo. B) Cabeça em vista dorsal, v = vértice; ocl = ocelos laterais; o = olhos compostos; p = pronoto; t = Tegula; m = mesonoto. C) Células em vermelho e veias em preto; t = Tegula; bc = célula basal; SCP+R = veia subcostal posterior e radial unidas; c = margem costal; pcc = célula pós costal; ScP+RA = veias subcostal posterior e radial anterior unidas; pt = pterostigma; RP(+MA) = veias radial posterior e média anterior unidas; MP = veia média posterior; A1 e A2 = veias anais = veia em "y"; Pcu = veias pós cubital; CuP = veia cubital posterior; CuA = veia cubital anterior; icu = veia intercubital; rc = célula radial; mc = célula medial; cuc = célula cubital.* Desenhos: Júlio César do Carmo Vaz Santos.

Atualmente, os Fulgoroidea contam com um banco de dados exclusivo, o *Fulgoromorpha Lists On the Web* (FLOW), onde são fornecidas informações sobre as 35

famílias, os 2.489 gêneros e as 13.888 espécies (BOURGOIN, 2021). Algumas destas famílias foram descritas apenas a partir de registros fósseis (por exemplo, Fulgoridiidae Handlirsch, 1939, Perforissidae Shcherbakov, 2007 e Neazoniidae Szwedo, 2007), sendo a maioria referente ao período Cretáceo (BOURGOIN, 2021; BOURGOIN; SZWEDO, 2008). Baptista (2006) foi o primeiro a reunir todos os artigos com informações taxonômicas de Fulgoroidea para o Brasil.

O autor demonstrou que 50% dos gêneros registrados no país também ocorrem em outros países, embora 75% das espécies registradas sejam endêmicas ao Brasil. Com base em artigos publicados e indexados no *Zoological Records*, Baptista registrou 627 espécies e 205 gêneros, em 14 famílias distribuídas nos estados brasileiros e também contabilizadas para o Brasil na base FLOW: Acanaloniidae Amyot & Audinet-Serville, 1843, Achilidae Stål, 1866, Caliscelidae Emeljanov, 1999, Cixiidae Spinola, 1839, Delphacidae Leach, 1815, Derbidae Spinola, 1839, Dictyopharidae Spinola, 1839, Flatidae Spinola, 1839, Fulgoridae Latreille, 1807, Issidae Spinola, 1839, Kinnaridae Muir, 1925, Nogodinidae Melichar, 1898, Ricaniidae Amyot e Audinet-Serville, 1843, Tropiduchidae Stål, 1866 e Lalacidae † Hamilton, 1990 (BOURGOIN, 2021). Recentemente, Viegas (2019) registrou a ocorrência de oito novas espécies do gênero Bebaiotes Muir, 1923 (Achilixiidae) para a região Norte do Brasil, somando 16 famílias Fulgoroidea para o país.

Assim como os demais Auchenorrhyncha, os Fulgoroidea são hemimetábolos (CARVER *et al.*, 1994). No estágio de ninfa, algumas espécies apresentam hábito subterrâneo e quando adultos, na maioria das vezes, estão associados às partes verdes de plantas (HOCH, 2002; WILSON, 2005). Em função do seu hábito alimentar fitófago (sugador de seiva), para algumas espécies também foi registrado o consumo de angiospermas, gimnospermas, fungos, musgos e algumas pteridófitas (O'BRIEN; WILSON, 1985; WILSON, 1994; WILSON, 2005). Quanto à dieta, as cigarras e cigarrinhas podem se alimentar de uma única espécie ou gênero hospedeiro - espécies "Monófagas", de até duas famílias de plantas – espécies "Oligófagas" ou de plantas de numerosas famílias – espécies "Polífagas" (NICKEL; REMANE, 2002; WILSON, 2005). Algumas famílias e espécies possuem importância econômica, como Delphacidae - *Peregrinus maidis* Ashmead, 1890) (WILSON, 2005).

Embora sejam fitófagas e apresentem fase subterrânea quando imaturas (REMANE; HOCH, 1988), muitas espécies podem permanecer no habitat ninfal mesmo depois de adultas (HOWARTH, 2019). Nesta condição, ninfas e adultos alimentam-se de raízes provenientes da vegetação epígea. Hoch (2002) indicou esta característica como sendo uma possível pré-adaptação ecológica que permite a colonização de diferentes ecossistemas subterrâneos,

incluindo cavernas. Atualmente, 62 espécies Fulgoroidea são consideradas troglóbias ao redor do globo. Entre as famílias Fulgoroidea que abrigam espécies troglóbias, há destaque para Cixiidae, que possui o maior número de gêneros nesta condição (16) (Tabela 1). Além disso, todas as espécies troglóbias conhecidas pertencem a famílias que apresentam estágio imaturo subterrâneo, sugerindo que esta característica seja realmente um importante fator evolutivo para o surgimento de espécies troglóbias em Fulgoroidea.

TABELA 1: Gêneros de Fulgoroidea troglóbios ao redor do mundo. Adaptado de Hoch (2002) e Bourgoin (2021).

Familia	Região	Gênero	Referência
Hypochthonellidae	Zimbabwe	*Hypochthonella*	CHINA & FENNAH, 1952
Delphacidae	Nova Caledônia	*Notuchus*	FENNAH 1980a; HOCH et al., 2006
Kinnaridae	Mexico	*Oecidius*	FENNAH, 1973b
	Jamaica	*Oecidius*	FENNAH, 1980b
	Brasil	*Kinnapotiguara, Iuiuia*	HOCH & FERREIRA 2013, 2016
	Espanha	*Valenciolenda*	HOCH et al., 2021
Meenoplidae	Australia	*Phaconeura*	FENNAH 1973b; HOCH, 1990,1993
	Ilhas Canárias	*Meenoplus*	REMANE & HOCH, 1988; HOCH & ASCHE, 1993; HOCH et al., 2012
	Samoa	*Suva*	HOCH & ASCHE, 1988
	Nova Caledônia	*Fennahsia*	HOCH, 1996
	Cabo Verde	*Nisia*	HOCH et al., 1999
Cixiidae	Madagascar	*Typhlobrixia, Tsingya*	SYNAVE, 1953; HOCH, 2014; PERKINS et al., 2015
	Mexico	*Cixius*	FENNAH, 1973b; HOCH, 1988
	Hawaii	*Oliarus*	FENNAH, 1973a; HOCH & HOWARTH, 1999
	Nova Zelândia	*Confuga*	FENNAH, 1975; SANTOS et al., 2018
	Ilhas Canárias	*Cixius, Tachycixius*	REMANE & HOCH, 1988; HOCH & ASCHE, 1993
	Australia	*Solonaima, Undarana*	HOCH & HOWARTH, 1989a, 1989b
	Açores	*Cixius*	HOCH, 1991
	Argentina	*Notolathrus*	REMES LENICOV, 1992
	Galapagos	*Oliarus*	HOCH & IZQUIERDO, 1996
	Ilha da Reunião	*Brixia*	HOCH, 2003
	Italia	*Ibleocixius*	D'URSO & GRASSO, 2009; D'URSO & PUGLISI, 2019
	Indonésia	*Celebenna*	HOCH & WESSEL, 2011
	Brasil	*Ferricixius*	HOCH & FERREIRA, 2012
	Croácia	*Trirhacus*	HOCH, 2013
	Filipinas	*Bennaria*	HOCH, 2013
	Vietnã	*Sanghabenna*	HOCH & BOURGOIN, 2017
	[Baleares]		RACOVITZA, 1907 (Dados não confirmados)
	[Nova Guiné]		Dados não publicados

O primeiro relato de um Fulgoroidea cavernícola foi feito por Racovitza (1907), nas ilhas Baleares (um arquipélago próximo à costa da Espanha, no Mediterrâneo). Infelizmente, os espécimes relatados por Racovitza (1907) não foram coletados para posterior descrição. China e Fennah (1952) realizaram o primeiro registro oficial de troglomorfismos observados em fulgoroidea. A família monotípica Hypochthonellidae (CHINA; FENNAH, 1952) foi erguida para abrigar uma única espécie de solo que alimenta-se de raízes do tabaco no Zimbábue. A primeira espécie de Fulgoroidea obrigatoriamente cavernícola, *Typhlobrixia namorokensis*, foi formalmente descrita e validada por Synave (1953) quase 50 anos após o registro de Racovitza (1907) em Madagascar (HOCH, 2002).

Historicamente, alguns autores contestaram o status de estritamente subterrâneo de algumas espécies de cigarrinhas, que era primariamente baseado apenas em características morfológicas exibidas por essas espécies. A exemplo disso, Vandel (1965) e Howarth (1972), com base na morfologia, discutiram o *status* de troglóbio da espécie *Typhlobrixia namorokensis*. Recentemente, Perkins e colaboradores (2015), em um estudo preliminar, analisaram a comunicação vibracional ("canto"), a morfologia dos adultos, assim como os dados moleculares de *T. namorokensis* Synave (1953) em cavernas da Namoroka, e concluíram que de fato trata-se de uma espécie troglóbia. O uso do canto para aferição de espécies de Fulgoroidea troglóbias é eficaz, uma vez que para as espécies se estabelecerem nas cavernas é necessário mais do que quantidade de alimento suficiente. São também necessários recursos e capacidade de se comunicarem de maneira eficiente, possibilitando, inclusive, sua reprodução no ambiente cavernícola (PERKINS *et al.*, 2015). Os autores também observaram que apenas quando a umidade estava alta e a temperatura baixa o suficiente (condição ideal), os espécimes emitiam sinais vibracionais. Além disso, o sinal era simplificado como em outras espécies de cigarrinhas obrigatoriamente cavernícolas (por exemplo: (HOCH; WESSEL, 2006)). Embora preliminar, tal estudo evidenciou a importância de estudos complementares e comportamentais como ferramentas no momento de relacionar as espécies como endêmicas de ambientes subterrâneos.

Claridge (1985) e Claridge e Vrijer (1994) estudaram a comunicação dos Fulgoroidea em função da reprodução e especiação, sugerindo que os sinais são eficientes apenas em curtas distâncias e por meio de um substrato ou planta hospedeira. Em um experimento de campo realizado em uma caverna em tubo de lava havaiano, as raízes também demonstraram ser uma importante ferramenta para a transmissão de sinais vibracionais entre indivíduos de *Oliarus* Stål , 1862, sendo possivelmente utilizadas para a localização de parceiros sexuais no interior das cavernas (HOCH; HOWARTH, 1993; HOCH, 2002). Além disso, como dito anteriormente, os principais recursos alimentares possíveis de serem explorados por cigarrinhas em ambientes

subterrâneos são as raízes provenientes da vegetação epígea (que crescem sobre as cavernas) e, possivelmente, fungos e musgos. Contudo, trabalhos relacionando exclusivamente à dieta dos Fulgoroidea cavernícolas e restrições ou preferências alimentares por raízes de espécies arbóreas específicas não foram encontrados para o Brasil.

Principais grupos encontrados em cavernas do Brasil

Apesar do histórico de pesquisas bioespeleológicas no país, apenas na última década foi feito o primeiro registro de um Fulgoroidea troglóbio no Brasil, *Ferricixius davidi* Hoch & Ferreira, 2012. Desde então, outras duas espécies foram descobertas no país, *Kinnapotiguara troglobia* (Hoch & Ferreira, 2013) e *Iuiuia caeca* Hoch & Ferreira, 2016 (Figura 3) e o Brasil passou a ser um dos três países com maior diversidade de gêneros de Fulgoroidea obrigatoriamente cavernícolas, ao lado da Austrália e da Espanha (Ilhas Canárias), todos com pelo menos três gêneros distintos (Tabela 1). O Brasil também é o país com maior número de registros de gêneros de Kinnaridae cavernícolas no globo (2) (Tabela 1), mesmo sendo uma família ainda pouco conhecida no território brasileiro, havendo apenas uma única espécie epígea descrita.

Embora Fulgoroidea não-troglóbios sejam frequentes em trabalhos de caracterização de fauna cavernícola (por exemplo: FERREIRA *et al.*, 2009, 2010; SOUZA-SILVA; FERREIRA, 2009; SIMÕES *et al.*, 2013, 2015; SOUZA-SILVA *et al.*, 2011abc; PELLEGRINI *et al.*, 2016; PROUS *et al.*, 2004; ROCHA, 1996), trabalhos voltados para a descrição de espécies troglófilas (que podem estabelecer populações viáveis tanto dentro quanto fora das cavernas) deste grupo ainda são escassos no Brasil. A Coleção de Invertebrados Subterrâneos de Lavras (ISLA), localizada no Centro de Estudos em Biologia Subterrânea da Universidade Federal de Lavras (MG) (CEBS-UFLA), atualmente conta com espécimes de seis famílias coletados em cavernas do Brasil (Achilixiidae, Cixiidae, Kinnaridae, Derbidae, Delphacidae e Dictyopharidae) alocadas provisoriamente em 19 gêneros (dados não publicados). Entre estes dados, deve-se atenção especial à família Cixiidae em razão da diversidade de espécies, Achilixiidae e Kinnaridae pela abundância de exemplares amostrados e carência de dados taxonômicos destas famílias no território brasileiro.

CIXIIDAE Spinola, 1839

Cixiidae é a maior família de Fulgoroidea, possuindo 2.583 espécies distribuídas em 4 subfamílias, 17 tribos, três subtribos e 247 gêneros (BOURGOIN, 2021). Esses táxons incluem representantes ainda viventes e extintos, sendo o fóssil mais antigo referente ao Barremiano (Cretáceo) [129,4 - 125 milhões de anos atrás] (BOURGOIN, 2021). Podem ocorrer em todo o

globo (exceto áreas polares): Europa, África, Ásia, Australásia, Pacífico, América do Norte e América do Sul (BOURGOIN, 2021).

A taxonomia dos Cixiidae foi mais bem examinada por Emeljanov (1989, 2002), Holzinger et al. (2002), Ceotto e Bourgoin (2008). No entanto, ainda há questões a serem esclarecidas, como a monofilia em relação aos Delphacidae (ASCHE, 1987; BARTLETT, 2021; CEOTTO et al., 2008; URBAN; CRYAN, 2007; URBAN et al., 2010).

Embora sejam definidos por caracteres plesiomórficos (características compartilhadas com outras famílias), os Cixiidae podem ser reconhecidos principalmente por exibirem ocelo mediano localizado na fronte, próximo à sutura fronte-clipeo (caráter compartilhado apenas com Kinnaridae), pela fileira de espinhos laterais (serrilhado) no segundo tarsômero posterior, e ainda, pelo ovopositor do tipo "ortopteróide" geralmente longo (caráter compartilhado apenas com Delphacidae). Devido à riqueza e à abundância de espécies registradas, Pintalia Stål, 1862 (Figura 2 D-F) é possivelmente o gênero de Cixiidae mais representativo encontrado em cavernas do Brasil**.**

Pintalia é amplamente distribuído por todo o País, tendo re- gistros em cavernas de 28 municípios de Minas Gerais e do Pará (material depositado na ISLA/CEBS-UFLA), além da ocorrência das nove espécies epígeas descritas para o Rio de Janeiro por Stål (1862) e outras 10 descritas para os estados do Pará, do Rio de Janeiro e de São Paulo, por Muir (1934a). A diagnose mais recente do gênero foi elaborada por Kramer (1983), que indicou como caracteres diagnósticos a forma e posição das carenas da cabeça, os caracteres do pronoto, o mesonoto, os espinhos das tíbias posteriores e o número de veias que atingem a margem distal das tégminas.

ACHILIXIIDAE Muir, 1923

A família Achilixiidae foi proposta por Muir (1923b) para abrigar cinco espécies. Atualmente, a família é composta por dois gêneros, *Achilixius* (Velho Mundo) e *Bebaiotes* (Novo Mundo), somando apenas 24 espécies. Achilixiidae foi alocada junto a Achilidae e tratada como duas subfamílias por Emeljanov (1991) e, mais tarde, junto aos Cixiidae por Liang (1999, 2001). No entanto, a filogenia proposta por Urban e Cryan (2007) evidenciou a paridade junto aos Achilidae e o distanciamento dos Cixiidae, o que garante o tratamento familiar até que haja maiores investigações. O tratamento a nível familiar foi revisado por Fennah (1946) e Wilson (1989) e catalogada por Metcalf (1945) (BARLETT, 2021).

Os Achilixiidae são facilmente reconhecidos pela presença de um (gen. *Bebaiotes* – Figura 2 A-C) ou dois (gen. *Achilixius*) processos no abdome. Processos abdominais também estão presentes em alguns Cixiidae (ver: (HOLZINGER; KUNZ, 2006)) e por isso a monofilia

da família em relação aos Cixiidae ainda gera incerteza em alguns autores. As tégminas dos Achilixiidae são fortemente tectiformes, transparentes, e acentuadamente alargadas após a primeira bifurcação de MP. O corpo é compri- mido (vs. deprimido em Achilidae). O vértice é estreito lateral- mente, principalmente em *Bebaiotes*, onde as carenas laterais são elevadas e contínuas. As antenas são simples e e os ocelos distintos.

O gênero *Bebaiotes* Muir, 1924 foi inicialmente proposto apenas para duas espécies do Equador, B. bucayensis (espécies tipo) e *B. nigrigaster*. Atualmente, o gênero *Bebaiotes* abriga 16 espécies, todas epígeas, sendo que oito delas foram registradas recentemente para a região amazônica no Brasil por Viegas (2019) que, até então, não contava com nenhum registro oficial (GRAZIA et al., 2012). Para as cavernas da região Norte, o material depositado na ISLA/CEBS-UFLA chama a atenção devido a uma elevada abundância de indivíduos de duas possíveis novas espécies do gênero *Bebaiotes*, presentes em cavernas do Tocantins e do Pará

KINNARIDAE Muir, 1925

Kinnaridae é uma pequena família, que soma 115 espécies descritas, distribuídas em duas subfamílias, seis tribos e 25 gêneros (BOURGOIN, 2021). Esses táxons incluem representantes viventes e extintos, sendo o registro mais antigo referente ao Oligoceno [33,9 - 23,03 milhões de anos atrás] (BOURGOIN, 2021). Muitas destas espécies estão registradas para o Novo Mundo, principalmente para o Caribe, América do Norte e Cen- tral (HOCH; FERREIRA, 2013), além de três espécies para a América do Sul, duas das quais troglóbias.

Embora bem pouco se saiba sobre a biologia e ecologia dos Kinnaridae, a maioria das espécies conhecidas é epígea, exibe olhos compostos bem desenvolvidos, coloração vívida do corpo e tégmina e possui asas funcionais, sendo capazes de voar (HOCH; FERREIRA, 2013).

Os Kinnaridae podem ser confundidos com Cixiidae em uma primeira vista, uma vez que ambos podem exibir espinhos laterais (serrilhado) no segundo tarso posterior e ocelo mediano na fronte, próximo à sutura fronte-clipeo (BARTLETT, 2021). No entanto, as fêmeas de Kinnaridae possuem o ovipositor menor, exibem os tergitos abdominais (6-8) transformados em placas produtoras de cera, e em forma de “V” em algumas espécies (MUIR, 1925; LIANG, 2002), sendo ainda as genitálias masculinas essencialmente diferentes entre as famílias, principalmente o edeago que é geralmente pequeno e bulboso em Kinnaridae (vs. alongado com processos espinhais em Cixiidae).

Kinnaridae são pouco relatados na literatura para o Brasil, tendo até o momento apenas uma espécie epígea descrita, *Oeclidius paralellus* Muir, 1934 e outras duas troglóbias, *Kinnapotiguara troglobia* (Hoch & Ferreira, 2013), e *Iuiuia caeca* Hoch & Ferreira, 2016.

Contudo, entre o material depositado na coleção da Universidade Federal de Lavras (ISLA/CEBS/UFLA), estão espécies de Kinnaridae de hábito epígeo (sem troglomorfismos aparente), coletados em cavernas de três estados do Brasil (Minas Gerais, Bahia e Pará) (Figura 2 G-I). Estas espécies possivelmente pertencem aos gêneros *Southia* Kirkaldy, 1904, *Oeclidius* Van Duze, 1904 e *Iuiuia* Hoch & Ferreira, 2016 ou mesmo gêneros ainda não descritos, sendo que os três chamam a atenção pela abundância e condições das cavernas onde são encontrados.

Principais troglomorfismos

Atualmente existem três espécies troglóbias no Brasil: *Ferricixius davidi* Hoch & Ferreira, 2012, *Kinnapotiguara troglóbia* (Hoch & Ferreira, 2013) e *Iuiuia caeca* Hoch & Ferreira, 2016 (Figura 3).

Muito embora alguns fatores comportamentais e fisiológicos possam ser interpretados como troglomorfismos (por exemplo: HOCH; HOWARTH, 1989ab; HOCH; WESSEL, 2006; HOWARTH, 1987), a grande maioria das cigarrinhas troglóbias são descritas apenas com base na morfologia. A evolução morfológica de cigarrinhas cavernícolas nos diferentes locais do mundo é caracterizada por tendências evolutivas redutivas de órgãos específicos, sugerindo o alto grau de paralelismo evolutivo destas espécies (WESSEL *et al*., 2007). Muito embora alguns táxons não apresentem todos os caracteres troglomórficos fortemente reduzidos, o que dificulta hipotetizar a adaptação de algumas espécies às cavernas (ver: *Undarana* Hoch & Howarth 1989a), maiores evidências podem ser obtidas pela presença de espécimes com troglomorfismos intermediários em uma mesma área de estudo (mudanças adaptativas - HOWARTH, 2019), e relacionando estimativas do distanciamento genético ao tempo evolutivo (HOCH; HOWARTH, 1989a; NEI, 1972; NEI *et al.*, 1975). Dentre as especializações mais comuns em cigarrinhas cavernícolas estão a redução e/ou perda de olhos compostos, os ocelos, as tégminas, as asas posteriores e a pigmentação corporal (HOCH, 2002; HOCH *et al.*, 2021). A redução dos olhos compostos foi associada a um aumento significativo do tamanho do vértice (WESSEL *et al.*, 2007). O surgimento de especializações alternativas em caracteres não troglomórficos também pode ocorrer. Foram observadas modificações em garras pré-tarsais das tíbias posteriores de espécies de *Oliarus* e *Solonaima* em cavernas do Hawaii e Austrália, respectivamente (HOCH, 2002). Possivelmente, este caráter confere maior adesão ao caminhar sobre rochas úmidas no interior do ambiente cavernícola (HOCH, 2002; HOCH; HOWARTH, 1999; HOWARTH, 1983). Outra modificação observada em algumas espécies de cigarrinhas troglóbias são cerdas de cera sobre as tégminas, que possivelmente conferem proteção contra

perturbações, umidade e/ou predadores no ambiente subterrâneo (HOCH, 2002; HOCH *et al.*, 2021; HOCH; FERREIRA, 2013).

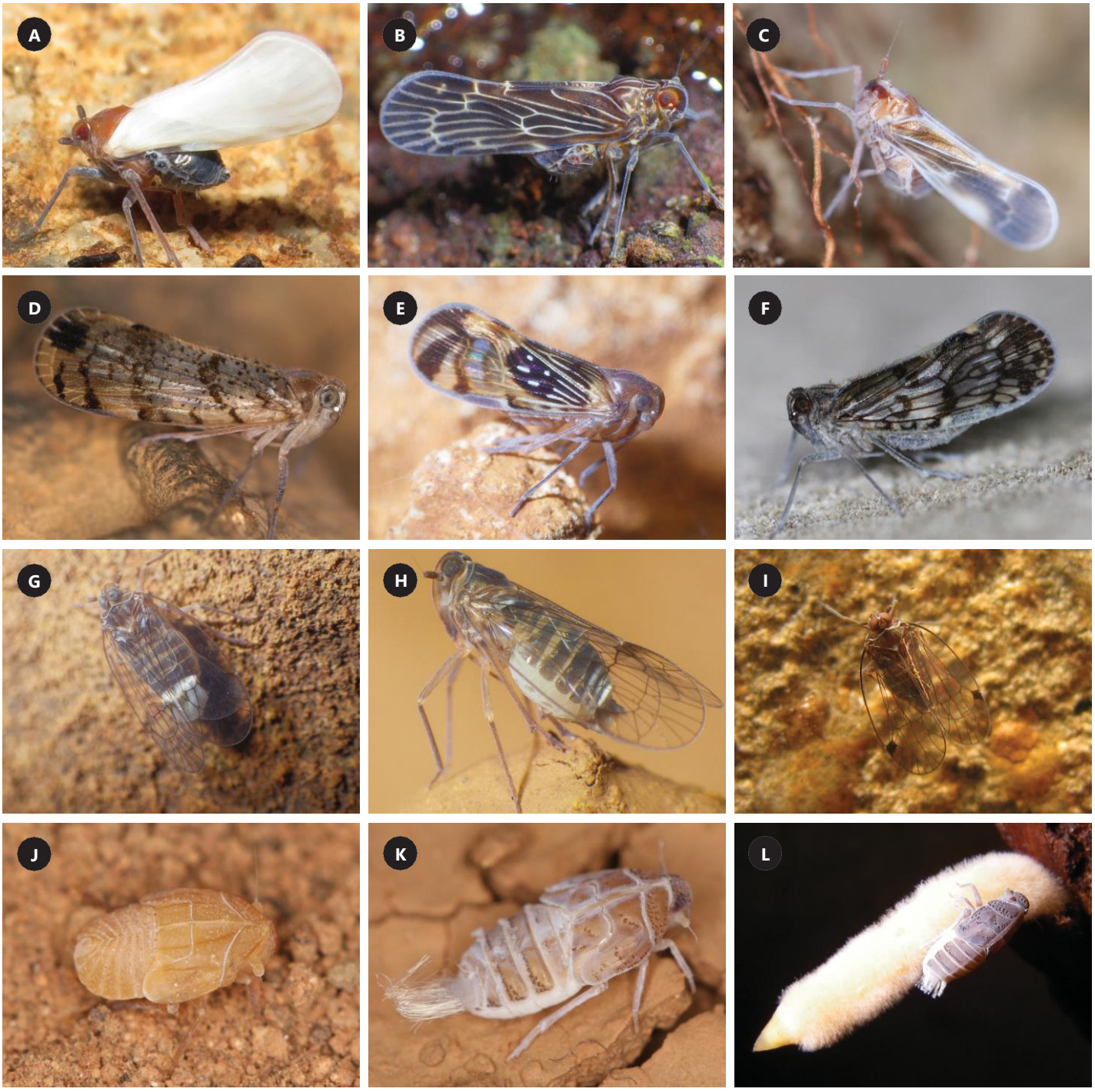

FIGURA 2: *A-C) Espécies de Achilixiidae Bebaiotes sp. Muir, 1924; D-F) Espécies de Cixiidae Pintalia sp. Stål, 1862; G-I) espécies de Kinnaridae sp. Muir, 1925; J) Kinnaridae sp. Muir, 1925 (ninfa); K-L) Cixiidae sp. Spinola, 1839 (ninfa). Fotos: A, C, D, F-K (Rodrigo Lopes Ferreira); B (Marcus P. A. de Oliveira); E (Lucas Mendes Rabelo); L (Robson Zampaulo).*

FIGURA 3*: Mapa com a diversidade e distribuição das espécies troglóbias de Auchenorrhynchas descritas para o Brasil.*

Diversidade de espécies troglóbias descritas para o Brasil

***FERRICIXIUS DAVIDI* Hoch & Ferreira, 2012**

Ferricixius davidi (Figura 4) é uma espécie de cigarrinha troglóbia da família Cixiidae, com ocorrência restrita a uma única caverna ferrífera, localizada em Itabirito, Minas Gerais. Ela foi a primeira espécie de cigarrinha troglóbia descrita para o país. Apresenta tamanho reduzido (ca. 3-4 mm de comprimento corporal) e morfologia fortemente troglomórfica: olhos

compostos e ocelos ausentes, tégmina extremamente curta que quase não chega a atingir a base do abdômen, asas vestigiais, pigmentação corporal extremamente reduzida. Esta espécie não apresenta nenhum parente próximo na fauna de superfície, sendo consequentemente uma espécie relicta. No entanto, tendo em vista o elevado grau de desconhecimento acerca da fauna epígea de Cixiidae na região Neotropical, não se pode excluir que parentes epígeos próximos de *F. davidi* ainda possam ser descobertos.

A caverna onde os espécimes foram coletados (caverna MP- 008, UTM 23K 619771/7764742N) localiza-se no Quadrilátero Ferrífero, mais especificamente na área de um empreendimento minerário denominado "Mina do Pico", em alusão à presença do Pico do Itabirito, uma referência geográfica e histórica da região. As cavernas associadas à formação ferrífera da região do Quadrilátero Ferrífero inserem-se em litotipos distintos, podendo estar associadas às brechas ferruginosas superficiais (formação de canga) ou diretamente no minério de ferro (hematita e itabirito). Milhares de cavernas são conhecidas em toda a região e boa parte delas foi amostrada durante estudos de licenciamento ambiental realizados na última década. No entanto, essa espécie nunca foi encontrada em outras cavernas, mesmo naquelas situadas bem próximo à caverna MP-008, o que demonstra sua extrema raridade e endemismo.

A caverna MP-008 é consideravelmente extensa para a formação ferrífera (cerca de 120 metros de comprimento), especialmente quando comparada a outras cavernas da região, que geralmente possuem menos de 50 metros de comprimento. Além disso, assim como outras cavernas associadas a esta litologia, a caverna MP-008 está conectada a uma enorme rede de pequenos espaços (canalículos), normalmente encontrados na formação da canga, o que aumenta consideravelmente a disponibilidade de habitats para a fauna subterrânea (FERREIRA, 2005; SOUZA-SILVA *et al.*, 2011a). No entanto, mesmo com esta expressiva conectividade a outros habitats subterrâneos, até o momento, a espécie é conhecida exclusivamente para a caverna MP-008.

O trabalho de descrição da espécie contou com um total de nove indivíduos, todos eles coletados entre os anos de 2005 e 2012, tanto no final do período seco (setembro de 2005) quanto no final da estação chuvosa (março de 2012). No entanto, um maior número de espécimes foi observado nas estações chuvosas, o que sugere que sejam mais abundantes na macrocaverna durante estes períodos, muito embora estudos adicionais sejam essenciais para definir com assertividade a dinâmica de sua população. A caverna MP-008 está localizada a uma altitude de 1.550 metros, estando consideravelmente acima das cotas altimétricas da maioria das cavernas do Quadrilátero Ferrífero. A importância da altitude na evolução de alguns

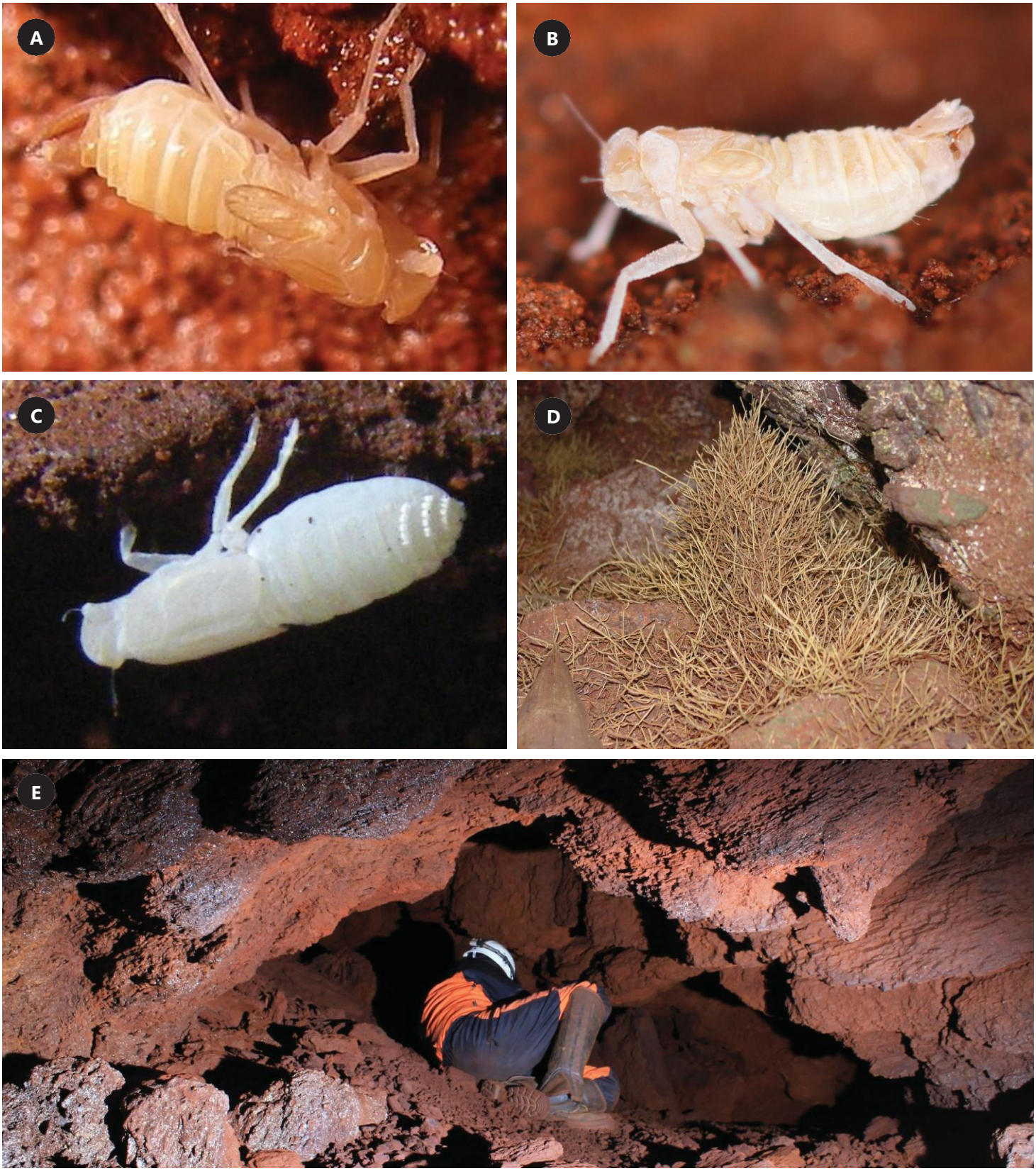

FIGURA 4: *A) Ferricixius davidi Hoch & Ferreira, 2012. Fêmea em vista laterodorsal; B) Macho em vista latera; C) Nin em vista laterodorsal; D) raízes em MP-008; E) Registro de coleta pelo método de busca ativa em MP-008. Fotos: A e (Marcus P. A. de Oliveira); B e D (Rodrigo Lopes Ferreira); E (Robson Zampaulo).*

táxons troglóbios já foi destacada em estudos anteriores (FERREIRA, 2005; PICKER; SAMWAYS, 1996; SOUZA-SILVA *et al.*, 2011a). As condições ambientais epígeas nestas altitudes podem ser mais severas, em função das maiores oscilações de temperatura (diárias e anuais) e dos ventos mais intensos (causando dessecação mais rápida), do que o observado em

altitudes mais baixas (FERREIRA, 2005). Tais condições podem ter favorecido o isolamento de populações subterrâneas, contribuindo para a especiação de *F. davidi* e para sua (aparente) restrição a uma única caverna.

A caverna MP-008 possui muitas raízes, que constituem o recurso alimentar de *F. davidi*. No entanto, a diversidade de vegetação superficial na área é elevada e ainda não foi determinado se a espécie possui algum hospedeiro específico ou uma alimentação mais diversificada.

A região no entorno da caverna MP-008 encontra-se bastante alterada em função da expansão das atividades de mineração (Figura 5). Tendo em vista o elevado grau de endemismo de *F. davidi*, é possível que a conservação da vegetação no entorno imediato da caverna possa ser suficiente para a manutenção da espécie. No entanto, é essencial que monitoramentos sejam realizados para verificar a condição dessa população, especialmente considerando outros impactos decorrentes das atividades minerárias, como a emissão de particulados que podem sedimentar no interior da caverna, modificando micro-habitats e prejudicando o crescimento de raízes. Além disso, o desmonte de rochas com o uso de explosivos ou o trânsito de máquinas no entorno da cavidade, eventualmente, podem alterar o ciclo de vida da espécie, lembrando que cigarrinhas dependem de sinais acústicos (em diferentes frequências) para a comunicação, especialmente reprodutiva.

FIGURA 5*: Localização da caverna MP-008, município de Itabirito, Minas Gerais. Imagens obtidas pelo Google Earth. A) 16/09/2010; B) 25/05/2011; C) 14/07/2013; D) 19/08/2020.*

***KINNAPOTIGUARA TROGLOBIA* (Hoch & Ferreira, 2013)**

Kinnapotiguara troglobia é uma espécie de cigarrinha troglóbia da família Kinnaridae, com ocorrência em diversas cavernas calcárias localizadas nos municípios de Felipe Guerra e Governador Dix-Sept Rosado, oeste do estado do Rio Grande do Norte (BENTO *et al.*, 2021; HOCH; FERREIRA, 2013). É um Kinnaridae pequeno (ca. 3mm de comprimento corporal) e fortemente troglomórfico, com olhos compostos e ocelos ausentes, tégmina reduzida, asas vestigiais e pigmentação corporal reduzida (Figura 6).

De acordo com a subdivisão dos Kinnaridae nas subfamílias Kinnarinae e Prosotropinae (FENNAH, 1945b), *K. troglobia* pertence à subfamília Kinnarinae, que é caracterizada pela presença de placas portadoras de cera no sexto, sétimo e oitavo tergitos abdominais femininos (HOCH; FERREIRA, 2013). Embora apresente algumas características que permitiriam sua inserção no gênero *Oeclidius*, segundo a chave para os gêneros do Novo Mundo proposta por Fennah (1980), alguns dos caracteres usados são troglomorfismos (impossibilidade de voo, redução de olhos compostos e de tégmina) e podem ser produto de evolução convergente. Assim, optou-se por estabelecer um novo gênero para acomodar a nova espécie.

O gênero *Kinnapotiguara* pode ser distinguido de todos os outros gêneros de Kinnaridae pela combinação única dos seguintes caracteres: genitália masculina bilateralmente simétrica, segmento genital no aspecto caudal arredondado, segmento anal em cada lado com dois processos proeminentes, parâmetros proximalmente estreitos e distalmente distintos com três processos conspícuos, edeago bulboso na base, comprimido distalmente e falotrema exposto dorso-caudalmente caudalmente (HOCH; FERREIRA, 2013).

Atualmente, há registro da espécie em 23 cavernas distribuídas em uma área de cerca de 50 km2 no oeste potiguar cortada pelo principal rio da região – rio Apodi-Mossoró – sendo 18 cavernas na margem esquerda (oeste) e cinco na margem direita (leste) do rio (Figura 7). As populações parecem ser bem estabelecidas e os indivíduos (machos, fêmeas e ninfas) são observados durante todo o ano em cavernas que possuem áreas sempre úmidas e com agregações de raízes. Isto, no entanto, não parece ser um padrão, já que em algumas cavernas (principalmente as que não apresentam grande estabilidade microclimática) os indivíduos só sejam observados na estação chuvosa e em outras a abundância é maior na estação seca (BENTO *et al.*, 2016). Assim, é possível que ocorra uma migração vertical da espécie das cavernas para outros habitats (como mesocavidades não acessíveis ao ser humano) e vice-versa, de acordo com as condições ambientais (HOCH; FERREIRA, 2013).

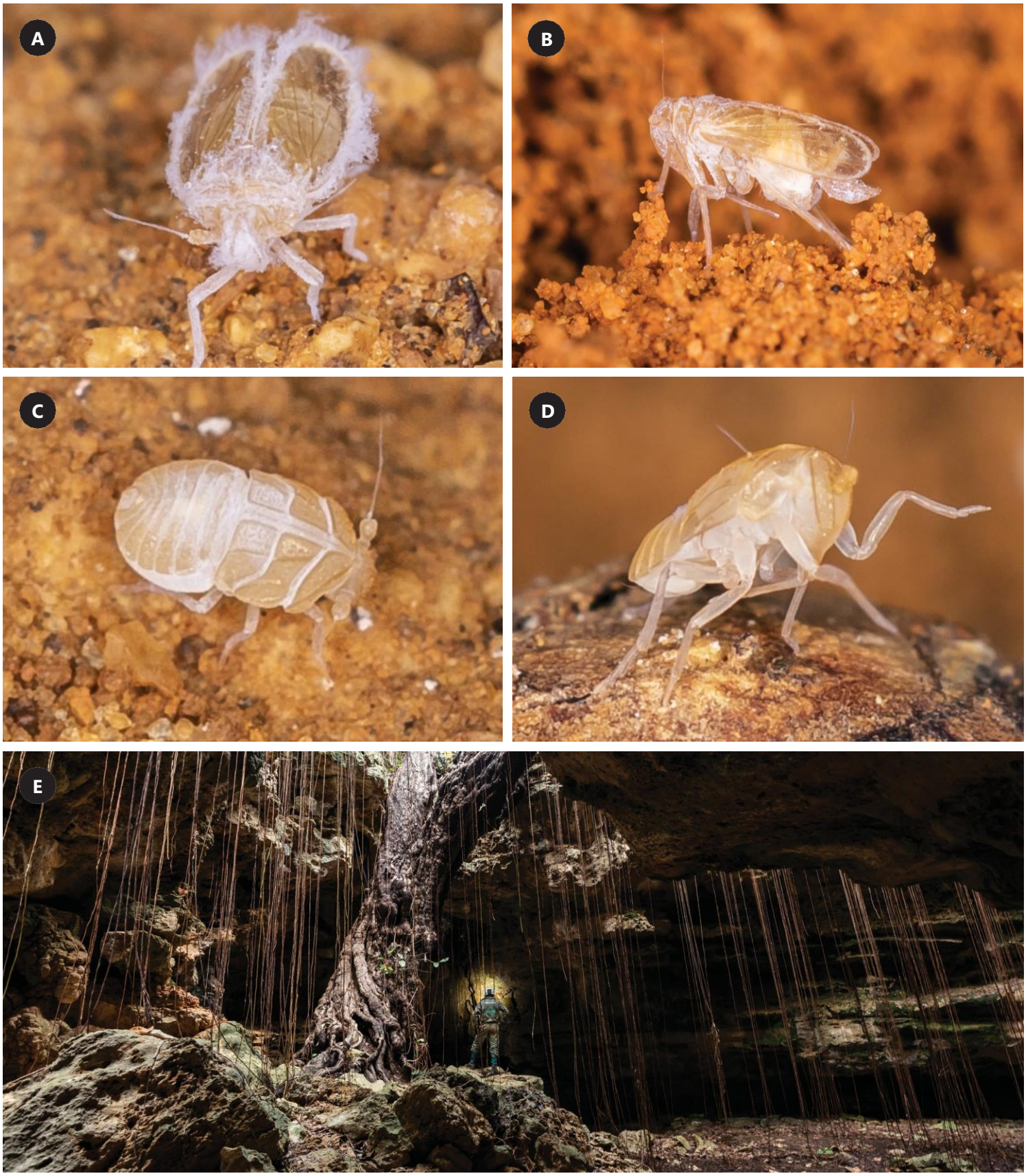

FIGURA 6*: A) Kinnapotiguara troglóbia (Hoch e Ferreira, 2013). Macho em vista frontodorsal; B) Macho em vista lateral; C) Ninfa em vista dorsal; D) Ninfa em vista frontolateral; E) Caverna dos Crotes, Felipe Guerra – RN. Fotos: (Diego de Medeiros Bento).*

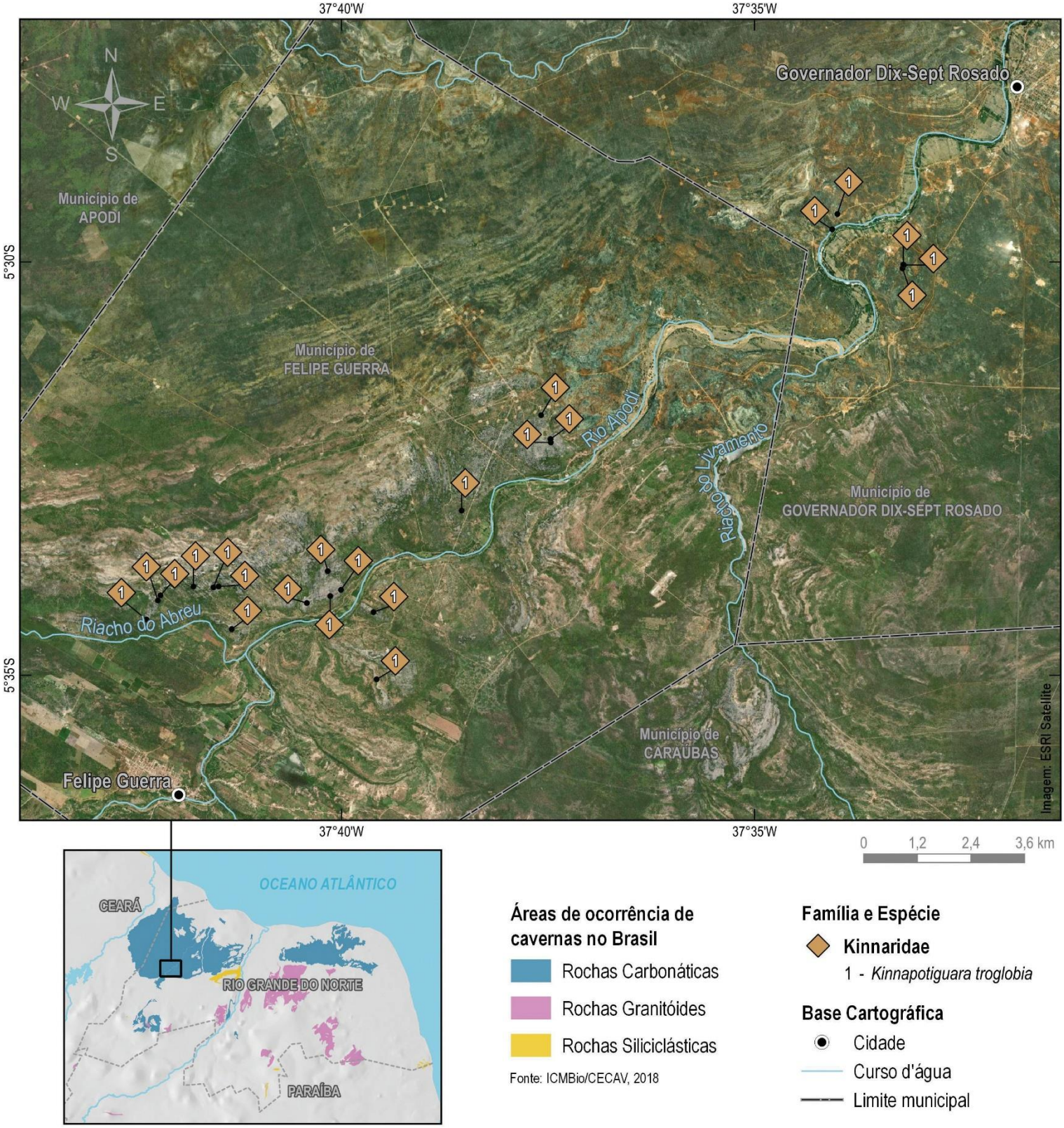

FIGURA 7: *Distribuição de Kinnapotiguara troglobia (Hoch & Ferreira, 2013).*

As maiores populações de *K. troglobia* foram observadas na gruta dos Troglóbios (a localidade-tipo), em Felipe Guerra, e na gruta Boca de Peixe, em GDS Rosado (25 e 17 indivíduos, respectivamente). Nas outras cavernas são normalmente observados entre 1 e 7

indivíduos, geralmente sob rochas ou caminhando sobre o sedimento úmido, sempre associados a agregações de raízes (HOCH; FERREIRA, 2013). Mais recentemente, foi observada uma grande concentração de ninfas de diferentes estágios em uma pequena caverna bastante superficial no município de Felipe Guerra (BENTO *et al.*, dados não publicados).

Com relação à dieta e especificidade da associação planta-hospedeiro, estudos em andamento (por meio do sequenciamento de DNA de amostras de raízes, nas áreas onde indivíduos foram encontrados, e de folhas de plantas nas imediações das entradas das cavernas) indicam que *K. troglobia* provavelmente é uma espécie polífaga, que se alimenta de seiva de raízes de plantas pertencentes a diferentes famílias (Bento *et al.*, dados não publicados). *Kinnapotiguara troglobia* apresenta uma distribuição relativamente ampla para uma espécie troglóbia e há populações em cavernas em ambos os lados do rio Apodi- Mossoró (uma possível barreira biogeográfica). Tendo em vista esta distribuição e a identificação de uma ligeira variação na morfologia genital masculina entre espécimes de diferentes cavernas, Hoch e Ferreira (2013) sugeriram a realização de estudos específicos (genéticos por exemplo) para avaliar se estas diferentes populações de *K. troglobia* podem representar, na verdade, um complexo de diferentes espécies muito similares morfologicamente.

De fato, estudos de filogeografia molecular em andamento indicam que *K. troglobia* pode ser um complexo de espécies (BENTO, 2021). Como especulado por Hoch e Ferreira (2013), a provável existência de um sistema de mesocavidades deve permitir a migração de indivíduos entre diferentes cavernas, mas o fluxo gênico provavelmente é mantido apenas entre populações de cavernas em um mesmo afloramento calcário (BENTO, 2021).

A maioria das cavernas onde *K. troglobia* ocorre estão bem preservadas, e embora algumas sejam utilizadas para visitação turística, a visitação é esporádica e de baixa intensidade (CRUZ *et al.*, 2010; FERREIRA *et al.*, 2010; HOCH; FERREIRA, 2013). No entanto, há registro de impactos relacionados à extração de calcário e exploração de petróleo na área de distribuição conhecida para a espécie (CRUZ *et al.*, 2010, FERREIRA *et al.*, 2010). Neste contexto, os impactos relacionados à indústria da cal são particularmente preocupantes, pois o uso frequente da vegetação nativa como combustível (lenha) para operação dos fornos de calcinação pode afetar indiretamente o ambiente subterrâneo, e a extração do calcário pode levar desde a destruição do epicarste e impactos sobre a fauna associada, até a supressão de cavernas (FERREIRA *et al.*, 2010, HOCH; FERREIRA, 2013). Tais impactos, apesar de localizados, podem levar até mesmo à extinção de linhagens geneticamente isoladas de K. troglóbia, que podem constituir novas espécies. Nesse sentido, é recomendável o estabelecimento de uma unidade de conservação para garantir a preservação das cavernas na

região oeste do Rio Grande do Norte, que abriga não apenas K. troglobia, mas também várias outras espécies de invertebrados troglóbios, algumas das quais são relictos (BENTO et al., 2021; FERREIRA et al., 2010; FISĚR et al., 2013; HOCH; FERREIRA, 2013; SOUZA et al., 2018).

***IUIUIA CAECA* Hoch & Ferreira, 2016**

Iuiuia caeca é uma espécie de cigarrinha troglóbia também pertencente à família Kinnaridae, com ocorrência em duas cavernas localizadas nos municípios de Iuiú e Malhada (Bahia). É um Kinnaridae pequeno (ca. 2.8 mm de comprimento corporal) e fortemente troglomórfico, com olhos compostos ausentes, tégmina reduzida, asas vestigiais e pigmentação corporal reduzida (Figura 8). Iuiuia pode ser diferenciada de todos os outros gêneros da família pela combinação única dos seguintes caracteres: vértice largo e curto; genitália masculina com segmento genital na face caudal próximo ao formatode “8”; segmento anal curto, ventralmente em cada lado com um processo comprimido distinto em forma de asa; estilos genitais delgados e estreitos, convergindo medialmente; edeago tubular robusto e periandrio com dois grandes lobos laterais.

A espécie foi originalmente descrita para a caverna Lapa do Baixão, localizada no município de Iuiú, estado da Bahia. A vegetação externa da área corresponde à formação Caatinga. A Lapa do Baixão não foi totalmente explorada, pois parte de suas galerias torna-se submersa nos períodos chuvosos. No entanto, as passagens conhecidas estendem-se por mais de 500 metros. A única entrada conhecida é relativamente pequena, o que determina grande estabilidade à atmosfera da caverna. Muito embora a descrição original mencione que a espécie é aparentemente endêmica à Lapa do Baixão, uma segunda população foi posteriormente encontrada na gruta Tapera d’Água, localizada no município de Malhada (Bahia). Destaca-se que ambas as cavernas, muito embora localizem-se em municípios distintos, pertencem ao conjunto cárstico conhecido como Serra de Iuiú, que representa um enorme afloramento carbonático contínuo. Desta forma, é plausível assumir que a espécie pode ainda ser encontrada em outras cavernas da região (mesmo que de forma pontual), especialmente naquelas localizadas na região compreendida entre as duas cavernas onde populações foram observadas.

Ambas as cavernas onde a espécie ocorre possuem muitas raízes, que são, no entanto, bem mais abundantes na Lapa do Baixão (Figura 8-E). Infelizmente, ainda não foi possível associar as raízes a nenhuma espécie da vegetação epígea, mas considerando a distância entre a superfície e as cavernas (aproximadamente entre 30 metros), parece provável que tais raízes pertençam a árvores com sistemas de raízes pivotantes, capazes de penetrar profundamente

dentro das fendas no solo e na rocha até chegarem às câmaras das cavernas. Essas raízes abrigam uma variedade de espécies de invertebrados que se alimentam especialmente de suas partes em decomposição. No entanto, muitos Cixiidae não troglomórficos (Pintalia spp.) foram observados também alimentando-se de raízes, especialmente aquelas localizadas mais próximo à entrada (mas também em zonas afóticas). Espécimes de Iuiuia caeca foram observados preferencialmente em raízes presentes na zona profunda das cavernas, raramente tendo sido observados nas mesmas raízes onde ocorrem os Cixiidae não troglomórficos. A maioria dos espécimes observados em uma visita a estas cavernas são ninfas, que frequentemente concentram-se em locais próximos às extremidades das raízes em crescimento. Curiosamente, elas parecem conviver pacificamente nesses locais com outros invertebrados não troglóbios, como formigas (Figura 8-D). Espécimes adultos são mais comumente encontrados nas paredes ou sobre espeleotemas, embora também possam ser observados próximo às raízes. Predadores potenciais incluem aranhas (especialmente Ochyroceratidae), Amblypygi (*Charinus iuiu* Vasconcelos & Ferreira 2016) e uma espécie troglóbia de pseudoescorpião (*Spelaeobochica iuiu* Ratton, Mahnert & Ferreira 2012).

A área externa ao redor das cavernas onde a espécie ocorre é consideravelmente alterada por atividades antrópicas, como a agricultura e a pecuária extensiva de bovinos e caprinos. Além disso, outra grande preocupação em relação à conservação dessa espécie é que a área está sendo avaliada quanto ao seu potencial para extração de calcário. Desta forma, embora atividades de mineração ainda não ocorram na área de distribuição da espécie, é provável que tenham início em um futuro próximo, representando um risco potencial para as cavernas onde a espécie ocorre. A Ferrovia de Integração Oeste-Leste, que está sendo construída ligando o litoral brasileiro ao interior da Bahia, favorecerá o escoamento de matéria-prima (principalmente produtos agrícolas e minerais), o que certamente contribuirá para o surgimento do interesse de explorar o calcário da região.

Diante deste contexto, é recomendável, conforme também sugerido para *K. troglobia*, o estabelecimento de uma unidade de conservação para garantir a preservação das cavernas na região da Serra de Iuiú, que abriga não apenas *I. caeca*, mas também vários outros invertebrados troglóbios, muitos dos quais ainda não descritos (HOCH; FERREIRA, 2016; RATTON et al., 2012; SOUZA et al., 2015).

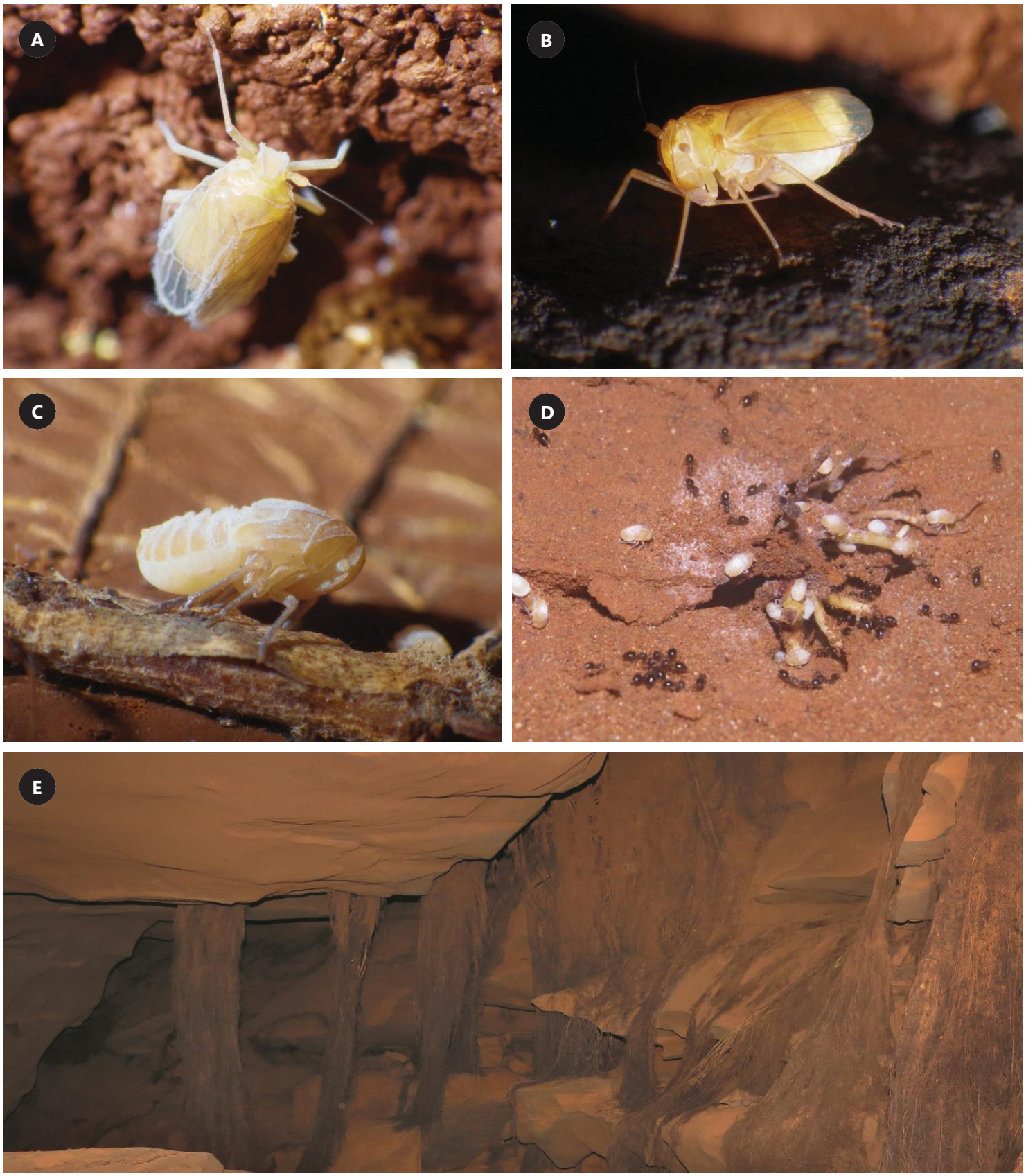

FIGURA 8: *A) Iuiuia caeca Hoch & Ferreira, 2016. Fêmea em vista dorsal; B) Fêmea em vista lateral; C) Ninfa em vista lateral; D) Ninfas em associação com raízes;* ***E)*** *Interior da caverna Lapa do Baixão. Fotos: A, B e C (Lucas Mendes Rabelo); D e E (Rodrigo Lopes Ferreira).*

Chave de identificação

A taxonomia dos fulgoroidea na América do Sul ainda é pouco explorada, sendo que muitos gêneros ainda possuem apenas a publicação das séries tipos. No Brasil, o último autor a revisar os fulgoroidea foi Baptista (2006), e embora a revisão tenha tido ênfase em Dyctiopharidae, o autor fornece uma chave de identificação das famílias atualmente alocadas em Fulgoroidea. A mais abundante família de cigarrinhas encontradas em cavernas, os Cixiidae foram revisados por Holzinger e colaboradores (2002), e os autores apresentaram uma lista com as respectivas regiões geográficas dos gêneros alocados em Cixiidae até a época, além de terem explorado melhor a morfologia da genitália feminina. Atualmente o FLOW *(Fulgoromorpha Lists On The Web)* – Hemiptera data-base abriga toda informação dos Fulgoromorpha no mundo, incluindo o Brasil. No Novo Mundo, a maior parte da informação reunida provém dos Estados Unidos, e o site em inglês "*Planthoppers of North América",* da Universidade da Delaware, abriga um grande número de informação para os Fulgoroidea, inclusive chaves e resumos para muitos gêneros de famílias que também ocorrem no Brasil. Infelizmente, para o Brasil e América do Sul não há nenhum catálogo ou banco de dados exclusivo para os fulgoroidea, embora seja um grupo muito diverso e abundante em todo o território.

Aqui iremos fornecer uma chave provisória para as principais famílias e gêneros que ocorrem em cavernas do Brasil. O status de provisória para esta chave se dá em razão do vasto material depositado em coleções científicas que ainda não foi devidamente examinado. Portanto, espera-se que a diversidade seja ainda maior.

FULGOROIDEA

1. Ocelo médio na fronte, tubérculos e cerdas nas tégminas geralmente presente. Ovipositor tubular e bastante desenvolvido geralmente ultrapassando o segmento anal.....**Cixiidae (2)**
1'. Veias da tegmina sem tubérculos ou cerdas. Ovipositor muito reduzido. Abdome distinto.....**(3)**

2. Hábito altamente troglomórfico. Olhos ausentes. Tégminas muito reduzidas. Corpo despigmentado. Tíbia posterior com pequenos espinhos laterais. Pigóforo aproximadamente trapezoidal em vista lateral. Edeago tubular, com processo ventral comprimido surgindo próximo ao comprimento médio da haste edeagal, e margem ventral irregularmente dentada.....***Ferricixius*** Hoch & Ferreira, 2012

2.1 Tégminas e olhos desenvolvidos, não troglomórfico. Vértice trapezoidal com dois compartimentos divididos por uma carena apical transversal. Tégminas geralmente com manchas. Células nodais com aproximadamente o mesmo tamanho e empilhadas lado a lado. Geralmente 12-13 veias atingindo a margem distal. Tíbias posteriores com espinhos laterais. Mesonoto plano em vista lateral.....***Pintalia*** Stål, 1862

3.Tergitos 6-8 em forma de “V” (mais comum nas fêmeas). Tégminas totalmente hialinas. Até 4 células subapicais .....**Kinnaridae (4)**

3’. Pronoto moderadamente grande. Tégminas fortemente tectiformes, quando em repouso acima do abdome. Margens laterais do vértice e fronte totalmente curvos e contínuas em vista lateral. Terceiro e quinto segmentos do abdome distintos.....**(5)**

4. Tégminas e olhos desenvolvidos, não troglomórfico. Margem anterior do vértice distante do meio dos olhos. Rostro com segmento apical mais longo que o subapical. Veia transversal entre M e Cu 1 no ápice da célula basal. Edeago geralmente bulboso na base, e apice cilíndrico.....***Oeclidius*** Van Duze, 1914

4.1 Tégminas e olhos desenvolvidos, não troglomórfico. Margem anterior do vértice ultrapassando pouco ou não ultrapassando o meio dos olhos compostos. Rostro com segmento apical mais curto do que o segmento subapical. Veia transversal entre M e Cu 1 no ápice da célula basal ausente. Edeago côncavo na base/em forma de concha .....***Southia*** Kirkaldy, 1904

4.2 Hábito troglomórfico. Olhos ausentes. Corpo despigmentado. Pigóforo com processos laterais na margem caudal. Segmento anal com dois processos finos. Estilos genitais distinto com três processos. Edeago sem processos laterais..... .....***Kinnapotiguara*** Hoch & Ferreira, 2013

4.3 Hábito troglomórfico. Olhos ausentes. Corpo despigmentado. Pigóforo com dois processos lateroventrais pequenos e “em forma de asa”. Estilos genitais finos, curvados e convergindo medialmente. Edeago com dois processos laterais..... ***Iuiuia*** Hoch & Ferreira, 2016

5. Corpo comprimido. Abdome geralmente mais largo que o tórax. Segmentos basais do abdômen exibem pares de processos laterais com furos largos e evidentes.....**Achilixiidae**

5.1 Olhos e asas desenvolvidos. Vértice estreito com carena mediana ausente. Pedicelo alongado. Um par de processos laterais localizados no terceiro segmento abdominal .....***Bebaiotes*** Muir, 1924

Principais coleções do Brasil

Muitas espécies descritas para o Brasil durante o século XVIII e XIX estão depositadas em coleções da América do Norte e Europa. Os acervos do National Museum of Natural History (NMNH) Smithsonian, Triplehorn Insect Collection (OSUC), Ohio State University, Bishop Museum (BPMNH), Honolulu, Hawai’i, Naturhistoriska Riksmuseet (NHRS) e Swedish Museum of Natural History podem ser úteis para redescrições e revisões de espécies Neotropicais. A ISLA/CEBS-UFLA atualmente conta também com espécimes coletados em diversas regiões do mundo, dentre elas *Oliarius polyphemus* (Hawaii), *Tachycixius lavatubus* (Ilhas Canárias), *Confuga persephone* (Nova Zelândia), Meenoplidae (Quênia), Cixiidae (Guatemala e Japão), além de muitos espécimes das principais famílias que ocorrem em cavernas do Brasil, Achilixiidae, Cixiidae e Kinnaridae.

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Referências

ASCHE, M. Preliminary thoughts on the phylogeny of Fulgoromorpha (Homoptera, Auchenorrhyncha). p. 47-53. 1987**.** *In*: AUCHENORRHYNCHA MEETING, 6, 1987, Turin, Italy. *Proceedings*…Turin, Italy: [s.*n.],* 1987.

BAPTISTA, M. S. **Taxonomia de Fulgoroidea no Brasil (Insecta: Hemiptera: Auchenorrhyncha), com ênfase em Dictyopharidae**. 2006. Tese (Doutorado em Entomologia) - Universidade Federal de Viçosa, Viçosa, 2006.

BARTLETT, C. R. **Planthoppers of North America, 2020**. Disponível em: https://sites.udel.edu/planthoppers/. Acesso em: jan. 2021.

BENTO, D. M.; FERREIRA, R. L.; PROUS, X.; SOUZA-SILVA, M.; BELLINI, B. C.; VASCONCELLOS, A. Seasonal variations in cave invertebrate communities in the semiarid Caatinga, Brazil. **Journal of Cave and Karst Studies**, [*s.l.*], v. 78, n. 2, p. 61-71, 2016. DOI 10.4311/2015LSC0111.

BENTO, D. M. **Filogeografia de artrópodes troglóbios do Oeste da formação Jandaíra, Nordeste do Brasil: evolução e conectividade biológica em ambientes subterrâneos como base para ações de conservação**, 2021. 161f. Tese (Doutorado) - Universidade Federal do Rio Grande do Norte, Natal, 2021.

BENTO, D. M.; SILVA, M. S.; VASCONCELLOS, A.; BELLINI, B. C.; PROUS, X.; FERREIRA, R. L. Subterranean “oasis” in the Brazilian semiarid region: neglected sources of biodiversity. **Biodiversity and Conservation**, [*s.l.*], p. 1-21, 2021. Disponível em: https://doi.org/10.1007/s10531-021-02277-6.

BOURGOIN, T. *et al.* From micropterism to hyperpterism: recognition strategy and standardized homology-driven terminology of the forewing venation patterns in planthoppers (Hemiptera: Fulgoromorpha). **Zoomorphology**, [*s.l.*], v. 134, n. 1, p. 63-77, 2015.

BOURGOIN, T. Female genitalia in Hemiptera Fulgoromorpha, morphological and phylogenetic data. *In*: **ANNALES de la Société entomologique de France (NS)**. [*S.l.: s. n.*], 1993. p. 225-244.

BOURGOIN, T. **FLOW (Fulgoromorpha Lists on The Web)**: a world knowledge base dedicated to Fulgoromorpha. version 8, updated 07/05/2020. Disponível em: http://hemiptera-databases.org/flow/. Acesso em: 13 set. 2021.

BOURGOIN, T. Morphologie imaginale du tentorium des Hemiptera Fulgoromorpha. **International Journal of Insect Morphology and Embryology**, [*s.l.*], v. 15, n. 4, p. 237-252, 1986.

BOURGOIN, T.; DEISS, V. Sensory plate organs of the antenna in the Meenoplidae-Kinnaridae group (Hemiptera: Fulgoromorpha). **International Journal of Insect Morphology and Embryology**, [*s.l.*], v. 23, n. 2, p. 159-168, 1994.

BOURGOIN, T.; HUANG, J. U. Morphologie comparée des genitalia mâles des Trypetimorphini et remarques phylogénétiques (Hemiptera: Fulgoromorpha: Tropiduchidae). *In*: **ANNALES de la Société entomologique de France**. [*S.l.: s.n.*], p. 555- 564. 1990.

BOURGOIN, T.; SZWEDO, J. The 'cixiid-like'fossil planthopper families. **Bulletin of Insectology**, [*s.l.*], v. 61, n. 1, p. 107-108, 2008.

CARVER, M. **Hemiptera: the insects of Australia-a textbook for students and research workers**, [*S.l.: s.n.*], 1991. p. 429- 509.

CARVER, M.; GROSS, G. F.; WOODWARD, T. E. **Hemiptera (Bugs, leafhoppers, cicadas, aphids, scale insects etc.)**. [*S.l.: s.n.*], 1994. p. 316-329. Disponível em: http://hdl.handle.net/102.100.100/240828?index=1.

CEOTTO, P.;KERGOAT, G. J.; RASPLUS, J. Y.; BOURGOIN, T. Molecular phylogenetics of cixiid planthoppers (Hemiptera: Fulgoromorpha): new insights from combined analyses of mitochondrial and nuclear genes. **Molecular Phylogenetics and Evolution**, [*s.l.*], v. 48, n. 2, p. 667-678, 2008.

CEOTTO, P.; BOURGOIN, T. Insights into the phylogenetic relationships within Cixiidae (Hemiptera: Fulgoromorpha): cladistic analysis of a morphological dataset. **Systematic Entomology**, [*s.l.*], v. 33, n. 3, p. 484-500, 2008.

CHINA, W. E.; FENNAH, R. G. XX: a remarkable new genus and species of fulgoroidea (Homoptera) representing a new family. **Annals and Magazine of Natural History**, [*s.l.*], v. 5, n. 50, p. 189-199, 1952.

CLARIDGE, M. F. Acoustic signals in the Homoptera: behavior, taxonomy, and evolution. **Annual review of entomology**, [*s.l.*], v. 30, n. 1, p. 297-317, 1985.

CLARIDGE, Michael F.; VRIJER, Peter W. F. Reproductive behavior: the role of acoustic signals in species recognition and speciation. *In*: **PLANTHOPPERS**. Boston, MA: Springer,1994. p. 216-233.

CRUZ, J. B.; BENTO, D. M.; BEZERRA, F. H. R.; FREITAS J. I. M.; CAMPOS, U. P. Diagnóstico Espeleológico do Rio Grande do Norte. **Revista Brasileira de Espeleologia**, [*s.l.*], v. 1, n. 1, p. 1-24, 2010.

CRYAN, J. R.; URBAN, J. M. Higher-level phylogeny of the insect order Hemiptera: is Auchenorrhyncha really paraphyletic?. **Systematic entomology**, [*s.l.*], v. 37, n. 1, p. 7-21, 2012.

DIETRICH, C. H. Keys to the families of Cicadomorpha and subfamilies and tribes of Cicadellidae (Hemiptera: Auchenorrhyncha). **Florida Entomologist**, [*s.l.*], v. 88, n. 4, p. 502-517, 2005.

EMELJANOV, A. F. To the problem of division of the family Cixiidae (Homoptera, Cicadina). **Entomologicheskoe Obozrenie**, [*s.l.*], v. 68, n.1, p. 93-106. 1989. In Russian.

EMELJANOV, A. F. To the problem of division of the family Cixiidae (Homoptera, Cicadina). **Entomological Review**, [*s.l.*], v. 68, n. 4, p.54-67, 1989. English translation.

EMELJANOV, A. F. To the problem of the limits and subdivisions of the family Achilidae (Homoptera, Cicadina). **Entomologicheskoe Obozrenie**, [*s.l.*], v. 70, n.2, p. 373-393, 1991. In Russian.

EMELJANOV, A. F. To the problem of the limits and subdivisions of the family Achilidae (Homoptera, Cicadina).**Entomological Review**, [*s.l.*], v. 71, n.1, p.53-73, 1992. English translation.

EMELJANOV, A. F. Contribution to classification and phylogeny of the family Cixiidae (Hemiptera, Fulgoromorpha). Obeoster- reichisches Landesmuseum, Linz, Austria. *In*: HOLZINGER, W. (ed.). **Zikaden: Leafhoppers, Planthoppers, and Cicadas (In- secta: Hemiptera: Auchenorrhyncha)**. Denisia: [*s.n.*], 2002. v. 4, p. 103-112.

FENNAH, R. G. New and little-known neotropical Kinnaridae (Homoptera Fulgoroidea). **Proceedings of the Biological Society**, Washington, v. 93, p. 674-696, 1980.

FENNAH, R. G. The external male genitalia of Fulgoroidea (Homoptera). **Proc. Entomol. Soc. Washington**, [*s.l.*], v. 47, p. 217-229, 1945a.

FENNAH, R. G. The Fulgoroidea, or lanternflies, of Trinidad and adjacent parts of South America. **Proceedings of the United States National Museum**, [*s.l.*], v. 95, n. 3184, p. 411-520, 1945b.

FENNAH, R. G. XXII: a synopsis of the Achilixiidæ of the New World (Homoptera: Fulgoroidea). **Annals and Magazine of Natural History**, [*s.l.*], v. 13, n. 99, p. 183-191, 1946.

FERREIRA, R. L., PROUS, X.; BERNARDI, L. F. O.; SOUZA SILVA, M. Fauna subterrânea do estado do Rio Grande do Norte: caracterização e impactos. **Revista Brasileira de Espeleologia**, [*s.l.*], v. 1, n. 1, p. 25-51, 2010. Título original: Subterranean Fauna of the State of Rio Grande Do Norte : Characterization and Impacts.

FERREIRA, R. L. A vida subterrânea nos campos ferruginosos. **O Carste**, [*s.l.*], v. 3, n. 17, p. 106-115, 2005.

FERREIRA, R. L.; BERNARDI, L. F. O.; SILVA, M. S. Caracterização dos ecossistemas das Grutas Aroê Jari, Kiogo Brado e Lago Azul (Chapada dos Guimarães, MT): subsídios para o turismo nestas cavidades. **Revista de Biologia e Ciências da Terra**, [*s.l.*], v. 9, n. 1, p. 41-58, 2009.

FIŠER, C.; ZAGMAJSTER, M.; FERREIRA, R. L. Two new Amphipod

families recorded in South America shed light on an old biogeographical enigma. **Systematics and Biodiversity**, [*s.l.*], v. 11, n. 2, p. 117-139, 2013. Disponível em: https://doi.org/10.1080/14772000.2013.788579.

GRAZIA, J. *et al.* Hemiptera. *In*: **OS INSETOS DO BRASIL: diversidade e taxonomia.** Ribeirão Preto: Editora Holos, 2012. p. 348-405.

HANDLIRSCH, A. Neue Untersuchungen über die fossilen Insek- ten mit Ergänzungen und Nachträgen sowie Ausblicken auf phylogenetische, palaeogeographische und allgemein biologische Probleme. II. Teil. **Annalen des naturhistorischen Museums in Wien**, [*s.l.*], p. 1-240, 1939.

HOCH, H.; WESSEL, A. Communication by substrate-borne vibra- tions in cave Planthoppers (Auchenorrhyncha: Homoptera: Fulgoromorpha: Cixiidae). *In*: DROSOPOULOS, S.; CLARIDGE,

M. F. (ed.). **Insect sounds and communication: physiology, behaviour, ecology and evolution**. Boca Raton, London, New York: CRC-Taylor & Francis, 2006. p 187-197.

HOCH, H.; SENDRA, A.; MONTAGUD, S.; TERUEL, S.; FERREIRA, R. L. First record of a cavernicolous Kinnaridae from the Old World (Hemiptera, Auchenorrhyncha, Fulgoromorpha, Kinnaridae, Adolendini) provides testimony of an ancient fauna. **Subterranean Biology**, [*s.l.*], v. 37, p. 1, 2021.

HOCH, H. **Hidden from the light of day: planthoppers in subterranean habitats (Hemiptera: Auchenorrhyncha: Fulgoromorpha)**, Denisia, v. 4, p. 139-146, 2002.

HOCH, H.; FERREIRA, R. L. *Ferricixius davidi* gen. n., sp. n.–the first cavernicolous planthopper from Brazil (Hemiptera, Fulgoromorpha, Cixiidae). **Deutsche Entomologische Zeitschrift**, [*s.l.*], v. 59, n. 2, p. 201-206, 2012.

HOCH, H.; FERREIRA, R. L. *Potiguara troglobia* gen. n., sp. n.–first record of a troglobitic Kinnaridae from Brazil (Hemiptera: Fulgoromorpha). **Deutsche Entomologische Zeitschrift**, [*s.l.*], v. 60, n. 1, p. 33-40, 2013.

HOCH, H.; FERREIRA, R. *Iuiuia caeca* gen. n., sp. n., a new troglobitic planthopper in the family Kinnaridae (Hemiptera, Fulgoromorpha) from Brazil. **Deutsche Entomologische Zeitschrift**, [*s.l.*], v. 63, p. 171, 2016.

HOCH, H.; HOWARTH, F. Evolutionary dynamics of behavioral divergence among populations of the Hawaiian cave- dwelling planthopper *Oliarus polyphemus* (Homoptera: Fulgoroidea: Cixiidae). **Pacific Science**, [*s.l.*], v. 47, n. 4, p. 303- 318, 1993.

HOCH, H.; HOWARTH, F. Multiple cave invasions by species of the planthopper genus *Oliarus* in Hawaii (Homoptera: Fulgoroidea: Cixiidae). **Zoological Journal of the Linnean Society**, [*s.l.*], v. 127, n. 4, p. 453-475, 1999.

HOCH, H.; HOWARTH, F. Reductive evolutionary trends in two new cavernicolous species of a new Australian cixiid genus (Homoptera: Fulgroidea). **Systematic Entomology**, [*s.l.*], v. 14, n. 2, p. 179-196, 1989a.

HOCH, H.; HOWARTH, F. Six new cavernicolous cixiid planthoppers in the genus *Solonaima* from Australia (Homoptera: Fulgoroidea). **Syst Entomol.**, [*s.l.*], v. 14, p. 377- 402, 1989b.

HOLZINGER, W. E.; EMELJANOV, A. F.; KAMMERLANDER, I. The

family Cixiidae Spinola 1839 (Hemiptera: Fulgoromorpha) – a review. *In*: HOLZINGER, W. (ed.). **Zikaden: Leafhoppers, Pl- anthoppers, and Cicadas (Insecta: Hemiptera: Auchenor- rhyncha)**, Denisia, Linz, v. 4: p. 113-138, 2002.

HOLZINGER, W. E.; KUNZ, G. A new genus and species of Ben- narellini from Costa Rica (Hemiptera: Fulgoromorpha: Cixi- idae). **Zootaxa**, [*s.l.*], v. 1353, n. 1, p. 53-61, 2006.

HOWARTH, F. G. Ecology of cave arthropods. **Annual Review of Entomology**, [*s.l.*], v. 28, p. 365-389, 1983.

HOWARTH, F. G. Adaptive shifts. *In*: **ENCYCLOPEDIA of caves**. [*S.l.*]: Academic Press, 2019. p. 47-55.

HOWARTH, F. G. Cavernicoles in lava tubes on the island of Hawaii. **Science**, [*s.l.*], v. 175, n. 4019, p. 325-326, 1972.

HOWARTH, F. G. The evolution of non-relictual tropical troglobites. **Int**. **J. Speleol.**, [*s.l.*], v. 16, p. 1-16, 1987.

HOWARTH, F. G. The zoogeography of specialized cave animals: a bioclimatic model. **Evolution**, [*s.l.*], v. 34, n. 2, p. 394-406, 1980.

KIRKALDY, G. W. Bibliographical and nomenclatorial notes on the Hemiptera. The Entomologist. **An illustrated Journal of Entomology**, London, v. 37, n. 3, p. 279-283, 1904.

KRAMER, J. P. Taxonomic study of the planthopper family Cixiidae in the United States (Homoptera: Fulgoroidea). **Transactions of the American Entomological Society**, [*s.l.*], p. 1-57, 1983.

LIANG, A. P. Do Achilixiidae belong to the Cixiidae? – evidence from antennal sensilla (Hemiptera: Fulgoromorpha: Fulgoroi- dea). *In*: INTERNATIONAL AUCHENORRHYNCHA, 10, 1999, Cardiff. **Meeting**… Wales: [*s.n.*], 6-10 Sep. 1999.

LIANG, A. P. Morphology of antennal sensillae in *Achilixius sandakanensis* Muir (Hemiptera: Fulgoromorpha: Achilixiidae) with comments on the phylogenetic position of the Achilixiidae. **The Raffles Bulletin of Zoology**, [*s.l.*], v. 49, n. 2, p. 221-225, 2001.

LIANG, Ai-Ping. Seven new species of *Kinnara* Distant (Hemiptera: Fulgoroidea: Kinnaridae), with notes on antennal sensilla and wax glands. **Zoological Studies Taipei**, [*s.l.*], v. 41, n. 4, p. 388- 402, 2002.

METCALF, Z. P. Smith College, Northhampton, Massachusetts *In*: **GENERAL Catalogue of the Hemiptera. Fascicle IV, Fulgoroidea. Part 5 Achilixiidae**. [*S.l.: s.n.*], 1945. p. 213-217.

MUIR, F. **On the Classification of the Fulgoroidea (Hompte- ra)**. [*S.l.: s.n.*], 1923a.

MUIR, F. *Achilixius*, a new genus, constituting a new family of the Fulgoroidea (Homoptera). **Philippine Journal of Scien- ce**, [*s.l.*], v. 22, n. 5, p. 483-487, 1923b.

MUIR, F. A New genus of the family Achilixiidae (Homoptera). **The Canadian Entomologist**, [*s.l.*], v. 56, n. 2, p. 33-34, 1924.

MUIR, F. A. G. On the genera of Cixiidae, Meenoplidae and Kinnaridae (Fulgoroidea, Homoptera). **Pan Pacific Entomo- logist**, [*s.l.*], v. 1, p. 97-110, 1925.

MUIR, F. The genus *Pintalia* Stål (Homoptera, Cixiidae). **Transac- tions of the Royal Entomological Society of London**, [*s.l.*], v. 82, n. 2, p. 421-441, 1934a.

MUIR, F. LVIII: new and little-known Fulgoroidea (Homoptera). **Journal of Natural History**, [*s.l.*], v. 14, n. 84, p. 561-586, 1934b.

NEI, M. *et al.* **Molecular population genetics and evolution**. North-Holland: Publishing Company, 1975.

NEI, M. Genetic distance between populations. **The American Naturalist**, [*s.l.*], v. 106, n. 949, p. 283-292, 1972.

NICKEL, H.; REMANE, R. Check list of the planthoppers and leaf- hoppers of Germany, with notes on food plants, diet width, life cycles, geographic range and conservation status (Hemiptera, Fulgoromorpha and Cicadomorpha). **Beiträge zur Zikadenkunde**, [*s.l.*], v. 5, p. 27-64, 2002.

O'BRIEN, L. B.; WILSON, S. W. Planthopper systematics and external morphology. **The leafhoppers and planthoppers**, [*s.l.*], v. 1985. p. 61-102.

PELLEGRINI, T. *et al.*, Linking spatial scale dependence of land- use descriptors and invertebrate cave community composi- tion. **Subterranean Biology**, [*s.l.*], v. 18, p. 17, 2016.

PERKINS, S. A.; OUVRARD, D.; HOCH, H.; BOURGOIN, T. Singing in the Namoroka caves, first record in situ for a cave dwelling insect: *Typhlobrixia namorokensis* (Hemiptera, Fulgoromorpha, Cixiidae). **Journal of insect behavior**, [*s.l.*], v. 28, n. 6, p. 704- 721, 2015.

PICKER, M. D.; SAMWAYS, M. J. Faunal diversity and endemicity of the Cape Peninsula, South Africa - a first assessment. **Biodiversity & Conservation**, [*s.l.*], v. 5, n. 5, p. 591-606, 1996. PROUS, X.; FERREIRA, R. L.; MARTINS, R. P. Ecotone delimitation: Epigean–hypogean transition in cave ecosystems. **Austral Ecology**, [*s.l.*], v. 29, n. 4, p. 374-382, 2004.

RACOVTTZA, E. G. Essai sur les problemes biospeologiques. **Ar- chives Zool. Exper. Gen.**,[*s.l.*], v. 4, n. 6, p. 371-488, 1907.

RATTON, P.; MAHNERT, V.; FERREIRA, R. L. A new cave-dwelling species of *Spelaeobochica* (Pseudoscorpiones: Bochicidae) from Brazil. **The Journal of Arachnology**, [*s.l.*], v. 40, n. 3, p. 274-280, 2012.

REMANE, R.; HOCH, H. Cave-dwelling Fulgoroidea (Homoptera: Auchenorrhyncha) from the Canary Islands. **Journal of Natural History**, [*s.l.*], v. 22, n. 2, p. 403-412, 1988.

ROCHA, R. P. Sinopse da fauna cavernícola do Brasil (1907-1994). **Papéis avulsos de zoologia**, Brasil, v. 39, n. 6, p. 61-73, 1996. SHCHERBAKOV, D. E. An extraordinary new family of Cretaceous planthoppers (Homoptera: Fulgoroidea). **Russian Entomological Journal**, [*s.l.*], v. 16, n. 2, p. 139-154, 2007.

SOUZA-SILVA; FERREIRA, R. L. Caracterização ecológica de algumas cavernas do Parque Nacional de Ubajara (Ceará) com considerações sobre o turismo nestas cavidades. **Revista de Biologia e Ciências da Terra**, [*s.l.*], v. 9, n. 1, p. 59-71, 2009.

SOUZA-SILVA; MARTINS, R. P.; FERREIRA, R. L. Cave lithology determining the structure of the invertebrate communities in the Brazilian Atlantic Rain Forest. **Biodiversity and Conservation**, [*s.l.*], v. 20, n. 8, p. 1713-1729, 2011a.

SOUZA-SILVA; NICOLAU, J. C.; FERREIRA, R. L. Comunidades de invertebrados terrestres de três cavernas quartzíticas no Vale do Mandembe, Luminárias, MG. **Espeleo-tema**, [*s.l.*], v. 22, n. 1, p. 155-167, 2011b.

SOUZA-SILVA; MARTINS, R. P.; FERREIRA, R. L. Trophic dynamics in a neotropical limestone cave. **Subterranean Biology**, [*s.l.*], v. 9, p. 127, 2011c.

SIMÕES, M. H.; SILVA, Marconi, S.; FERREIRA, R. L. Species richness and conservation of caves in the Urucuia River sub-basin, a tributary of the San Francisco River: a case study in caves of Arinos, Minas Gerais, Brazil. **Revista Brasileira de Espeleolo- gia**, [*s.l.*], v. 2, n. 2, p. 1-17, 2013.

SIMÕES, M. H.; SILVA, M; S.; FERREIRA, R. L. Cave physical attributes influencing the structure of terrestrial invertebrate communities in Neotropics. **Subterranean Biology**, [*s.l.*], v. 16, p. 103, 2015.

SOUZA, S.; RIUTORT, M.; FERREIRA, R. L.; LEAL-ZANCHET, A. An in- tegrative taxonomic approach reveals the first marine triclad (Platyhelminthes) trapped in a cave from a

semiarid Neotrop- ical environment. **Invertebrate Systematics**, [*s.l.*], v. 32, n. 3, p. 627-638, 2018. Disponível em: https://doi.org/10.1071/ IS17062.

STÅL, C. Bidrag till Rio Janeiro-trakens Hemipterfauna. II**. K. svenska Vetensk. Akad.**, [*s.l.*], v. 3, n 6, p. 1-75, 1862.

SYNAVE, H. Un cixiide troglobie decouvert dans les galeries souterraines du systeme de Namoroka (Hemiptera- Homoptera). **Nat Malgache**, [*s.l.*], v. 2, p. 175-179, 1953.

SZWEDO, Jacek. Nymphs of a new family Neazoniidae fam. n. (Hemiptera: Fulgoromorpha: Fulgoroidea) from the Lower Cretaceous Lebanese amber. **African Invertebrates**, [*s.l.*], v. 48, n. 1, p. 127-143, 2007.

URBAN, J. M.; BARTLETT, C. R.; CRYAN, J. R. Evolution of Delphacidae (Hemiptera: Fulgoroidea): Combined-evidence phylogenetics reveals importance of grass host shifts. **Systematic Entomol- ogy**, [*s.l.*], v. 35, p. 678-691, 2010.

URBAN, J. M.; CRYAN, J. R. Evolution of the planthoppers (Insecta: hemiptera: Fulgoroidea). **Molecular Phylogenetics and Evolution**, [*s.l.*], v. 42, n. 2, p. 556-572, 2007.

VAN DUZEE, E. P. A preliminary list of the Hemiptera of San Diego County, California. **Transactions of the San Diego Society of Natural History**. San Diego, v. 2, p. 1-57, 1914.

VANDEL, A. **Biospeology: the biology of cavernicolous animals**. Oxford: Pergamon Press, 1965. p. 524.

VASCONCELOS, A. C. O.; FERREIRA, R. L. Two new species of cave-dwelling Charinus Simon, 1892 from Brazil (Arachnida: Amblypygi: Charinidae). **Zootaxa**, [*s.l.*], v. 4312, n. 2, p. 277- 292, 2017.

VIEGAS, E. F. G. *et al.* **Estudo taxonômico de Achilixiidae Muir, 1923 (Hemiptera: Auchenorrhyncha: Fulgoroidea) no Brasil**. 2019. 113 f. Dissertação (Mestrado em Entomologia) – Instituto Nacional de Pesquisas da Amazônia, Manaus, 2019.

WESSEL, A.; ERBE, P.; HOCH, H. Pattern and Process: evolution of troglomorphy in the cave-planthoppers of Australia and Hawai'i-Preliminary observations (Insecta: Hemiptera: Fulgoromorpha: Cixiidae). **Acta carsologica**, [*s.l.*], v. 36, n. 1, 2007.

WILSON, M. R. The planthopper family Achilixiidae (Homoptera, Fulgoroidea): a synopsis with a revision of the genus Achilixius. **Systematic Entomology**, [*s.l.*], v. 14, n. 4, p. 487-506, 1989.

WILSON, S. W. *et al.* Evolutionary patterns of host plant use by delphacid planthoppers and their relatives. *In*: **PLANTHOPPERS**. Boston, MA: Springer, 1994. p. 7-113.

WILSON, S. W. Keys to the families of Fulgoromorpha with emphasis on planthoppers of potential economic importance in the southeastern United States (Hemiptera: Auchenorrhyncha). **Florida Entomologist**, [*s.l.*], v. 88, n. 4, p. 464-481, 2005.

XING, Ji-Chun; HOCH, H.; CHEN, Xiang-Sheng. New replacement name for the planthopper genus Potiguara Hoch et Ferreira, 2013 (Hemiptera: Fulgoromorpha: Kinnaridae). **Zootaxa**, [*s.l.*], v. 3734, n. 3, p. 400, 2013.

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The genus *Pintalia* Stål, 1862 (Hemiptera: Fulgoromorpha: Cixiidae) in Neotropics: a preliminary review with the establishment of three subgenera and description of twelve new species from Brazilian caves.

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Abstract

Here we redescribe the type-series of *Pintalia* Stål, 1862 (Hemiptera, Fulgoroidea) and provide an emended diagnosis for the genus. Furthermore, we propose three subgenera for the Neotropical region and describe twelve new species found in Brazilian caves: *P. (Pictipennis)* **subgen. nov.**, which includes *P. (P.) pictipennis* Stål, 1862, *P. (P.) propria* Muir 1934, *P. (P.) minuta* **sp. nov**, *P. (P.) minima* **sp. nov**, *P. (P.) magnaepiprocti* **sp. nov**, *P. (P.) serratilis* **sp. nov** and *P. (P.) stali* **sp. nov**; *P. (Ecuadorensis s)* **subgen. nov,** which includes *P. (E.) constellaris* (Walker,1858), *P. (E.) ecuadorensis s* Muir, 1934, *P. (E.) speciosa* **sp. nov** and *P. (E.) fennahi* **sp. nov**; and *P. (Caudata)* **subgen. nov,** which includes *P. (C.) dorensis* **sp. nov**, *P. (C.) lundi* **sp. nov**, *P. (C.) painensis* **sp. nov**, *P. (C.) montalvaniensis* **sp. nov**, and *P. (C.) muiri* **sp. nov**. A key to the Brazilian new subgenera and new species is provide. Adults and nymphs were observed inside the caves feeding on roots from epigean vegetation and are hence tentatively classified as troglophiles (Subtroglophiles and Eutroglophiles). All new species were collected from caves from the Minas Gerais state. Some species are currently known only from their type localities. Information on the distribution, habitat, ecology, and a list of previously described taxa from Brazil are also provided. The species described herein raise the number of *Pintalia* species described for Brazil to thirty-one, and Ninety-three on the New World in total.

Key words: cave, troglophiles, planthopper, taxonomy, adaptive shifts, root community.

Introduction

Fulgoromorpha hemipterans are phytophagous and usually feed on the green parts of plants (Hoch, 2002). However, several species are commonly found in caves, feeding on roots from the epigean vegetation (Howarth, 1972; Hoch & Asche, 1993; Hoch, 1994; Hoch et al., 2013; Hoch et al., 2017). Such cave-inhabiting species are mainly from groups in which immatures have a cryptic way of life, living in leaf litter, close to or even inside the soil (Hoch, 1994; Hoch, 2002). Several lineages within each of these groups are capable to establish populations both inside and outside caves, being recognized as eutroglophiles (Sket, 2008et al.,), while other species are unable to complete all their life cycle inside caves and are associated with epigean habitats for feeding or reproduction, thus being considered subtroglophiles (Sket, 2008; Hoch et al., 2013).

The adaptive shift model (ASH) (Howarth, 1972, 1981, 1987, 1993, 2004, 2019; Howarth & Hoch, 2005) explored the migration of some individuals from an epigean population to the subterranean environment, in search for a new habitat and/or resource to complete its life cycle. If such individuals find the required resources to establish themselves, different populations can thrive along an environmental gradient towards the interior of the caves (parapatry). In this context, selective mating, selection against hybridization, and distancing of the hybrid zone are identified as incipient processes for the maintenance of the gene flow barrier, leading to a consequent speciation within the caves (Howarth, 2019). So far, strictly subterranean species have been reported for five families in Fulgoroidea (Hoch, 2002), including the Cixiidae.

The Cixiidae Spinola, 1839 comprises the largest family within Fulgoroidea (Bourgoin, 2021). This family is also the oldest in the group, according to fossil records from Cretaceous and even lower Jurassic periods (130 to 200 million years) (Szwedo et al. 2004; Bourgoin & Szwedo, 2008; Bartlett, 2020). Holzinger et al. (2002), revised the family and provided information on morphology, ecology, economic importance, and and hints on keys for the identification, and a list of genera of this family. Several studies published in the last decades examined the phylogenetic relations within the Cixiidae, based on morphological (Holzinger et al., 2002; Ceotto & Bourgoin 2008; Brożek & Bourgoin 2013), and molecular data (Urban & Cryan 2007; Ceotto et al., 2008). Some genera within Cixiidae are defined by plesiomorphic traits, and as a result, they act as "trash bucket" genera. Most of such problematic genera are types of some tribes and were erected a long time ago, when there were still few techniques for unambiguous identifications, for example *Cixius* Latrelle, 1804 and *Pintalia* Stål, 1862.

Pintalia Stål, 1862 is the type genus of the Pintaliini (Metcalf, 1938). Several phylogenetic studies including Pintaliini were published during the last decades (Emeljanov, 2002; Ceotto & Bourgoin, 2008; Ceotto et al., 2008; Brożek & Bourgoin 2013). The genus *Pintalia* was erected by Stål, 1862 to accommodate nine species from Rio Janeiro, Brazil. The author reported that structures from the head, thorax and tegmina (forewings) were the main traits for identifying species in the genus (Stål, 1862). Muir (1934) added ten new species from Brazil to the genus and emphasized the importance of using the male genitalia when describing species of Fulgoroidea, and of understanding the ontogeny for inferences about homologies in the group. Fennah (1945c) reported that the shape of the male anal segment and genital styles are among the most stable traits used for the identification of species within the genus. Additionally, he grouped the species described by Muir (1934) and by himself (Fennah,1945c) into nine groups. The most recent taxonomic treatment of the genus was proposed by Kramer (1983), with a taxonomic key for North American species, accompanied by the description of two new species, *P. vibex* Kramer, 1983, and *P. gurneyi* Kramer, 1983. Kunz and Holzinger (2022) recently they described *Pintalia hannae* Kunz and Holzinger, 2022 for Costa Rica and highlighted that the genus *Pintalia* Stål, 1862 needs to be urgently revised.

Kunz and Holzinger (2022) indicate that *Pintalia* Stål, 1862 is possibly a polyphyletic group and allocation of new species is tentative. Here, we redescribe the nine species of the type series proposed by Stål, 1862. In addition, we describe twelve new species for Brazil, and propose three subgenera to allocate them. We also propose new characters for identification and provide an emended diagnosis for the genus. With the species herein described, *Pintalia* Stal,1862, adds up to 93 species in New World and 31 in Brazil.

Materials and methods

Redescription

The redescriptions of the species proposed by Stål, 1862 were made based in the photographs. Doubts were resolved with the curator responsible for sending the images. The specimens were photographed by Gunvi Lindberg (© 2021 Naturhistoriska riksmuseet). Used a system camera Canon EOS 7D at a kopistand and motorized stackshot rail. Camera lens: MPE-65 mm; 1-5X. Used together with software: Canon EOS Utility, Digital Photo Professional, Zerene Stacker and Photoshop Extended (for the scale). The original images have cropped, light levels and contrast slightly adjusted [or similar if modified from the original]. Made available by the Swedish Museum of Natural History under Creative Commons Attribution 4.0 International Public License, CC-BY 4.0

[https://creativecommons.org/licenses/by/4.0/legalcode]. Measurements were made based on the scale provided in each photograph, with the help of a dynamic scale created by the software Zen 2.3. For some species described by Stål (1862) it is difficult to measure Body length due to the long time in conservation and the specimen condition. Therefore, sometimes the only measure for *Body length* informed here are the same informed by Stål (1862).

Collection, preservation, and depository

Specimens were collected manually in the caves using brushes moistened with ethanol and immediately transferred to vials containing 70% ethanol. Type material of the species herein described are deposited in the Coleção de Invertebrados Subterrâneos de Lavras (ISLA), in the Centro de Estudos em Biologia Subterrânea (CEBS) from the Universidade Federal de Lavras (UFLA).

Morphological examination techniques and visualization

A Zeiss Axio Zoom V16 stereomicroscope and Zen 2.3 software were used to examine the morphological characters of the specimens, to capture images and to take measurements (presented in millimeters on the descriptions). The color description follows the standard names of sRGB Centroids for the ISCC-NBS Color System, Centore (2016). Measurements and examinations of the external morphological traits were made from the holotypes and paratypes immersed in ethanol, without additional manipulation. The Inkscape software (https://inkscape.org/) was used for to process the images and make the drawings.

Male genitalia preparation and examination

To keep the holotypes intact, paratypes, if available, were chosen to prepare the male genital parts for dissection. The specimens are stored in ethanol 70%. The male genitalia were removed from the specimens with the aid of pins and entomological scissors and transferred to ethanol in gel, with a layer of liquid ethanol 70%, which was added to remove reflections on the photographs.

Terminology

The morphological terms applied here follow, in parts, Löcker et al., (2006b), with some adaptations for the names of some structures of the male genitalia (Anal tube = Anal segment). The terminology of the carinae and compartments on the head follows Löcker (2014a) and the terminology of the tegmina cells and venation follows Bourgoin et al., (2015), with an adapted image which is provided here (Figure 13).

Measurements

The measures used in this study were:

- Body length: Dorsally, from the middle of the apical transverse carinae to the base of the pygofer;
- Length of vertex: Medially, from the apical transverse carina to the caudal border (measured separately and add up).
- Width of vertex: at the level of the caudal border medially;
- Width of apical compartment: greater width, here from the apical transverse carina or subapical carina;
- Length of the apical compartment: Greater length medially from the subapical carina to the apical transverse carina;
- Length of frons: medially, from the frontoclypeal suture to the apical transverse carina;
- Width of frons: greater width in facial view, here at the same level or just below the scape;
- Width of anterior region of frons: slightly down level as the apical transverse carina in facial view;
- Length of anterior wings (Forewings): Tegulae to distal margin;
- Length of hind tibia: from the base of the hind tibia to the base of apical teeth.

Abbreviations

BPBM	Bernice Pauahi Bishop Museum, Honolulu, United States of America
NHRS	Naturhistoriska Riksmuseet, Stockholm, Sweden
ISLA	Invertebrados subterrâneos de Lavras, Lavras, Brazil
NW	New World
AS	South America
BRA	Brazil
ECU	Ecuador
BOL	Bolivia
USA	United States of America
PER	Peru
RJ	Rio de Janeiro state
PA	Pará state
MG	Minas Gerais state

SP	São Paulo state
AP	Amapá state
BA	Bahia state
PR	Paraná state
SC	Santa Catarina state
RCH	Climate relict
ASH	Adaptive shifts
LGM	Last Glacial Maximum

Maps and overlay analysis.

We used approximate coordinates obtained from the literature records, from coordinates of specimens deposited in the ISLA collection and from records from the INaturalist database (last access 28/12/2021). We used Qgis 3.16.15 software to create of distribution maps and the "*Counting points in polygon*" function for the overlay analyses.

Results

Genus *Pintalia* Stål, 1862.

Pintalia Stål C, 1862.

Type species: *Pintalia lateralis* Stål C, 1862 by original designation.

Diagnosis emended. Muir (1934) provided the most accurate diagnosis for brazillian species of the genus, where he reported that head, thorax and tegmina present the main characteristics for the identification. In parts Kramer (1983) and other authors propose that *Pintalia* species are characterized mainly by a vertex trapezoidal, with two compartments (apical and basal) and with two carinae (apical transverse carina and subapical carina); mesonotum with three carinae, flat in lateral view; lateral ocelli and frontal ocellus developed; tegmina tectiform, in resting position usually surpassing approx. 1/3 of body length with distal margins touching each other, and apical cells and veins usually elongated and parallel (between RA and icu veins), usually with 12-13 distal veins; hind tibia with lateral spines in most species, rarely without (see morphology). However, other characters are essential for the genus identification such as: Pygofer is laterally compressed, and in lateral view usually wider medially; the ventromedian process is triangular as wide as long. Females exhibit the ovoid or rounded IX-segment and the elongated, upward-curved ovipositor. Vertex with apical transverse carina usually visible in dorsal view; basal compartment larger than apical compartment. Frons with median carina

developed. Rostrum reaching or surpassing the hind coxae. Pronotum narrow. Mesonotum usually distally inclined, sometimes medially rounded and with carinae narrower near of the pronotum. Tegmina (Figure 13), with RP quadrifid and petiolate or punctual anastomosis in RP3+RP4, sometimes with punctual anastomosis between RA+RP1; rm-1 and mcu-1 usually near the first MP fork; fork of MP1+2 usually trifid and MP 3+4 usually bifid; fork ScP+RA and RP starting little after basal cell, and usually before to the fork in Cua1 e Cua2 or the same height; C1 and C5 cells usually more elongated; C1 cell always larger than C5 cell. Hind wing with RP bifid, MP usually trifid (petiolate anastomosis in MP3+CuA1 distally forked) or bifid (complete anastomosis with distal fusion MP3+CuA1) (Emeljanov, 2002b). Hind tibia with 6 apical teeth grouped as follows: 1 larger lateral (distal), 2 smaller together (medial), 1 larger (medial), and 2 (medium size) (internal) with approximately the same size. Females are like males but moderately larger.

Remarks. Muir (1934) also pointed out the importance of using the fulgoroid genitalia and described the first male genitalia for the genus. However, since then, a wide variety of genitals have been described, and some patterns can be better observed nowadays. Some of these patterns of male and female genitalia are best observed in *morphology*.

Morphology. Body length: ♀ 2.8 -6.0 mm (n=40). ♂ 2.6 -5.3 mm (n=42).

Head. The apical transverse carina and subapical carina are approx. the same size and can be straight, almost straight, straight bent forward or concave. However, the apical transverse carina can be distinct in some species, e.g. elongated medially and touching the median carina of the frons, (more visible in frontal view) (*P. ustulata* Stål, 1862; *P. inortata* Stål, 1862); the angle formed by the caudal border of the vertex can be concave or triangular; the lateral carinae is elevated (except *P. fasciatipennis* Stål ,1862); the basal emargination (median carina) is absent or is inconspicuous (*P. lateralis* Stål, 1862; *P. obscuripennis* Stål, 1862; *P. pictipennis* Stål, 1862), and also, weakly developed (*P. inortata* Stål, 1862), or well developed (*P. consobrina* Stål, 1862; *P. fasciatipennis* Stål, 1862; *P. ustulata* Stål, 1862). Frons longer than wide; usually up to 2.0 times wider at the same height or just below the antennas than in the anterior region of the frons; the anterior region of frons is trapezoidal, usually above the compound eyes (except *P. ustulata* Stål, 1862; *P. inortata* Stål, 1862) and can be straight or concave apically (apical transverse carina in facial view); median carina not reaching or rarely reaching the frontal ocelli (except *P. consobrina* Stål, 1862), in some species in facial view touching to apical transverse carina medially, "y-shaped" apically; lateral carinae of the frons

usually elevated (except *P. fasciatipennis* Stål, 1862). Antenna with short scape and semi-globular pedicel, slightly surpassing the margins of the frons when in facial view.

Thorax. Pronotum tricarinate, with median carina absent or inconspicuous; submedian carina moderately developed, often not continuous dorsally (weakly developed); dorsally shorter length in the middle between the eyes; caudal border rounded or straight/obtuse. Mesonotum dorsally with three carinae, which are usually narrow near the pronotum and wide near the abdomen (except *P. inortata* Stål, 1862); some species exhibit the region between carinae lighter than on the lateral area near the tegulae (*P. lateralis* Stål, 1862 and little in *P. consobrina* Stål, 1862). Tegmina (Forewings) in some species with punctual anastomosis between RA+RP1 (*P. consobrina* Stål 1862; *P. pictipennis* Stål, 1862); tubercles can also occur through all veins of the tegmina, often more evident in some species; such tubercles can be double (*P. consobrina* Stål 1862), simple (*P. fasciatipennis* Stål, 1862; *P. obscuripennis* Stål, 1862; *P. proxima* Stål, 1862 and *P. ustulata* Stål, 1862), evanescent (*P. fraterna* Stål, 1862; *P. lateralis*, Stål, 1862 and *P. pictipennis* Stål, 1862), or yet absent or inconspicuous (*P. inortata* Stål, 1862); distal margin totally curved (except *P. ustulata* Stål, 1862); Cells C2a, C2, C3a, C3 and C4 (central prenodal cells), stacked together little after the center of the tegmina; C1 and C5 elongated (lateral prenodal cells), C1 a little closer to bc than C5 (except: *P. ustulata* Stål, 1862), or C5 very short (*P. inortata* Stål, 1862) or approx. the same size as C1 (*P. ustulata* Stål, 1862); usually 12 apical cells (nodal) and 7 subapical cells (prenodal) (except *P. fasciatipennis* Stål, 1862 and *P. obscuripennis* Stål, 1862). Hind wing with RP bifid, MP trifid usually with petiolate anastomosis in MP3+CuA1 distally forked (*P. ustulata* Stål, 1862, *P. lateralis* Stål, 1862, *P. fraterna* Stål, 1862) or with complete anastomosis with distal MP3+CuA1 fusion (possibly *P. (P.) pictipennis* Stål, 1862).

Posterior legs. Hind tibia usually with 1-7 lateral spines, which are tiny near base, but unarmed in some species (*P. inortata* Stål, 1862; *P. obscuripennis* Stål, 1862; *P. ustulata* Stål, 1862); and 6 apical teeth. 1st tarsomere with 7 apical teeth of approx. the same size or, with 1-2 lateral larger and 2 apical teeth moderately large in the middle. 2nd tarsomere with 7-9 apical teeth, rarely 7 and rarely 9, all with approx. the same size, or with 1-2 lateral larger teeth and intermediate teeth gradually smaller at middle or with the same size, usually 1-3 platellae (*P. (Caudata)* **subgen. nov,** *P. (Ecuadorensis*) **subgen. nov)** or with 3 very thin setae (*P. (Pictipennis)* **subgen. nov)**.

Male genitalia. Pygofer with or without processes between dorsal and distal margins; asymmetric in some species with ventromedian process triangular and crooked sometimes. The anal segment may be longer than wider and distally developed, bent (deflexed) at between 45°

- 90° with epiproct and paraproct small or not developed (*P. (Caudata)* **subgen. nov)**; or elongated but not developed distally, with epiproct and paraproct small or not developed (*P. (Ecuadorensis)* **subgen. nov)**; or moderately short and wide not developed distally, sometimes the epiproct is developed, but the paraproct is ever developed (*P. (Pictipennis)* **subgen. nov)**. Genital styles in lateral view can be long and well expanded apically (*P. (Pictipennis)* **subgen. nov,** (*P. (Ecuadorensis)* **subgen. nov)**, or long with the apex slightly or moderately expanded (*P. (Caudata)* **subgen. nov.**); in ventral view, genital styles touching medially forming a basal opening; the basal opening of the genital styles can be moderately large, laterally concave, and apically triangular (*P. (Pictipennis)* **subgen. nov)** or small and diamond-shaped (*P. (Ecuadorensis)* **subgen. nov** and *P. (Caudata)* **subgen. nov)**. The shaft of the aedeagus is tubular with ventral ridge developed, and flagellum spineless (*P. (Pictipennis)* **subgen. nov)**, or tubular almost as wide at base as at apex, and usually with three conspicuous spines at the apex of the aedeagal shaft, ventral ridge absents and flagellum spineless (*P. (Ecuadorensis)* **subgen. nov)**; or tubular and wider apically near to flagellum, ventral ridge absents, usually flagellum with spines and phallotreme laterally (*P. (Caudata)* **subgen. nov)**.

Female genitalia: The X-segment is not developed distally; but it may be elongated, tubular or cylindrical dorsally with lateral borders moderately developed (*P. lateralis* Stål 1862. *P. (Ecuadorensis)* **subgen. nov,** *P. (Caudata)* **subgen. nov)**, or slightly longer than wider and flattened ventrally (*P. obscuripennis* Stål, 1862; *P. consobrina* Stål, 1862; *P. ustulata* Stål, 1862) and in parts *P. (Pictipennis)* **subgen. nov,** *P. (P.) minuta* **sp. nov** and *P. (P.) minima* **sp. nov**, is rounded apically; usually the epiproct and paraproct is flattened, and small. The epiproct is triangular in dorsal view, with two rounded borders bent down laterally; the paraproct in dorsal view is rounded, and sometimes is weakly elongated. Segment IX is truncated, with a rounded border, usually small ovoid or rounded. The ovipositor is arch-shaped (upwardly curved), sometimes protruding beyond the X-segment.

Distribution. Neotropical region. In most parts of South America (mainly Southeastern Brazil and Ecuador), Central America (mainly Costa Rica) and North America (Mainly Mexico and Southeastern USA).

Remarks. All species here treated have the vertex formed by two compartments and two carinas as *P. lateralis* Stål, 1862. However, the apical transverse carina in *P. inortata* Stål, 1862 and *P. ustulata* Stål, 1862 is distinct. In these species, the apical transverse carina is medially elongated and, as a result, it exhibits a larger apical compartment than in other species. Most species present the vertex with elevated carinae in dorsal view; however, in *P. consobrina* Stål, 1862 the subapical carina is engraved on the disc (not elevated) and in *P. fasciatipennis* Stål,

1862 the two carinae are not elevated (apical transverse and subapical) which is also uncommon for the genus. Furthermore, *P. inortata* Stål, 1862, *P. consobrina* Stål, 1862, *P. fasciatipennis* Stål, 1862 and *P. ustulata* Stål, 1862 are the only species with moderately to well-developed median carina in the basal compartment.

In the three subgenera herein proposed, the transverse apical carina can be concave in facial view as in *P. (Pictipennis)* **subgen. nov,** or straight as in *P. (Caudata)* **subgen. nov** and *P. (Ecuadorensis)* **subgen.n**. In dorsal view, it may be the same size or larger than the subapical carina as observed for *P. (Pictipennis)* **subgen. nov** but also of the same size or smaller than the subapical carina as in *P. (Caudata)* **subgen. nov** and *P. (Ecuadorensis)* **subgen. nov.** In the facial view of the frons, it is possible to observe two main frontoclypeal suture patterns. Some species exhibit the semicircular frontoclypeal suture bent upwards as in *P. lateralis* Stål, 1862 and *P. (Pictipennis)* **subgen. nov;** however, in other species it is straight bent upwards as in *P. fraterna* Stål, 1862 and *P. (Caudata)* **subgen. nov.**

We did not find significant variations in the thorax (pronotum and mesonotum) among the species reported here, except for *P. inortata* Stål, 1862, which dorsally exhibits almost straight and parallel carinae on mesonotum vs. a narrow near the pronotum and wide distally, which is the pattern observed in most species. All species reported here have lateral spines on the posterior tibia, except for *P. inortata* Stål, 1862; *P. obscuripennis* Stål, 1862 and *P. ustulata* Stål, 1862. Although this be to be a convenient character for the species subgeneric grouping, it was not possible to observe species without lateral spines on the hind tibia between the material deposited in the ISLA collection, to be able to associate them them with other characters and create here a new group or a new subgenre with that feature. Furthermore, it was not possible to accurately assess the apical teeth of the hind tibia of the species described by Stål, 1862. On the other hand, we observed thin setae (*P. (Pictipennis)* **subgen. nov)** and platellae *(P. (Caudata)* **subgen. nov** and *P. (Ecuadorensis)* **subgen. nov)** on the new species herein described, and this character is normally used for subgeneric grouping in Cixiidae. However, it can be sometimes absent or in a smaller number on one of the legs.

Although the tegmina can present different anastomosis and crossveins in some species, it usually exhibits stable cell patterns, with 12 apical (nodal) cells and 7 subapical (prenodal) cells. However, in some species, it may present asymmetry of cells and veins between the right and left tegminae. For most species, the distal margin is fully curved between RA and icu, except in *P. ustulata* Stål, 1862. In *P. (Pictipenniss)* **subgen. nov** the punctual anastomosis between RA+RP1 is an important identification character among the subgenera proposed here. The shape of the basal margin of the pterostigma can be also useful for identification, since in

P. (Pictipennis) **subgen. nov** it is small and distally triangular, while in *P. dorensis (Ecuadorensis s*) **subgen. nov** it is large and sub rectangular weakly angled distally, and in *P. (Caudata)* **subgen. nov** it is large and sub rectangular, weakly, or well angled distally. Although there are conspicuous spotting patterns in some species and subgenres, some patterns can be observed in species of the three subgenera herein proposed, such as an inclined transverse spot in the center of the tegmina (most species), two semicircular spots in pcc (most species), and another three semicircular or rounded between ScP+RA and A1.

Unfortunately, it was only possible to observe the posterior wings of *P. lateralis* Stål, 1862 (type), *P. ustulata* Stål, 1862 and *P. fraterna* Stål, 1862. These species have a petiolate anastomosis in MP3 + CuA1 distally forked as *Pintalia (Caudata)* **subgen. nov** (Figure 14 D) and *Pintalia (Ecuadorensis s)* **subgen. nov** (Figure 14 E). However, *Pintalia (Pictipennis)* **subgen. nov** exhibits complete anastomosis with distal MP3+CuA1 fusion (Figure 14 F), as the specimen used by Emeljanov (2002).

Main characters evaluated

Here we suggest the main characters for species allocation and for the subgenera in *Pintalia* Stål, 1862 (Table 1): Vertex with two transverse carina (apical and subapical) and two compartments (apical and basal) present (1) or absent (0) (AP); vertex with apical transverse carina and subapical carina elevated (2), not elevated (1) or only apical transverse carinae elevated (0) (CV); apical transverse carina in facial view concave medially (2), straight (1), medially elongated (0) (AT); median carina of the basal compartment developed (1) or undeveloped (0) (MC); Frons with lateral carinae elevated (1) or no elevated (0) (FR); Frontoclypeal suture semicircular bent forwards (1) or straight bent forwards (0)(FS); Median carina touching the frontal ocellus (1) or evanescent near of the frontal ocellus (0)(FM). Tegmina with RA+RP1 with punctual anastomosis (1) or anastomosis absent (0) (TR); ScP+R well forward od fork CuA (3), slightly (2), in the same level (1), behind (0) (TV); Hind wing with a petiolate anastomosis in MP3+CuA1 distally forked (1) or with complete anastomosis with distal fusion between MP3+CuA1 (0) (WA). Females with anal segment long (1) or short (0) (FA). Hind legs with presence of thin setae (1) or patellae (0) on the 2nd, tarsomere (PS); lateral spines in hind tibia presence (1) or absence (0) (LS). Anal segment distally developed (1), undeveloped (0) (AS); Male anal segment in dorsal view with narrowing (lesser width) just before the base (1) or not narrowing (0) (AD); paraproct distally developed (1), undeveloped (0) (PP); epiproct distally developed (1), undeveloped (0) (EP); presence of a ventral ridge on the aedeagal shaft (1), absence(0) (VR); flagellum spine-like (1) or flagellum spineless (0) (FS);

Pygofer with process in cone shaped laterally, wide, in caudal view (1) or without process in cone shaped laterally (0) (PY); the shape and size of the genital styles, well large (1), or moderately large (0) (GS); shape and size of the basal opening of the genital styles, larger and laterally concave (1) or small in diamond shape (0) (OG); the shape of the aedeagal shaft, tubular (1) tubular and apically larger (0) (AF); Pregenital segment totally evanescent in the middle (2), moderately evanescent (1), not evanescent (0) (PG).

	AP	CV	AT	MC	FR	FS	FM	TR	TV	WA	FA	OS	LS	AS	AD	PP	EP	VR	FS	PY	GS	OG	AF	FS	PG
Pintalia lateralis Stål, 1862 (**type)**	1	2	1	0	1	1	0	0	2	1	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Pintalia consobrina Stål, 1862	1	0	1	1	1	0	1	1	2	-	0	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Pintalia fasciatipennis Stål, 1862	1	2	1	1	1	1	0	1	0	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Pintalia fraterna Stål, 1862	1	1	1	0	0	0	0	0	2	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Pintalia inortata Stål, 1862	1	2	0	1	1	1	0	-	3	-	-	-	0	-	-	-	-	-	-	-	-	-	-	-	-
Pintalia obscuripennis Stål, 1862	1	2	1	0	1	1	0	0	2	-	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-
Pintalia proxima Stål, 1862	1	2	1	0	1	0	0	0	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
Pintalia ustulata Stål, 1862	1	2	0	1	1	1	0	0	1	1	0	-	0	-	-	-	-	-	-	-	-	-	-	-	-
Pintalia (Pictipennis) serratilis **sp. nov.**	1	2	2	0	1	1	0	1	2	0	0	1	1	0	0	1	0	1	0	0	1	1	1	0	2
Pintalia (Pictipennis) stali **sp. nov.**	1	2	2	0	1	1	0	1	2	0	0	1	1	0	0	1	0	1	0	0	1	1	1	0	2
Pintalia (Pictipennis) minima **sp. nov.**	1	2	2	0	1	1	0	1	2	0	0	1	1	0	0	1	0	1	0	0	1	1	1	0	2
Pintalia (Pictipennis) minuta **sp. nov.**	1	2	2	0	1	1	0	1	2	0	0	1	1	0	0	1	0	1	0	0	1	1	1	0	2
Pintalia (Pictipennis) magnaepiprocti **sp. nov.**	1	2	2	0	1	1	0	1	2	0	0	1	1	0	0	1	1	1	0	0	1	1	1	0	2
Pintalia (Pictipennis) pictipennis Stål, 1862	1	2	2	0	1	1	0	1	2	0	0	1	1	0	0	-	0	1	0	0	1	1	-	-	2
Pintalia (Pictipennis) propria Muir, 1934	1	2	2	0	1	1	0	1	2	0	0	1	1	0	0	1	0	1	0	0	1	1	1	0	2
Pintalia (Ecuadoriensis) fennahi **sp. nov.**	1	2	1	0	1	0	0	0	2	1	1	0	1	0	0	0	0	0	0	1	1	0	1	0	1
Pintalia (Ecuadoriensis) speciosa **sp. nov.**	1	2	1	0	1	1	0	0	2	1	1	0	1	0	0	0	0	0	0	1	1	0	1	0	1
Pintalia (Ecuadoriensis) constellaris (Walker, 1858)	1	2	1	0	1	1	0	0	2	1	1	0	1	0	0	0	0	0	0	1	1	0	1	0	0
Pintalia (Ecuadoriensis) ecuadorensis s Muir, 1934	1	2	1	0	1	1	0	0	2	1	1	0	1	0	0	0	0	0	0	1	1	-	1	0	-
Pintalia (Caudata) lundi **sp. nov.**	1	2	1	0	1	0	0	0	2	1	1	0	1	1	1	0	0	0	1	0	0	0	0	1	0
Pintalia (Caudata) dorensis **sp. nov.**	1	2	1	0	1	0	0	0	2	1	1	0	1	1	1	0	0	0	1	0	0	0	0	1	0
Pintalia (Caudata) muiri **sp. nov.**	1	2	1	0	1	0	0	0	2	1	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0
Pintalia (Caudata) montalvaniensis **sp. nov.**	1	2	1	0	1	0	0	0	2	1	1	0	1	1	1	0	0	0	0	0	0	0	0	1	0
Pintalia (Caudata) painensis **sp. nov.**	1	2	1	0	1	0	0	0	2	1	1	0	1	1	1	0	0	0	1	0	0	0	0	1	0

Table 1: Main characters evaluated for the proposal of new species and subgenera here.

Checklist of species of *Pintalia* Stål, 1862 from Brazil.

Pintalia lateralis Stål, 1862 (**type)**	(BRA)	(NHRS)
Pintalia albomarginata Muir, 1934	(PA)	(BMNH)
Pintalia angustinotata Muir, 1934	(PA)	(BMNH)
Pintalia consobrina Stål, 1862	(BRA)	(NHRS)
Pintalia (Caudata) dorensis **sp. nov**	(MG)	(ISLA)
Pintalia fasciatipennis Stål, 1862	(BRA)	(NHRS)
Pintalia (Ecuadoriensis) fennahi **sp. nov**	(MG)	(ISLA)
Pintalia (Ecuadoriensis) speciosa **sp. nov**	(MG)	(ISLA)
Pintalia fraterna Stål, 1862	(RJ)	(NHRS)
Pintalia fuscomaculata Muir, 1934	(PA)	(BMNH)
Pintalia infuscata Muir, 1934	(SP)	(BMNH)
Pintalia inortata Stål, 1862	(RJ)	(NHRS)
Pintalia latinotata Muir, 1934	(PA)	(BMNH)
Pintalia longispinis Muir, 1934	(PA)	(BMNH)
Pintalia (Caudata) lundi **sp. nov**	(MG)	(ISLA)
Pintalia (Pictipennis) minima **sp. nov**	(MG)	(ISLA)
Pintalia (Pictipennis) minuta **sp. nov**	(MG)	(ISLA)
Pintalia (Caudata) muiri **sp. nov**	(MG)	(ISLA)
Pintalia (Pictipennis) magnaepiprocti **sp. nc**	(MG)	(ISLA)
Pintalia (Caudata) montalvaniensis **sp. nov**	(MG)	(ISLA)
Pintalia obscuripennis Stål, 1862	(RJ)	(NHRS)
Pintalia (Caudata) painensis **sp. nov**	(MG)	(ISLA)
Pintalia (Pictipennis) pictipennis Stål, 1862	(RJ)	(NHRS)
Pintalia propria Muir, 1934	(RJ)	(BMNH)
Pintalia proxima Stål, 1862	(RJ)	(NHRS)
Pintalia quadrispinosa Muir, 1934	(AP)	(BMNH)
Pintalia (Pictipennis) serratilis **sp. nov**	(MG)	(ISLA)
Pintalia (Pictipennis) stali **sp. nov**	(MG)	(ISLA)
Pintalia ustulata Stål, 1862	(BR)	(BMNH)

Complementary description

***Pintalia lateralis* Stål, 1862 (Type).**
(Figures: 1 A, 2 A-D, 3 A-B, 12 A, 13)

Type material. *Holotype* ♀. **Brazil (BRA)**; (NHRS - GULI000075710).

Redescription.

Coloration (preserved specimen): Deep brown (59) contrasting with some areas which are light yellow (86), hyaline tegmina with regions dark yellowish brown (78) (conspicuous dark spot).

Body length. Female (examined): 5.267 mm (n =1); 6.00 mm (Stål, 1862).

Head (Figures 2 A-D). Vertex (Figure 2 B-C): Apical compartment 4.0 to 4.3 times wider than medially long; the caudal border of the vertex and subapical carina is concave; the apical transverse carina is also concave but with opening towards the frons. Frons (Figure 2 A): Approx. 1.4 times longer than wide, approx. 2.1 times wider at the height of the antennas than at the anterior region of the frons; median carina moderately developed; thin lateral carinae; anterior region of the frons is trapezoidal, and straight apically (apical transverse carina). Frontoclypeal suture semicircular, bent upwards, slightly straight laterally. Post and anteclypeus, with median carina well developed.

Thorax (Figures 2 B-D). Pronotum (Figure 2 B-D). Submedian carinae weakly developed; hind margin obtuse; light coloration in the region between the eyes (like at vertex). Mesonotum (Figure 2 B-D). Tricarinate; darker lateral margins than between the carinae; flat in lateral view with distal region slightly inclined. Tegmina (forewings) (Figure 2 D, 12 A): length (8.407), approx. 2.5 times longer than wide; hyaline/opaque with conspicuous dark spot in y-shaped; fork of ScP+RA and RP ahead of forks CuA1 and CuA2; C5 with two crossveins; r-m1 occurring before mcu-1; m-cu1 occurs at the first MP fork; RP quadrifid; MP1+2 trifid; MP3+MP4 bifid; tubercles evanescent, more evident between the cubital cell and postclaval margin, and some in ScP+RA and RP; 12 apical cells; 7-8 subapical cells. Hind wing with RP bifid, MP trifid with petiolate anastomosis in MP3+CuA1 distally forked, CuA1 and CuA2 bifid.

Posterior legs (Figure 3A-B). The hind tibia has four lateral spines and 6 apical teeth. It was not possible to observe the apical teeth of the 1st and 2nd tarsomere.

Female genitalia (Figures 2D; 3A). The segment X is elongated; curved dorsally and excavated ventrally. The segment IX is ovoid with lateral margins totally curved. The ovipositor is long and in arc-shaped curved up-wards.

Diagnosis. *P. lateralis* Stål, 1862 can be distinguished from other species of the genus *Pintalia* by the concave carinae of the vertex, frons, and vertex totally light (excepting lateral of basal compartments) and conspicuous dark spot with an "y" shape on the tegmina.

Distribution. The only location reported by Stål (1862) is "Brazil" **(Type location).** Hence, it is not possible to determine, unfortunatey, a more precise location of this species occurrence.

Notes. As with the other species redescribed here, it was not possible to observe the apical teeth of the 1st and 2nd tarsomere with accuracy. Moreover, in all species, it is difficult to accurately determine the size of the teeth of the hind tibia. Hence, in the *Posterior legs* redescriptions sometimes will be only provided the number of lateral spines of the hind tibia.

***Pintalia consobrina* Stål, 1862.**
(Figures: 1 B, 4 A-D, 12 B)

Type material. Holotype ♀. **Brazil (BRA)**. (NHRS - GULI000075711).

Redescription.

Coloration (preserved specimen): Dark brown (59) contrasting with areas, which are deep brown (56), Strong brown (55) and brownish orange (54), tegmina light grayish yellowish brown (79) with regions dark yellowish brown (78).

Body length. Female (examined): 4.393 mm (n =1); 4.5 mm (Stål, 1862).

Head (Figures 4 A-D). Vertex (Figure 4 B-C): Distinct, subapical carina recorded on the disk; median carina developed in the basal compartment and evanescent in the apical compartment; raised apical transverse carina; curved caudal border; basal compartment slightly larger than the apical compartment. Frons (Figure 4 A): Approx. 1.2 times longer than wide; approx. 2.4 times larger next the antennae than anterior region; median carina well developed; thick lateral carinae between the largest width (near the scapus) and the anterior region of the frons; anterior region of the frons is trapezoidal, curved in the middle, and straight apically. Frontoclypeal suture is straight/arched and slightly concave bent upwards and bypassing the ocelli. Post and anteclypeus, with median carina well developed and rounded in the middle.

Thorax (Figures 4 B-D). Pronotum (Figures 4 B-D): Submedian carina totally developed; median carina developed; hind margin obtusely angled or rectangular; coloration a little lighter in the region between the eyes. Mesonotum (Figures 4 B-D):

Tricarinate, little darker lateral margins than between the carinae; flat in lateral view with distal region slightly inclined. Tegmina (forewings) (Figure 4 D, 12 B): length (5.909) approx. 2.6 times longer than wide; transverse dark spot in the center of the tegmina with curved lateral elongation towards the anterior cubital margin; two dark spots with "C"-shapped form in prenodal cells, and two dark spots in the postcostal cell; double tubercles occurring throughout the tegmina; fork of ScP+RA and RP, ahead of forks CuA1 and CuA2; C5 with one traversal vein; r-m1 emerging from the MP1+2 and MP3+4 fork; mcu1 occurring close to r-m1 yet emerging from MP3; RA bifid with punctual anastomosis RA+RP1; RP quadrifid; MP1+2 trifid; MP3+MP4 bifid; 12 apical cells; 7 subapical cells.

Posterior legs. Hind tibia with four lateral spines, and six apical teeth (see remarks).

Female genitalia. The segment X is slightly longer than wide; flattened ventrally. The segment IX is apparently ovoid with lateral margins rounded. The ovipositor is curved up-wards, in arc-shaped apparently surpassing little (if surpassing) the X segment.

Diagnosis. *P. consobrina* Stål, 1862 can be distinguished from other species of the genus *Pintalia* mainly by the distinct vertex with subapical carina engraved into disc instead of elevated, and transverse dark spot in the center of the tegmina with curved lateral elongation towards the cubital margin.

Distribution. The only location reported by Stål, 1862 is Brazil **(Type location)**. Hence, as for *P. lateralis*, it is not possible to determine the precise location of this species occurrence.

Notes. A female specimen very similar to *P. consobrina* Stål, 1862 was found in the ISLA collection. The specimen was collected during the dry season (20.x.2011) (ISLA 100960) in the MP-008 cave, in Itabirito municipality (MG), a region strongly impacted by mining. A frame with images of this specimen is provided in the supplementary material. This species is probably a subtroglophile due to the low occurrence recorded in these cavities so far. The referred specimen exhibits three lateral spines on the posterior tibia, eight apical teeth on the first posterior tarsomere and nine apical teeth on the second tarsomere posterior, five of them with platellae.

***Pintalia fasciatipennis* Stål, 1862.**
(Figures: 1 C, 5 A-D, 12 C)

Type material. Holotype ♀. **Brazil (BRA)**; (NHRS - GULI000075712).

Redescription.

Coloration (preserved specimen): this species has contrasting colors ranging from Light yellow (86) to Brownish black (65), with two areas in Dark brown (60) on the tegmina.

Body length. Female (examined): 4.115 mm (n =1); 4.3 mm (Stål, 1862).

Head (Figures 5 A-D). Vertex (Figure 5 B-C): Carinae weakly or not elevated. Apical compartment 4.8 to 5.0 times wider than medially long; apical transverse carina and subapical carina arched; basal compartment with well-developed median carina. Frons (Figure 5 A): 1.1 times longer than wide; approx. 1.7 times wider at the height of the antennas than at the anterior region; lateral carinae weakly elevated; median carina well developed; anterior region of the frons is trapezoidal wide, and straight apically. Frontoclypeal suture is bent upwards, moderately semicircular, and slightly straight on the laterally and below the frontal ocellus. Post and anteclypeus, wide apically, and wellrounded medially with median carina moderately developed.

Thorax (Figures 5 B-D). Pronotum (Figures 5 B-D). Submedian carinae weakly developed; hind margin obtusely angulated or rectangular; light coloration in the region between the eyes (as at the vertex). Mesonotum (Figures 5 B-D). Tricarinate and uniformly dark; flat in lateral view with distal region slightly inclined. Tegmina (forewings) (Figures 5 D, 12C). Length (5.371mm). Hyaline/opaque with two transverse dark spots, one near the tegulae and other in the center of tegmina; postcostal cell with light longitudinal spot next to the costal vein and four transverse dark spots close to the pterostigma; radial area with two light spots emerging from the distal margin; distinct veins and cells; fork of ScP+RA and RP, after forks CuA1 and CuA2; C5 with 4 or 5 crossveins, 4 are grouped; C4 with 3-4 crossveins, 3 are grouped occurring at approx. the same height as the crossveins of C5; C3b very elongated; mcu-1 occurs before the rm-1; rm-1 occurs after the first fork of MP; RA bifid with punctual anastomosis RA+RP1; RP quadrifid; MP1+2 bifid; MP3+4 bifid; simple tubercles occurred to all veins; 12 apical cells (small); 7-13 subapical cells (elongated).

Posterior Legs. The hind tibia has two lateral spines and six apical teeth.

Diagnosis. *P. fasciatipennis* Stål, 1862 can be distinguished from other species of the genus *Pintalia* mainly by the distinct frons, slightly longer than wide, with non-elevated lateral carinae, vertex totally clear in dorsal view, nodal line near the distal margin and two transverse dark spots on the tegmina, one near the tegulae and the other in the center of tegmina.

Distribution. The only location reported by Stål (1862) is Brazil **(Type location)**. Hence, as for the previously redescribed species, it is not possible to determine the precise location of this species occurrence.

Remarks. It was difficult to observe some of the veins and cells in the images, since they are in light blue in the figure 12 C, so the information about the pattern of veins and cells of the tegmina of *P. fasciatipennis* Stål, 1862 provide here must be interpreted with care.

***Pintalia fraterna* Stål, 1862.**
(Figures: 1 D, 6 A-D, 12 D)

Type material Holotype ♀. **Brazil (RJ)**. (NHRS - GULI000075713).

Redescription.

Coloration (preserved specimen): Deep yellowish brown (75) contrasting in some areas with Light orange yellow (70).

Body length. Female (examined): 4.692 mm (n =1); 5.5 mm (Stål, 1862).

Head (Figures: 6 A-D). Vertex (Figure 6 B-C): Apical compartment 2.6 to 2.8 times wider than medially long; apical transverse carina slightly concave, almost straight; the subapical carina and caudal border are concave. Frons (Figure 6 A): 1.5 times longer than wide, approx. 1.8 times wider at the height of the antennae than anterior region; median carina moderately or weakly developed; thin lateral carinae; anterior region of the frons is trapezoidal, and straight apically. Frontoclypeal suture straight/arched, bent upwards. Post and anteclypeus with median carina moderately developed.

Thorax (Figures 6 B-D). Pronotum (Figures 6 B-C). Short dorsally with submedian carina moderately developed and hind margin obtusely angled or rectangular. Mesonotum (Figures 6 B-D): Tricarinate, flat in lateral view. Tegmina (forewings) (Figure 6 D, 12 D): length (7.941), approx. 2.9 times longer than wide; hyaline / opaque with blurred spots, a thin dark spot inclined occurs in the center connecting the pt and icu; fork of ScP+RA and RP, ahead of forks CuA1 and CuA2; r-m1 is inclined, and emerge in first MP fork, before mcu1; mcu1 emerging after the first MP fork; RP quadrifid; MP1+2 trifid; MP3+MP4 bifid; tubercles evanescent, more evident between the cubital cell and postclaval margin, and some in ScP+RA and RP(+MA); 12 apical cells; 7 subapical cells. Hind wing with RP bifid, MP trifid with petiolate anastomosis in MP3+CuA1 distally forked, CuA1 and CuA2 bifid.

Posterior legs. The hind tibia has one lateral spine and six apical teeth.

Diagnosis. *P. fraterna* Stål, 1862 can be distinguished from other species of the *Pintalia* genus by the predominantly Deep yellowish-brown color (75) in dorsal view, anterior compartment of the vertex is well rectangular, and the tegmina exhibit the nodal evanescent.

Distribution. The only location reported by Stål (1862) is Brazil and Rio de Janeiro State **(Type location).**

***Pintalia inortata* Stål, 1862.**
(Figures: 1 E, 7 A-D, 12 E)

Type material. Holotype ♀. **Brazil (RJ)**. (NHRS - GULI000075714).

Redescription.

Coloration (preserved specimen): predominant Dark brown (59), contrasting in some areas with Deep orange (51), hyaline tegmina with Dark brown veins (59).

Body length. Female: 5.0 mm (n = 1) (Stål, 1862).

Head (Figures 7 A-D). Vertex (7 B-C): Distinct; Apical compartment 1.2 to 1.4 times wider than medially long; apical transverse carina elongated medially, more visible in facial view; the subapical carina is straight; concave caudal border; the median carina occurs in little more 1/2 of basal compartment. Frons (Figure 7 A): Approx. 1.0 times longer than wide; approx. 1.4 times wider at the height of the antennae than to the anterior region of the frons; median carina moderately developed even before the level of the antennae; later it is evanescent but touching apical transverse carina apically; thin lateral carinae; anterior region of the frons is distinct, at same eye level. Frontoclypeal suture is semicircular, very curved, bent upwards. Post and anteclypeus, with median carina well developed, starts at about half the length of anteclypeus.

Thorax (Figures 7 B-D). Pronotum (Figures 7 B-D). Submedian carinae weakly developed; hind margin obtusely angled or rectangular; lighter coloration at the caudal margin and between the eyes. Mesonotum (Figures 7 B-D). Tricarinate, in dorsal view almost straight and parallel carinae, very flat in lateral view. Tegmina (forewings) (Figures 7 D, 12 E) length (7.196), approx. 2.5 times longer than wide; hyaline / opaque without spots; C2a exhibit a crossvein; C5 is small; fork of ScP+RA and RP, very ahead of forks CuA1 and CuA2; r-m1 emerges from the first MP fork; mcu1 emerging after r-m1 and laterally to MP3+4; RP quadrifid, RP2+3 with petiolate anastomosis distally

forked; MP 1+2 trifid with petiolate anastomosis in MP1; MP 3+4 bifid; simple or inconspicuous tubercles; 12-13 apical cells; 8 subapical cells.

Posterior legs. Hind tibia without spines or with inconspicuous spines.

Diagnosis. *P. inortata* Stål, 1862 can be distinguished from other species of the genus *Pintalia* mainly by the distinct vertex, and when in frontal view with median carina of the frons joined to the anterior margin of the vertex in a "y" shape, lighter coloration on the lateral carinae of the frons than in the middle.

Distribution. The only location reported by Stål (1862) is Brazil and Rio de Janeiro State **(Type location)**.

***Pintalia obscuripennis* Stål, 1862.**
(Figures: 1 F, 8 A-D, 12 F)

Type material. Holotype ♀. **Brazil (RJ)**; (NHRS - GULI000075715).

Redescription.

Coloration (preserved specimen): Deep orange (51) contrasting with some areas for Deep orange yellow (69), hyaline tegmina / Deep brown (56) with regions Strong yellowish brown (74), no contrasting spots.

Body length. Female (examined): 4.002 mm (n =1); 4.3 mm (Stål, 1862).

Head (Figures 8 A-C). Vertex (Figure 8 B-C): Apical compartment 2.5 to 2.8 times wider than medially long; the apical transverse carina is almost straight; subapical carina is slightly concave and caudal border is concave. Frons (Figure 7A): 1.1 times longer than wide; approx. 1.6 times wider at the height of the antennae than at the anterior region of frons; median carina moderately or weakly developed, apically y-shaped forming a triangular region apically along with the apical transverse carina; thin lateral carinae; anterior region of the frons is trapezoidal, and straight apically. Frontoclypeal suture semicircular, bent upwards. Post and anteclypeus, with median carina well developed

Thorax (Figures 8 B-D). Pronotum (Figures 8 B-D). Short, with submedian carina moderately developed and hind margin obtusely angled or rectangular. Mesonotum (Figures 8 B-D). Tricarinate, flat in lateral view with inclined distal region. Tegmina (forewings) (Figures 8 D, 12 F). length (7.270), approx. 2.5 times longer than wide; uniform color, no contrasting dark spots; fork of ScP+RA and RP, little ahead of forks CuA1 and CuA2; parallel r-m1 and mcu-1, occurring after of first MP fork; RP quadrifid;

MP1+2 trifid; MP3+MP4 trifid; simple tubercles, in all veins; 12-13 apical cells; 7 subapical cells.

Posterior legs. Hind tibia without lateral spines or with inconspicuous spines.

Female genitalia. The segment X is small, wider than long and cylindrical. The segment IX is truncate, with lateral margin almost straight and moderately elevated; ovipositor arc-shaped (curved upwards) no surpassing the segment X.

Diagnosis. *P. obscuripennis* Stål, 1862 can be distinguished from other species of the genus *Pintalia* by uniform coloration (varying little), and opaque tegmina without conspicuous dark spots, and Cua1 trifid.

Distribution. The only location reported by Stål (1862) is Brazil and Rio de Janeiro State **(Type location)**.

***Pintalia (P.) pictipennis* Stål, 1862.**
(Figures: 1 G, 9 A-D, 12 G)

Type material. Holotype ♂. **Brazil (RJ)**; (NHRS - GULI000075716).

Redescription.

Coloration (preserved specimen): contrasting colors ranging from dark brown (59) to light yellow (86), hyaline tegmina with Strong yellowish-brown spots (79) and in some areas with Light yellow (86).

Body length. Male (examined), 3.028 mm (n =1). Female, 3.3 mm (Stål, 1862).

Head (Figures 9 A- D). Vertex (Figures 9 B-C): Apical compartment 4.0 to 5.0 times wider than medially long; the apical transverse carina and subapical carina is concave; straight caudal border. Frons (Figure 9 A): 1.4 times longer than wide, approx. 1.9 times wider at the height of the antennae than at the anterior region; median carina well developed; anterior region of the frons is trapezoidal, sunken low apically. Frontoclypeal suture semicircular, bent upwards, slightly straight laterally. Post and anteclypeus with median carina well developed.

Thorax (Figures 9 B-D). Pronotum (Figures 9 B-D): Submedian carina weakly developed; hind margin obtusely angled or rectangular; light color as at vertex. Mesonotum (Figures 9 B-D): Tricarinate; uniformly dark in color, flat in lateral view with slightly elevated distal region. Tegmina (forewings) (Figure 9 D, 12G). length (4.889), approx. 2.3 times longer than wide; hyaline / opaque with dark spots; anterior cubital area and Postclaval area totally dark with a triangular hyaline spot between CuA1 and the A2;

the costal/radial half is predominantly hyaline with 6 dark stripes (as follows: 2 small between SC and C; 1 long and curved starting in vein C and ending on the opposite side, in A2 near CuP - 1 very thin starts in pt and ends near the bifurcation of RP2 and RP3; 1 short but wide occurring between RP3 and the radial margin; 1 thin, starts at the radial margin and ends in RP4; fork of ScP+RA and RP, ahead of forks CuA1 and CuA2; r-m1 occurring before first MP fork and mcu-1; m-cu1 occurs at the firs MP fork; RA bifid with punctual anastomosis RA+RP1; RP quadrifid; MP1+2 trifid; MP3+MP4 bifid; C2a well small or inconspicuous; tubercles evanescent after the region between cubital cell and postclaval margin; 12 apical cells; 7 subapical cells.

Posterior legs. Hind tibia has two lateral spines and six apical teeth.

Male genitalia. In lateral view, Pygofer without processes, dorsal margin straight/slanted, distal margin concave; the ventromedian process is triangular. Anal segment elongated and flattened dorsoventrally without ventral process distally, the paraproct is developed and too flattened dorsoventrally with distal border concave. The genital styles wider apically and smaller near to the base.

Diagnosis. *P. (P.) pictipennis* Stål, 1862 can be distinguished from other species of the genus *Pintalia* by the darker frons in the middle than on the lateral carinae, spots pattern of the tegmina, and anal segment long and dorsoventrally flattened without process lateroventral distally, and paraproct developed flattened dorsoventrally.

Distribution. The only location reported by Stål (1862) is Brazil and Rio de Janeiro State **(Type location)**.

***Pintalia proxima* Stål, 1862.**
(Figures: 1 H, 10 A–D; 12 H)

Type material. Holotype ♂. **Brazil (RJ)**; (NHRS - GULI000075717).

Redescription.

Coloration (preserved specimen): dark brown (59) contrasting with few areas to light yellow (86), hyaline tegmina with conspicuous dark spot Dark yellowish brown (78).

Body length. Male (examined): 3.696 mm (n =1). Female 4.5 mm (n = 1) (Stål, 1862).

Head (Figures 10 A-D). Vertex (Figures 10 B-C): Apical compartment 2.8 to 3.0 times wider than medially long; apical transverse carina is slightly concave, almost straight; subapical carina is slightly arched, slightly concave and asymmetrical; concave caudal border with small basal emargination. Frons (Figure 10 A): Approx. 1.2 times

longer than wide; approx. 1.5 times wider at the height of the antennae than on the anterior region; median carina moderately developed, evanescent basally, slighter y-shaped apically; thin lateral carinae. Anterior region of the frons is trapezoidal, almost straight apically. Frontoclypeal suture straight bent upwards. Post and anteclypeus, with median carina well developed.

Thorax (Figures 10 B-D). Pronotum (Figures 10 B-D): Submedian carina moderately developed and hind margin obtusely angled or rectangular. Mesonotum (Figures 10 B-D): Tricarinate; lateral margins darker than between the carinae; flat in lateral view with distal region inclined. Tegmina (forewings) (Figures 10 D, 12 H): length (6.033), approx. 2.8 times longer than wide; hyaline with a conspicuous spot that covers all the nodal cells and narrows in the prenodal area, until reaching the costal margin; ScP+RA and RP, ahead of forks CuA1 and CuA2; r-m1 and mcu-1 occurring after first MP fork; m-cu1 occurs before r-m1; RP quadrifid; MP1+2 trifid; MP3+MP4 bifid; simple tubercles throughout all the veins; 12 apical cells; 7-8 subapical cells.

Posterior legs. Hind tibia with one lateral spine and six apical teeth.

Diagnosis. *P. proxima* Stål, 1862 can be distinguished from other species of the *Pintalia* genus by the tegmina with radial cells distinct, in the transverse direction, with a conspicuous spot that covers all the nodal cells and narrows before to MP fork, until reaching the costal margin.

Distribution. The only location reported by Stål (1862) is Brazil and Rio de Janeiro State **(Type location)**.

***Pintalia ustulata* Stål, 1862.**
(Figures 1 I, 11 A-D, 12 I)

Type material. Holotype ♀. **Brazil (RJ)**; (NHRS - GULI000075718).

Redescription.

Coloration (preserved specimen): Dark yellowish brown (78) contrasting with some areas for Moderate orange yellow (71), hyaline tegmina / Moderate yellowish brown (77) with regions Pale yellow (89) (without conspicuous dark spots).

Body length. Female (examined): 3.995 mm (n =1); 4.0 mm (n = 1) (Stål, 1862).

Head (Figures 11 A-D). Vertex (Figures 11 B-C): Apical compartment 1.5 to 1.7 times wider than medially long; the apical transverse carina and subapical carina, medially elongated; apical transverse carina more visible in facial view; concave caudal

border and wider medially, with median carina moderately developed. Frons (Figures 11 A): 1.1 times longer than wide, approx. 1.5 times wider below the antennae than on the anterior region; median carina moderately or weakly developed, touching the apical transverse carina; thin lateral carinae and sinuous in facial view; anterior region of the frons below the eyes; very low sunk apically. Frontoclypeal suture semicircular (shallow-open), bent upwards. Post and anteclypeus distinct, a little longer than wide and tubular basally.

Thorax (Figures 11 B-D). Pronotum (Figures 11 B-D): short, with submedian carina weakly developed and hind margin obtuse. Mesonotum (Figure 11 B-D): Tricarinate, slightly darker between carinae than laterally; flat in lateral view weakly or not inclined distal region. Tegmina (forewings) (Figures 11 E, 12 I): length (5.445), approx. 2.5 times longer than wide; hyaline, uniform coloration without conspicuous spots; fork of ScP+RA and RP, at the same height or slightly forward of forks CuA1 and CuA2; r-m1 occurring before mcu-1, and before the first MP fork; m-cu1 occurs after the first MP fork; RP quadrifid; MP1+2 trifid; MP3+MP4 bifid; simple tubercles in all veins; 12 apical cells; 7 subapical cells. Hind wing with RP bifid, MP trifid with petiolate anastomosis in MP3+CuA1 distally forked, CuA1 and CuA2 bifid.

Posterior legs. Hind tibia without lateral spines or with inconspicuous spines.

Female genitalia. The segment X is moderately small, approx. 1.2-1.4 times longer than wide; in dorsal view is elevated medially and with two “grooves” laterally. The segment IX is rounded slightly larger apically, with lateral margins rounded and elevated. The ovipositor is long and in arc-shaped curved up-wards.

Diagnosis. *P. ustulata* Stål, 1862 can be distinguished from other species of the genus *Pintalia* mainly by features of the head, such as the sinuous lateral carinae of the frons, and carinae of the vertex elongated medially.

Distribution. The only location reported by Stål (1862) is Brazil and Rio de Janeiro State **(Type location)**.

Key to the subgenera and new species of *Pintalia* Stål, 1862.

1. Males with long anal segment, developed distally (deflexed). Flagellum usually with spines. Hind wing with of petiolate anastomosis in MP3+CuA1 distally forked ……..……...…..……. *P. (Caudata)* **subgen. nov.** (9)

- Males with short anal segment, not developed distally. Flagellum spineless…….....2

2(1). Apical transverse carina is concave in facial view and larger than the subapical carina in dorsal view. Paraproct long, developed distally. Genital styles well expanded apically. Aedeagal shaft with ventral ridge developed. Females with small X-segment. Hind wing with complete anastomosis between MP3+CuA ……..….... *P. (Pictipennis)* **subgen. nov.** (4)

- Apical transverse carina is straight in facial view and smaller than the subapical carina in dorsal view; Paraproct short, not developed distally. Genital styles moderately to well expanded apically. Aedeagal shaft without ventral ridge. Females with X-segment long or moderately long. Hind wing with of petiolate anastomosis in MP3+CuA1 distally forked…..... *P. (Ecuadorensis)* **subgen. nov.** (8)

4(2). Males with epiproct short and flattened dorsoventrally…….…….....5

- Males with epiproct distinct, short, and swollen dorsally or developed distally……....6

5(4). Pygofer symmetrical bilaterally. Aedeagal shaft usually with three small ventral ridges laterally; in right lateral view the bifid spine has fork distant to the base; in left lateral view with curved spine large in C-shaped on the apex of the shaft…….……*P. (P.) minuta* **sp. nov.**

- Pygofer asymmetrical bilaterally. Aedeagal shaft has a curved ventral ridge; in right lateral the bifid spine has fork near to the base; in left lateral view with a moderately large or well large spine elongated on the apex of the shaft…….……...…*P. (P.) minima* **sp. nov.**

6(4). Males with epiproct in cone-shaped developed distally. The paraproct is rectangular and flattened dorsoventrally. Ventral ridge well developed and curved occurs in basal half. Apex of the shaft aedeagal with three long and thin spines, two on the right lateral and one in left lateral…….……...……*P. (P.) magnaepiprocti* **sp. nov.**

- Males with epiproct short and swollen dorsally; the paraproct is concave with basal half-higher, and apical half lower. Aedeagal shaft has ventral ridge distinct occurs dorsally near to the base. Apex of the shaft aedeagal with two spines.....……7

7(6). Pygofer symmetrical bilaterally. The anal segment is flattened near to the base and rounded distally, with ventral process large and rectangular distally. In dorsal view, the epiproct is rounded apically. Ventral ridge is composed of two pairs of spines the ones above is smaller. In right lateral the shaft of the aedeagus exhibit a wide spine near to the apex, and one other small spine no movable below, medially; in left lateral view a single small spine occurs apically. ……..... *P. (P.) stali* **sp. nov**.

- Pygofer weakly bilaterally asymmetrical; the anal segment is short and wide, well tubular, with ventral process small and triangular distally. In dorsal view, the epiproct is truncate apically. Ventral ridge form two lines serrated and curved to right lateral. In right lateral the shaft of the aedeagus exhibits two wider spines near to the apex, one is bifid; in left lateral view without spine.……..…*P. (P.) serratilis* **sp. nov**.

8(2). Pygofer narrow distally with cone-shaped process sloping upwards and apically rounded. Genital styles moderately wide distally. The aedeagus exhibits the three spines on the apex of the shaft towards to the base; in right lateral with a moderately large spine (d) and in left lateral with short spine (e). Flagellum with process spine-like in right lateral…….……*P. (E.) speciosa* **sp. nov**.

- Pygofer wider distally; with cone-shaped process sloping upwards and apically sharp. Genital styles well wide distally. The aedeagus exhibits the three spines on the apex of the shaft up towards the apex of the flagellum; the other two spines in opposite sides of the shaft (d) and (e) are small, and approx. the same size. Flagellum well small, without process……...…*P. (E.) fennahi* **sp. nov**.

9(3). Anal segment distally bent (deflexed) in approx. 45°. Pygofer laterally with distal/dorsal inclination very large and rounded. ……...*P. (C.) muiri* **sp. nov.**

- Anal segment distally bent (deflexed) in approx. 90°. Pygofer laterally with distal/dorsal inclination weakly or moderately large and rounded…….....11

11(9). Shaft aedeagal with a larger spine in left lateral of the apex; in right lateral the apical spine is small, below in the middle of the shaft occur a small spine; flagellum with four spines, one near to the base, and three apically……..……*P. (C.) montalvaniensis* **sp. nov.**

- Shaft aedeagal with a larger spine in right lateral of the apex……....12

12(11). Pygofer laterally with process rounded and bent apically. Aedeagus with four spines on the shaft, two on each side; in right lateral the larger spine occurs on the apex of the shaft; flagellum with three spines, one medially and two apically……. *P. (C.) dorensis s* **sp. nov.**

- Pygofer without process laterally……...…….13

13(12). Flagellum with a bifid spine medially and a spine common short apically. The shaft has three spines; in right lateral the long spine is tubular and moderately wide, below near the middle of the shaft occur a spine moderately large……*P. (C.) lundi* **sp. nov.**

- Flagellum without bifid spine, but with three common short spines, one basally, one medially and one apically. The shaft has four spines; in right lateral, the long spine is flattened, wide and curved, below occurs two small spines with approx. the same size. ……...…….……*P. (C.) painensis* **sp. nov.**

***Pintalia (Pictipennis)* Santos et al., 2021, subgen. nov.**

Type species: *Pintalia (P.) stali* **sp. nov**.

Description. This subgenus can be distinguished mainly by characters of the male genitalia; however, some other characters may be useful for identification. The vertex is small, with transverse apical carina slightly larger than the subapical carina; the apical compartment is small; the caudal border is well triangular or concave, and with small basal emargination; in facial view usually exhibits the apical transverse carina (anterior region of the frons apically) concave/sunken medially, rarely almost straight. Frons approx. 1.5-2.3 times wider at the height of the antennae than at the anterior region; the frontoclypeal suture usually is medially concave bent up wards and straight/inclined laterally. Tegmina (forewings) exhibit pt small and distally triangular; RA bifid with punctual anastomosis RA+RP1; fork of ScP+RA and RP slightly ahead or on the same level of fork CuA1 and CuA2; rm-1 and mcu-1 usually together or the same level, slightly ahead, after, or very close to the first MP fork; crossveins are in greater number in one of the tegmina (asymmetry). Hind wing with RP bifid, MP trifid with complete anastomosis in distal fusion of MP3+CuA1. In ventral view, males exhibit narrow pregenital sternite, basally almost straight or slightly rounded, and well evanescent in the middle (not touching medially). Hind tibia exhibit 3-7 lateral spines, usually three spines are larger and spines closest to the femur are well small, and 6 apical teeth as provide for the genus; 1st tarsomere with 7 apical teeth without platellae or setae; 2nd tarsomere with 8-9 apical teeth, without platellae but with 3 very fine setae.

Male genitalia. Exhibit asymmetry in some species. The Pygofer does not present processes laterally; the ventromedian process is triangular usually as wide as long, crooked in some species. The anal segment is short and wide, sometimes larger and conspicuous distally; the epiproct and paraproct are developed; usually paraproct more than 2 times larger than epiproct; in dorsal view epiproct larger medially. Genital styles usually are thin at the base and very wide apically, in lateral view approx. 3.0 times wider apically, or moderately wide apically and very curved (sub angulated); are excavated ventrally and with bent borders to the ventral region; in ventral view, the basal opening of the styles is laterally concave and apically triangular. The aedeagus usually with shaft aedeagal as wide or slightly wider at base than apically and exhibit 2-3 spines at the apex, in some species one right lateral spine is bifid; ventral ridge developed. Flagellum without spines, rarely exhibit a spine-like process apically.

Female genitalia. Exhibit the X-segment short, in dorsal view usually is slightly larger than wider, and flattened near at base with apex truncated or rounded; in lateral view with lateral border slightly projected and straight, usually flattened ventrally or slightly rounded; the epiproct and paraproct is thin and short. The segment IX is truncated, rounded or smaller apically, in lateral view usually with lateral border surpassing the middle moderately or reaching the base; in caudal view usually rounded/swelling laterally and excavated out in the middle. The ovipositor is large and in sabre-shaped (curved upwards) in some species surpassing the segment X.

Morphology. Body length: ♂ 3.5 -5.0 mm (n=5). ♀ 4.0 -5.5 mm (n=4).

Head. Vertex with rectangular apical compartment, in facial view small/narrow laterally (*P. (P.) minuta* **sp. nov**, *P. (P.) minima* **sp. nov**, *P. (P.) magnaepiprocti* **sp. nov**), or apical compartment large, in dorsal view with forward bent carinae (*P. (P.) serratilis* **sp. nov**) or with straight transversal apical carina and concave subapical carina (*P. (P.) stali* **sp. nov,** *P. (P.) pictipennis* Stål 1862). In facial view the frons width larger below the scapus, approx. 2.1-2.3 times wider at the height of the antennae than at the anterior region (*P. minuta* **sp. nov**, *P. (P.) minima* **sp. nov**, *P. (P.) magnaepiprocti* **sp. nov**) or on the same level as the scapus, approx. 1.5-1.7 times wider at the height of the antennae than at the anterior region (*P. (P.) serratilis* **sp. nov**, *P. (P.) stali* **sp. nov**, *P. (P.) pictipennis* Stål 1862); usually anterior region of the frons is concave apically or almost straight (*P. (P.) propria* Muir, 1934).

Thorax. Pronotum narrow, median carina is evanescent or inconspicuous and submedian carina is moderately developed but evanescent behind the eyes. Mesonotum with distance between lateral carinae slightly larger distally than near the pronotum (*P. (P.) serratilis* **sp. nov**, *P. (P.) stali* **sp. nov**) moderately larger (*P. (P.) minuta* **sp. nov**, *P. (P.) minima* **sp. nov**), or considerably larger (*P. (P.) magnaepiprocti sp. nov*). Tegmina (forewings) mostly hyaline with a few light gray spots, and with three moderately elongated spots occurs between RP(+MA) and A2. (*P. (P.) minuta* **sp. nov**, *P. (P.) minima* **sp. nov**, *P. (P.) magnaepiprocti* **sp. nov**, *P. propria* Muir,1934); dark tegmina with two conspicuous hyaline spots in Cua1 and Cua2 (*P. (P.) serratilis* **sp. nov**); tegmina with prenodal region mostly hyaline, and nodal region with dark spots between the postclaval cell and radial area there are 5 conspicuous longitudinal spots (*P. (P.) stali* **sp. nov**, *P. (P.) pictipennis* Stål 1862). Posterior legs. Hind tibia with three lateral spines (*P. (P.) serratilis* **sp. nov**), four lateral spines (*P. (P.) magnaepiprocti* **sp. nov,** *P. (P.) propria* Muir,1934**),** six lateral spines (*P. (P.) minuta* **sp. nov**, *P. (P.) stali* **sp. nov**) or seven

lateral spines (*P. (P.) minima* **sp. nov**). 1st tarsomere with 7 apical teeth, approx. the same size (*P. (P.) minuta* **sp. nov**, *P. (P.) minima* **sp. nov**, *P. (P.) magnaepiprocti* sp. nov) with one or the two externals slightly larger and 1-2 spines of the middle larger (*P. (P.) serratilis* **sp. nov**, *P. (P.) stali* **sp. nov**). 2nd tarsomere with 8 apical teeth (*P. (P.) minuta* **sp. nov**, *P. (P.) minima* **sp. nov**, *P. (P.) magnaepiprocti* sp. nov, *P. (P.) stali* **sp. nov,** *P. (P.) propria* Muir,1934) or rarely with 9 apical teeth (*P. (P.) serratilis* **sp. nov**), usually with 3 thin setae.

Male genitalia. Pygofer in symmetry bilaterally (*P. (P.) stali* **sp. nov**), slightly asymmetrical (*P. (P.) minuta* **sp. nov**, *P. (P.) serratilis* **sp. nov**), or very asymmetrical (*P. (P.) minima* **sp. nov**, *P. (P.) magnaepiprocti* sp. nov). Flattened anal segment, dorsally rounded and distinct distally, without processes (*P. (P.) minuta* **sp. nov**, *P. (P.) minima* **sp. nov**, *P. (P.) magnaepiprocti* sp. nov**,** *P. (P.) pictipennis* Stål 1862), or tubular or moderately tubular and distally with processes in the ventral region (*P. (P.) stali* **sp. nov**, *P. (P.) serratilis* **sp. nov**). Genital styles are usually thin at the base and very wide apically in lateral view approx. 3.0 times wider apically, or moderately wide apically and very curved (sub angulated) (*P. (P.) propria* Muir, 1934); the basal opening of the styles usually large (except in *P. (P.) serratilis* **sp. nov**). Aedeagus with bifid spines in right lateral of (*P. (P.) minuta* **sp. nov**, *P. (P.) minima* **sp. nov**, *P. (P.) serratilis* **sp. nov**) or without bifid spines (*P. (P.) magnaepiprocti* **sp. nov**, *P. (P.) stali* **sp. nov,** *P. (P.) propria* Muir, 1934); ventral ridge small weakly developed (*P. minuta* **sp. nov**), or ventral ridge moderately developed and curved (*P. (P.) minima* **sp. nov**, *P. (P.) magnaepiprocti* **sp. nov**), serrated (*P. (P.) serratilis* **sp. nov**), armed with a pair of large spines, on each side of the base of the aedeagal shaft (*P. (P.) propria* Muir, 1934) or two pairs of spines (*P. stali* **sp. nov**).

Female genitalia. In lateral view, short X-segment, distally rounded and ovipositor surpassing the X-segment (*P. (P.) minuta* **sp. nov**, *P. (P.) minima* **sp. nov**); or tubular dorsally, apically truncated and ovipositor not extending beyond segment IX (*P. (P.) stali* **sp. nov**, *P. (P.) serratilis* **sp. nov**). The segment IX is short, slightly developed laterally (*P. (P.) minuta* **sp. nov**, *P. (P.) minima* **sp. nov**); or moderately developed laterally (*P. (P.) stali* **sp. nov**, *P. (P.) serratilis* **sp. nov**).

Distribution. BRA. Rio de janeiro and Minas Gerais State.

New species

***Pintalia (P.) minuta* sp. nov.**
(Figures: 15 A-F; 16 A-G; 17 A-C)

Type material. *Holotype*: Male **Brazil, MG**. Itabirito municipality, MP8 Cave, (UTM 619795W, 7764761S, 23K), 29.iii.2012, (Col. Carste et al.) (ISLA 100935); Female same data as male holotype (ISLA 100936). Holotype condition: Not dissected, stored in an individual vial in ethanol 70%. *Paratypes*: 1♂ same data as holotype (partially dissected) (ISLA 100937); 3♀ same data as holotype (ISLA 100938); 1♂ and 2♀ same data as holotype except for MP7 Cave, 20.x.2011, (Col. Carste et al.) (ISLA 100939); 2♀ same data as male holotype except for 20.x.2011, (Col. Carste et al.) (ISLA 100940).

Other material examined. Brazil, MG: Mariana municipality, 2♀ FZL-0006 Cave, (UTM 665069W, 7754333S, 23K), 27. ix. 2018, (Col. Carmo T.O) (ISLA 100941) and 14. ii. 2019 (ISLA 100942); 1♀ FZLM5-0007 Cave, (UTM 665265W, 7756203S, 23K), 12. ii. 2019, (Col. Carmo T.O) (ISLA 100943); 1♀ FZL-0009 Cave, (UTM 665210W, 7753768, 23K), 14. ii. 2019, (Col. Carmo T.O) (ISLA 100944); 1♂ FZL-0010 Cave, (UTM 665210W, 7753756S, 23K), 14. ii. 2019, (dissected), (Col. Carmo T. O) (ISLA 100945); 1♂ FN-0005 Cave, (UTM 663582W, 7763205S, 23K), 23.xii.2020, (Col. Spelayon et al.) (ISLA 100946); 1♂ FN-0025 Cave, (UTM 662636W, 7763761S, 23K), 24.IX -30. x.2020, (Col. Spelayon et al.) (ISLA 83490); 1♂ FN-0012 Cave, (UTM 663142W, 7764734S, 23K), 24.IX- 9.x.2020, (Col. Spelayon et al.) (ISLA 83537); 1♂ GOGO_030 Cave, (UTM 662662W, 7749239S, 23K), 13-16. i.2014, (Col. Spelayon et al.) (ISLA 46347); 1♂ GOGO_032 Cave, (UTM 662166W, 7749320S, 23K), 13-6. i. 2014, (Col. Spelayon et al.) (ISLA 46345).

Description.

Coloration (specimen preserved in 70% ethanol): Strong orange yellow (68) contrasting with some areas with Brilliant orange yellow (67) and Light orange yellow (70), hyaline tegmina with few very light spots in Yellowish gray (93).

Body length. Male. 3.137-4.022 mm (n = 9); Female. 3.851- 4.008 (n = 8).

Head (Figures 15A-C). Vertex (Figures 15A, C): Approx. 1.7 times wider (0.405) than long (0.233); apical compartment is small and laterally narrow, approx. 3x wider (0.247) than medially long (0.085); the apical transverse carina (0.247) slightly larger than the subapical carina (0.222); the angle formed by the caudal border is concave. Frons (Figure 15B): Approx. 1.4 times longer (0.878) than wide (0.600), approx. 2.2 times wider at the height of the antennae than at the anterior region (0.265); anterior region of the frons is narrows laterally and weakly concave apically. Frontoclypeal suture is straight bent up wards, and evanescent close to the lateral carinae. Postclypeus (Figure 15B), compressed laterally with median carina moderately developed. Anteclypeus (Figure

15B), with median carina well developed from the second half after suturing anterior to the clypeus. Rostrum reaching or surpassing slightly the middle of the abdomen.

Thorax (Figures 15A-C). Pronotum (Figure 15A, C): Submedian carinae weakly developed, evanescent behind the eyes; hind margin obtusely angled. Mesonotum (Figure 15A), with well-developed median carina but evanescent distally; lateral carinae strongly developed. Tegmina (forewings) (Figures 15D): Length (5.630 mm); hyaline with light gray spots, three spots on the basal cells distinguishable as follows: One on the Pcu + A1 fork, between CuP and A2; another spot occurs on C5, between CuP and MP; a third larger and curved spot occurs over mc, rc and C1, between Cua1 and ScP+RA; three cross spot occur in pcc; r-m1 occurring after mcu-1, and after to the first MP fork; m-cu1 occurs before the first MP fork; petiole in RP3+RP4 weakly developed; simple tubercles in all veins; 12 apical cells; 7 subapical cells.

Posterior legs (Figure 15E-F). The hind tibia (Figure 15E) approx. 2.1 mm, with six lateral spines, the three closest to the femur being small, and six apical teeth. First tarsomere (Figure 15F), with 7 apical teeth of approx. the same size, one lateral is larger. Second tarsomere (Figure 15F), with 8 apical teeth, the outer 2 are larger and the middle ones are smaller, and with 3 thin setae, one is separated by apical teeth without setae.

Male genitalia (Figures 16A-G). Pygofer (Figures 16A-C, G): Usually bilaterally symmetrical, or weakly asymmetrical; in lateral view without conspicuous processes and medially larger; the ventromedian process is triangular. Anal segment (Figures 16A-C): Usually symmetrical bilaterally; dorsally wider at the distal border than at the base; thick distal border; curved ventral border; epiproct moderately developed, flattened dorsoventrally and in dorsal view is triangular; the paraproct is long, approx. 3x longer than epiproct and flat dorsoventrally, wider below epiproct. Genital styles (Figures 16A-C, G): In lateral view, wide in the apical region and narrow near the base; rounded distal margin apically. Aedeagus (Figures 16D-F) tubular, asymmetrical; aedeagal shaft with four ventral ridges, three are rounded and one distinct; in right lateral one rounded crest is larger, and a distinct one is sharp (triangular) and occurs medially on the stem; in left lateral a moderately small and rounded crest occurs; in dorsal view there is a small almost straight ridge; in right lateral view the shaft there are two movable spines, 1st is long and bifid (a) and is towards the dorsal region with fork distant of the base, 2nd is well elongated (b) and towards the ventral region (below the flagellum); in left lateral view the 3rd spine is conspicuous (c), semicircular near the apex of the shaft. The Flagellum is thin and spineless, wider, and apically curved. Phallotreme below of the flagellum crossed.

Female genitalia (Figures 17A-C). The segment X (Figures 17A, C): In lateral view is rounded and larger distally with lateral border well developed; in dorsal view is basally excavated and apically swollen; in ventral view is medially carinated and laterally excavated; the epiproct and paraproct is flattened dorsoventrally and not developed as to the males; in dorsal view the paraproct is weakly wide, apically straight, and laterally rounded. Segment IX (Figures 17A-B): In ventral view is truncated, smaller apically; in lateral view with lateral margins evanescent before to the base. Ovipositor (Figures 17, A-B): In sabre-shaped (curved upwards), surpassing the segment X.

Etymology. The specific epithet *minuta* comes from Latin and means *small or diminutive*, and refers to the reduced size of *P. minuta* **sp. nov.**

Diagnosis. *P. (P.) minuta* **sp. nov** can be distinguished from other species of the genus *Pintalia* mainly by components of the male genitalia, as aedeagus with a conspicuous spine, well curved - "C" shape- laterally on the apex of shaft of the aedeagus and three small ventral ridges medially.

Distribution. BRA, MG; Itabirito municipality MP8 cave, **(Type locality)**, and Mariana municipality.

***Pintalia (P.) minima* sp. nov.**
(Figures: 18 A-F; 19 A-G; 20 A-C)

Type material. Holotype: Male **Brazil, MG.** Igarapé municipality, SAZ-0001-Cave, (UTM 575027W, 7776185S, 23K), 24.vii.2018, (Col. Alves, J.P) (ISLA 100947); Female same data as male holotype (ISLA 100948); Holotype condition: Intact, not dissected, stored individually in a vial with ethanol 70%. *Paratypes*. 1♂(dissected) 1♀ and 5 nymphs' same data as male holotype (ISLA 100949).

Other material examined. Brazil, MG: São Joaquim de Bicas, municipality, 2♂ 11-cave, and 1 nymph (UTM 575687W, 7776492S, 23K), 16.i.2018, (Col. Alves, J.P) (ISLA 100950); 1♀ 13-Cave, (UTM 575602W, 7776349S, 23K), 16.i.2018, (Col. Alves, J.P) (ISLA 100951); 1♀ 16-Cave, (UTM 575654W, 7776271S, 23K), 15.i.2018, (Col. Alves, J.P) (ISLA 100952); 2♀ 1♂ and 2 nymphs, 22-Cave (UTM, 575821W, 7776137S, 23K), 17.i.2018, (Col. Alves, J.P) (ISLA 100953); Doresopólis municipality, 1♂ 34-Cave, (UTM 410938W, 7750122S, 23K) 24.i.2019, (ISLA 100954). Conceição do Mato dentro municipaly, 1♂, css-009 cave, (UTM 667151W, 7905478S, 23K), 20-29.xi.2018, (Col. Carste et. al) (ISLA 100955); 1♂, SERP_0126 cave (UTM 762010W, 7888377S, 23K), 23.xi.2013 (Col. Spelayon et al.) (ISLA 100956).

Description.

Coloration (specimen preserved in 70% ethanol): Strong orange yellow (68) contrasting with some areas with Brilliant orange yellow (67) and Light orange yellow (70), hyaline tegmina with few very light spots in Yellowish gray (93).

Body length. Male. 2.903-2.907 (n = 2); Female. 4.014-4.529 (n = 2).

Head (Figures 18A-C). Vertex (Figure 18A, C): Approx. 1.8 times wider (0.343) than long (0.185); apical compartment is small and laterally narrow, approx. 2.9 times wider (0.279) than medially long (0.094); apical transverse carina (0.279) weakly larger than the subapical carina (0.257); the angle formed by the caudal border is well concave and irregular. Frons (Figure 18B): 1.5 times longer (0.789) than wide (0.516), approx. 1.7 times wider below of the antennae than at the anterior region (0.294); anterior region of the frons is moderately large laterally and weakly concave apically. Frontoclypeal suture semicircular, almost straight apically and narrow medially, well bent upwards in the middle and straight/inclined laterally. Postclypeus (Figure 18B), with median carina moderatelly developed, slightly wider than the base of the anteclypeus; Anteclypeus (Figure 18B), with median carina moderately developed. Rostrum reaching or surpassing the middle of the abdomen

Thorax (Figures 18A-B). Pronotum (Figures 18A-B): Submedian carinae weakly developed; hind margin asymmetrical, obtusely angled, or little rectangular. Mesonotum (Figure 18A): Median carina weakly developed and evanescent distally; lateral carinae well developed. Tegmina (forewings) (Figure 16D): Length (4.342 mm); hyaline with light gray spots, as in *P. minuta* sp. nov; fork of ScP+RA and RP, moderatelly ahead of forks CuA1 and CuA2; r-m1 occurs almost together to mcu-1 before the first MP fork, or with mcu-1 before to rm-1; simple tubercles in all veins; usually with punctual anastomosis in RP3+RP4; 12 apical cells rarely 9; 7 subapical cells rarely 8.

Posterior legs (Figure 18E-F). The hind tibia (Figure 18E) approx. 1.9 mm, has seven lateral spines, the two closest to the femur being small, and six apical teeth, with is provide for the genus. First tarsomere (Figure 18F) with 7 apical teeth of approx. the same size, one lateral is larger. Second tarsomere (Figure 18F) with 5-8 apical teeth (asymmetric in some specimens), the outer 2 are larger and the middle ones are smaller, and with 3 thin setae, one is separated by apical teeth without setae.

Male genitalia (Figures 19A-G). Pygofer (Figures 19A-C, G): bilaterally asymmetric; in right lateral view, medially larger and angulated near at the high of the apex of genital styles; in left lateral view is larger length is near at the base of genital styles; the ventromedian process is triangular and slightly crooked/inclined to right lateral. Anal segment (Figures 19A-C): bilaterally asymmetric; in dorsal view is wry,

tipped to the right lateral and rounded medially; in lateral view the distal border is thick; the epiproct in lateral view is flat dorsoventrally and in dorsal view is slightly triangular with lateral border weakly rounded; long and asymmetrical paraproct, flattened dorsoventrally, approx. 3x larger than epiproct. Genital styles (Figures 19A-C, G): bilaterally asymmetric; it is wider and rounded in right lateral and elongated laterally in left lateral. Aedeagus (Figures 19D-F): tubular, asymmetrical; it has three movable spines; ventral ridge developed in right lateral, with small not movable process dorsally; shaft of aedeagus in right lateral view with two spines movables, the 1st is bifid spine and elongated (a) with bifurcation moderately near the base, the 2nd spine is moderately elongated and curved (b), occurs on the apex of the shaft aedeagal, not reaching the middle of the flagellum; in left lateral view, the 3rd is single spine is elongated and slightly curved (c), emerging near the apex of the shaft and surpassing the middle of the shaft. The Flagellum and Phallotreme as in *P. (P.) minuta* **sp.n**.

Female genitalia (Figures 20A-C). As in *P. (P.) minuta* **sp.n**

Etymology. The specific epithet *minima* come from the Latin *minimum* and means *the smallest of all* and refers to the reduced size of *P. minima* **sp. nov**, the smallest among its congeners described here.

Diagnosis. *P. (P.) minima* **sp. nov** can be distinguished from other species of the genus *Pintalia* by the spines of the aedeagus exhibiting the fork of bifid spine moderately distant to the base, and with the spine "b" moderately elongated and curved, and in left lateral with a single spine emerging on the apex of the shaft elongated surpassing the middle of the shaft.

Distribution. BRA, MG; Igarapé municipality, SAZ-0001 cave, **(Type locality).**

Remarks. Specimens from other material examined are very similar to the type-series, however with some differences. In cave 11 the male specimens are smaller, approx. 2.7 mm, tegminas exhibit complete anastomosis in RA+RP1, and sometimes between RP4+Cua1; the aedeagus are similar to the type-series but much smaller. In cave 22 the male individual found is as in the type-series. In cave 34 the male specimen has approx. 3.7 mm and the left lateral spine (c) is large and robust facing the dorsal region of the aedeagus, and the bifid spine (a) exhibits the bifurcation moderately distant from the base. Individual females were found in caves 13 and 16, not associated with males but very similar to females of the type series. Two other specimens from two caves were taken from the material examined, as they exhibited a moderately distinct aedeagus. The two specimens were found in Conceição do Mato Dentro municipally and the individual collected in css-009 cave exhibits on the right side of the aedeagal stem a spine

moderately elongated and straight (b), and on the left side (c) a spine moderately small and curved , not surpassing the middle of the aedeagal shaft; and the individual found in Serp_0126 cave, exhibits the spines (b) (c) small and straight, and the bifid spine (a) with the bifurcation very close to the base. Here we propose that this species can be interpreted as Eutroglophilic (Sket, 2008), as it presents populations on different cavities.

***Pintalia (P.) magnaepiprocti* sp. nov.**
(Figures: 21 A-F; 22 A-G)

Type material. Holotype: Male **Brazil, MG.** Presidente Olegário municipality, Lapa Vereda da Palha cave (UTM 380963W, 7981204S, 23K), 13.x.2010, (Col. Ferreira, R.L.) (ISLA 100957). Holotype condition: Intact, not dissected, stored individually vials with ethanol 70%. *Paratypes.* 1 ♂ same data as holotype, except for (ISLA 100958) (dissected); 1 ♂ same data as holotype, except for (ISLA 2761).

Description.

Coloration (specimen preserved in 70% ethanol): Strong orange yellow (68) contrasting with some areas with Brilliant orange yellow (67) and Light orange yellow (70), hyaline tegmina with few very light spots in yellowish gray (93).

Body length. Male. 3.489 - 3.789 mm (n = 3).

Head (Figures 21A-C). Vertex (Figure 21A, C): approx. 1.7 times wider (0.410) than long (0.239); apical compartment is small and laterally narrow, approx. 3 times wider (0.258) than medially long (0.086); apical transverse carina (0.258) slightly larger than the subapical carina (0.248); the angle formed by the caudal border is well concave or weakly triangular. Frons (Figure 21B): 1.5 times longer (0.938) than wide (0.623), approx. 2.1 times wider below antenna than at anterior region (0.288); anterior region of the frons is narrow laterally and moderately concave apically. Frontoclypeal suture semicircular well bent upwards in the middle and straight laterally. Postclypeus (Figure 19B), with median carina weakly developed. Anteclypeus (Figure 21B), with median carina moderately developed, more carinated from the second half after suture anterior to the clypeus. Rostrum in ventral view surpassing the middle of the abdomen, almost reaching the base of the Pygofer.

Thorax (Figures 21A, C). Pronotum (Figures 21A, C): submedian carina weakly developed, well evanescent behind the eyes; hind margin obtusely angled. Mesonotum (Figure 19A): Median carina weakly developed or evanescent; lateral carinae strongly developed. Tegmina (forewings) (Figures 21D): length (6.262); the tegmina spots are in parts as in *P. (P.) minuta* sp. nov and *P. (P.) minima* sp. nov; fork of ScP+RA and RP,

ahead of forks CuA1 and CuA2; r-m1 occurring after mcu-1 and together the first MP fork; m-cu1 occurs before the first MP fork; simple tubercles in all veins; punctual anastomosis RP3+RP4; 12 apical cells; 7 subapical cells.

Posterior legs (Figure 21E-F). The hind tibia (Figure 21E) approx. 2.3 mm, has four lateral spines, the two closest to the femur being small, and six apical teeth, with is provide for the subgenus. First tarsomere (Figure 21F) with 7 apical teeth of approx. the same size, one lateral is larger. Second tarsomere (Figure 21F) with 8 apical teeth, the outer 2 are larger and the middle ones are smaller, and with 3 thin setae, one is separated by apical teeth without setae.

Male genitalia (Figures 22A-G). Pygofer (Figures 22A-C, G): bilaterally asymmetric; in right lateral view, medially larger and rounded; in left lateral view is smaller medially, and larger near at the base of genital styles; the ventromedian process is well crooked to right lateral. Anal segment (Figures 22A-C): bilaterally asymmetric; "crooked" to right lateral; ventrally excavated and elevated dorsally; larger medially than at the distal border; the distal border is thin and flattened dorsoventrally; the epiproct is long, tubular and pointed at the distal border; the paraproct is long, quadratic and flattened dorsoventrally, bent towards the base of the anal segment ventrally; the distal border is triangular with a small process medially. Genital styles (Figures 22A-C, G): bilaterally asymmetric; in right lateral view the apical portion is large and very rounded, in left lateral view the apical portion is smaller and slightly angulate. Aedeagus (Figures 22D-F) tubular, asymmetrical; ventral ridge without process or inconspicuous; aedeagal shaft with three elongated and thin movable spines; in right lateral view there are two spines, the 1st almost straight (a) occurs laterally to the apex of the shaft, the 2nd is approx. the same size, but is curved (b), occurs just below the first, towards to flagellum; in left lateral view 3rd spine is long and curved (c), too emerging from the apex of the shaft aedeagal and reaching the base dorsally. The flagellum is thin and spineless. Phallotreme laterally.

Etymology. The specific epithet *magnaepiprocti* comes from the junction of the Latin *magnus* maning large and epiproct structure of the anal segment, highly developed in males, thus *magnaepiprocti* would mean *large epiproct*, referring to the overdeveloped epiproct of this species.

Diagnosis. *P. (P.) magnaepiprocti* **sp. nov** can be distinguished from other species of the genus *Pintalia* mainly by components of the male genitalia, which is very asymmetrical with a distinct anal segment, where the epiproct is cylindrical and long in cone-shaped, and the paraproct is quadratic/large, flattened dorsally and bent to ventral region.

Distribution. BRA, MG; Presidente Olegário municipality, Lapa Vereda da Palha cave **(Type locality).**

***Pintalia (P.) serratilis* sp. nov.**
(Figures: 23 A-F; 24 A-H; 25 A-C)

Type material. Holotype: Male **Brazil, MG**. Arcos municipality, BRAS_010 cave (UTM 441818W 7746510S, 23K), 14-20.xii.2018, (Col. Spelayon et al.) (ISLA 70225). Female, the same location of male holotype except for s2_CRH_279 Cave, (UTM 439790W, 7751428S, 23K), 06.xi-13.xii.2018, (Col. Spelayon et al.) (ISLA 68546). Holotype condition: not dissected, stored in an individual vial in ethanol 70%. *Paratypes*. 2♂, 1♀ and 1 nymph same data as female holotype except for, (Col. Spelayon et al.) (ISLA 100959).

Description.

Coloration (specimen preserved in 70% ethanol): Deep orange yellow (69) contrasting with some areas with Light orange yellow (70) and Dark orange yellow (72), tegmina with some hyaline regions and colors ranging from Light yellowish brown (76) to Dark yellowish brown (78).

Body length. Male. 3.011-3.769 mm (n = 3); Female. 3.956-4.0169 mm (n = 2).

Head (Figures 23A-C). Vertex (Figures 23A, C): approx. 1.9 times wider (0.363) than long (0.190); apical compartment is narrow and medially elongated, approx. 3.7 times wider (0.287) than medially long (0.077); apical transverse carina (0.287) very slightly larger than the subapical carina (0.285); the angle formed by the caudal border is triangular. Frons (Figure 23B): 1.2 times longer (0.678) than wide (0.528), approx. 1.7 times wider below antenna than at the anterior region of the frons (0.310); the median carina is evanescent; anterior region of the frons is large laterally and moderately concave apically. Frontoclypeal suture is concave in the middle moderately bent upwards and straight/inclined laterally. Postclypeus (Figure 23B), with median carina weakly developed or absent. Anteclypeus (Figure 23B), with median carina moderately developed or evanescent. Rostrum in ventral view surpassing slightly the base of the abdomen.

Thorax (Figures 23A, C). Pronotum (Figures 23A, C): submedian carinae weakly developed; hind margin obtusely angled or rectangular. Mesonotum (Figure 23A): median carina well developed but evanescent distally; lateral carinae strongly developed and slightly closer near the pronotum than distally. Tegmina (forewings) (Figures 23D): length (5.224 mm); tegmina with some hyaline regions and colors ranging from Light

yellowish brown to Dark yellowish brown and two round and hyaline patches on the CuA1 and CuA2 veins in the C5 cell, and is darker in this region; in addition, the tegmina exhibit long bristles mainly in CuP, Pcu, A1 and A2. fork of ScP+RA and RP, ahead of forks CuA1 and CuA2; C5 is approx. half the size of C1; r-m1 occurring after mcu-1; r-m1 and m-cu1 occurs before the first MP fork; simple tubercles in all veins; petiole in RP3+RP4 moderately developed; 12 apical cells; 7 subapical cells.

Posterior legs (Figure 23E-F). The hind tibia (Figure 23E), with approx. 1.3 mm; has three lateral spines, the first one closest to the small femur, and six apical teeth, with is provide for the subgenus. First tarsomere (Figure 23F) with 7 apical teeth the outer and inner lateral teeth are the largest, and the intermediate teeth are approx. the same size. Second tarsomere (Figure 23F) with 9 apical teeth, the 2 external ones are bigger, and the intermediate ones are smaller, and with 3 thin setae, one is separated by apical teeth without setae.

Male genitalia (Figures 24A-H). Pygofer (Figures 24A-C, H): bilaterally asymmetric (little); wider medially; ventromedian process is triangular slightly wider than long. Anal segment (Figures 24A-C): short and slightly bilaterally asymmetric; distal border ventrally with two processes moderately elongated and in cone-shaped; epiproct moderately developed, dorsally elevated/swollen with distal border straight; the paraproct is long, elevated dorsally with rounded distal border. Genital styles (Figures 24A-C, H): slightly asymmetric; in right lateral view is slightly elongated apically; in left lateral view is rounded apically. Aedeagus (Figures 24D-G) tubular, asymmetric; the shaft of the aedeagus has two spines movables, one is bifid; in left lateral view without spines; in right lateral view there are two wide spines, the 1st is short, apically curved and flattened at the base (b), occurs on the apex of the shaft aedeagal, the 2nd is slightly larger, tubular and bifid (a); the ventral ridge is dorsally developed, and with two rows of teeth towards the right lateral, almost reaching half the length of the shaft. The flagellum is thin and without spines, however with an apical process, a spine-like but flattened. Phallotreme apically.

Female genitalia (Figures 25A-C). The segment X (Figures 25A, C) is well short; moderately elevated dorsally with two grooves pronounced laterally; the epiproct and paraproct flattened dorsoventrally; in dorsal view, the epiproct is triangular and rounded apically. Segment IX (Figures 25A, B) in ventral view is truncated, larger medially; in lateral view with lateral margins well developed, almost straight. Ovipositor (Figures 25A, B) in sabre-shaped (curved upwards), slightly surpassing or no surpassing the segment X.

Etymology. The specific epithet *serratilis* comes from Latin and means *serrated* and refers to the serrated ventral ridge on shaft aedeagal of the males.

Diagnosis. *P. (P.) serratilis* **sp. nov** can be distinguished from other species of the *Pintalia* genus mainly by two round and hyaline patches on the CuA1 and CuA2 veins in the C5 cell, and by components of the male genitalia, such as short anal segment and developed paraproct (large); exhibiting two rows of teeth dorsally on base of the shaft aedeagal, and two wider spines apically, one is bifid.

Distribution. BRA, MG; Arcos municipality, BRAS_010 cave **(Type location)**.

***Pintalia (P.) stali* sp. nov.**
(Figures: 26 A-F; 27 A-G; 28 A-C)

Type material. Holotype: Male, **Brazil, MG**. Prados municipality, SJDR_HOL_028 cave, (UTM 597088W, 7657227S, 23K), 17-19.xi.2014, (Col. Spelayon et al.) (ISLA 40189); female, same data as male holotype except for SJDR_HOL_016 Cave, (UTM 597015W, 7657150S, 23K), (Col. Spelayon et al.) (ISLA 40193). Holotype condition: Elements of genitalia and left tegmina dissected and stored in individual vials with 70% ethanol**.** *Paratypes*. 1♀ same data as holotype except for SJDR_HOL_015 Cave, (UTM 596994W, 7657161S, 23K), (Col. Spelayon et al.) (ISLA 40192); 1♀ same data as holotype except for SJDR_HOL_025 Cave, (UTM 597005W, 7657260S, 23K), (Col. Spelayon et al.) (ISLA 40196); 1♀ same data as holotype except for SJDR_HOL_007 Cave, (UTM 596995, 7657216, 23K), (Col. Spelayon et al.) (ISLA 40183).

Description.

Coloration (specimen preserved in 70% ethanol): Strong orange (50) contrasting with some areas with Deep orange (51) and Moderate orange yellow (71), hyaline tegmina with some regions ranging from Light grayish yellowish brown (79) to Dark grayish yellowish brown (81).

Body length. Male. 3.099 mm (n = 1); Female. 2.869-3.812 mm (n = 4).

Head (Figures 26A-C). Vertex (Figure 26A, C): approx. 1.5 times wider (0.359) than long (0.225); apical compartment approx. 4.5x wider (0.298) than medially long (0.065); apical transverse carina (0.298) larger than the subapical carina (0.254); the angle formed by the caudal border is well triangular. Frons (Figure 24B): 1.4 times longer (0.728) than wide (0.512), approx. 1.6 times wider at the height of the antennae than at the anterior region (0.304); median carina with two lines side by side that separate near the frontal ocelli and in the anterior region of the frons; anterior region of the frons is large and moderately concave apically. Frontoclypeal suture is concave in the middle

moderately bent upwards and straight/inclined laterally. Postclypeus (Figure 26B), with median carina moderately developed. Anteclypeus (Figure 26B), with median carina well developed. Rostrum in ventral view surpassing slightly the base of the abdomen.

Thorax (Figures 26A, C). Pronotum (Figures 26A, C): submedian carina weakly developed; hind margin obtusely angled. Mesonotum (Figures 26A): median carina weakly developed or evanescent; lateral carinae moderately developed. Tegmina (forewings) (Figures 26D): length (4.945 mm); hyaline with light gray to dark brown spots, the shape of the spots and veins are in parts as in *P. (P.) pictipennis* Stål 1862, see Remarks; fork of ScP+RA and RP, approx. the same height or a little forward of forks CuA1 and CuA2; parallel r-m1 and m-cu1 occurs after the first MP fork; simple tubercles in all veins; short subapical cells (C2a, C2, C3a, C3 and C4); petiole in RP3+RP4 weakly developed; 12 apical cells; 7 subapical cells.

Posterior legs (Figures 26E-F): Hind tibia ((Figures 26E) approx. 1.4 mm. The hind tibia has six lateral spines, the four closest to the femur being small or inconspicuous, and six apical teeth, with is provide for the genus. First tarsomere (Figure 26F) with 7 apical teeth of approx. the same size, one being larger lateral. Second tarsomere (Figure 26F) with 8 apical teeth, the 2 external ones are larger, and the intermediate ones are smaller, and with 3 thin setae, one is separated by apical teeth without setae.

Male genitalia (Figures 27A-G). Pygofer (Figures 27A-C, G): bilaterally symmetric; larger medially; ventromedian process is triangular, slightly crooked to left lateral. Anal segment (Figures 27A-C): short and bilaterally asymmetric (weakly); in lateral view expanded and rounded distally, with two flat and rectangular lateral processes ventrally, dorsally flattened near the base and rounded on the distal margin; epiproct in lateral view is moderately developed, dorsally elevated/swollen; in dorsal view is rounded apically; the paraproct is long and rounded dorsally with curved distal border; in caudal view approx. with the same wide on the base and to apex. Genital styles (Figures 25A-B, G): bilaterally asymmetric, in left lateral view is short and rounded apically; in right lateral view is also rounded but slightly elongated apically. Aedeagus (Figures 25D-F) tubular, asymmetrical; the shaft of the aedeagus has three spines, two movable and one rigid; in right lateral view the 1st spine is wide (a), occurs at the apex of the shaft of the aedeagus towards the ventral region of the flagellum; in left lateral view the 2nd spine is small (b) and also occurs at the apex of the shaft aedeagal; 3rd process is spine-like, is small and rigid and as wide as long (c), occurs below the middle of the shaft; the ventral ridge is developed dorsally near the base of the shaft, with four conspicuous spines, they are rigid and short, the two closest to the base being larger. The flagellum is thin and

curved, slightly larger than the shaft of the aedeagus with a small process apically. Phallotreme apically covering the flagellum.

Female genitalia (Figures 28A-C). The X-segment (Figures 28A-C) is almost as wide as it is long and is wider towards the base; in dorsal view is rounded medially and with lateral border well developed, but evanescent apically; is flat ventrally; the epiproct and paraproct is weakly developed. Epiproct with elongated base, slightly triangular apically. Paraproct is rounded in dorsal view. Segment IX (Figures 28A-B) is truncated, with lateral border well developed and rounded. Ovipositor (Figures 28A-B) in sabre-shaped (curved upwards), slightly surpassing or no surpassing the segment X.

Etymology. The specific epithet *stali* is a tribute to the author Carolo Stål, who made major contributions to the Fulgoroidea and described the genus *Pintalia* Stål, 1862.

Diagnosis. *P. (P.) stali* **sp. nov** can be distinguished from other species of the genus *Pintalia* mainly by components of the male genitalia, the anal segment is rounded and expanded distally, with two conspicuous processes flattened in the lateral/ventral region. Additionally, the aedeagus displays four not movable spines dorsally on the base of shaft of the aedeagus.

Distribution. BRA, MG; Prados municipality, SJDR_HOL_028 cave **(Type locality)**.

***Pintalia (Ecuadorensis)* Santos et al., 2021, subgen. nov.**

Type species: *P. (E.) ecuadorensis* Muir, 1934.

Description. This subgenus can be distinguished mainly by characters of the male genitalia; however, some other characters may be useful for identification. The vertex is large, with apical transverse carina smaller than the subapical carina; the apical compartment is wide; the caudal border is concave and slightly triangular medially, with small basal emargination or inconspicuous; in facial view usually exhibits the apical transverse carina straight or distinct convex distally. Frons approx. 1.5 times wider at the height of the antennae than at the anterior region of the frons; the frontoclypeal suture usually is concave or almost straight bent up wards. Tegmina (forewings) pt large and sub rectangular weakly angled distally; with C5’ large and quadratic; fork of ScP+RA and RP ahead of fork CuA1 and CuA2; rm-1 and mcu-1 usually together or very close to the first MP fork, or with mcu-1 slightly after; in some species C5 and C3 cell is large; Hind wing with RP bifid, MP trifid with petiolate anastomosis in MP3+CuA1 distally forked, CuA1 and CuA2 bifid. In ventral view, males exhibit moderately large pregenital sternite, and is slightly or moderately evanescent in the middle. Hind tibia usually exhibits

2-3 lateral spines, and a spine near the femur is very small and 6 apical teeth as provide for the genus; 1st tarsomere with 7 apical teeth without platellae or setae; 2nd tarsomere with 7-8 apical teeth, usually with 3 platellae, or with platellae absent.

Male genitalia. Pygofer with sharp processes laterally; in caudal view, these processes are wider than the rest of the distal margins, vs. thin in *P. (Caudata)* **subgen. nov;** the ventromedian process is triangular. The anal segment is long or moderately long, but not developed distally (deflexed); in lateral view it is medially flattened; in ventral view it is concave medially with a small longitudinal ridge in the middle; the epiproct and paraproct are short, in dorsal view the epiproct is triangular, with lateral border near to the base larger and bent down; the paraproct is rounded, narrow laterally and slightly larger than the epiproct distally. Genital styles are thin at the base and usually from half onwards the length is moderately wide or very wide apically, with concave or convex apical ventral border (rounded); excavated ventrally with distal borders bent to the ventral region; and with triangular process near to the base ventrally; in ventral view the basal opening of the styles is shaped like a small diamond-shaped, with rounded lateral angles. Aedeagus usually with shaft as wide as or slightly wider at base than apically; exhibit 3-5 spines, usually three spines (1st, 2nd, 3rd) occur at the apex of the shaft aedeagal near to flagellum; without ventral ridge. Flagellum without spines, but in some species with a spine-like process laterally.

Female genitalia. The X-segment is moderately large or well developed, in dorsal view usually swollen medially or apically, slightly rounded, with lateral border slightly developed or moderately developed; usually flattened ventrally or slightly excavated; the epiproct and paraproct is thin and short as to the males. The segment IX istruncated, in lateral view usually with lateral border short not reaching the middle of the segment. Ovipositor is large and in sabre-shaped (curved upwards) usually surpassing the segment X.

Morphology. Body length: 4.0 -4.4 ♂ mm (n=4). 5.0 -6.4 mm ♀ (n=4).

Head. Vertex with apical compartment wide laterally (*P. (E.)constellaris* (Walker 1858), *P. (E.) speciosa* **sp. nov,** *P. (E.) ecuadorensis s* Muir 1934), or distinct apical compartment, apical transverse carina evanescent and apical compartment weakly excavated (*P. (E.) fennahi* **sp. nov**); subapical carina straight or weakly straight (*P. (E.) constellaris* (Walker, 1858), *P. (E.) ecuadorensis* Muir, 1934) or straight forward bent (*P. (E.) speciosa* **sp. nov**, *P. (E.) fennahi* **sp. nov)**. Frons in facial view with anterior region swollen and curved distally (*P. (E.) fennahi* **sp. nov**) or trapezoidal straight apically (*P.*

(E.) constellaris (Walker 1858), *P. (E.) speciosa* **sp. nov,** *P. (E.) ecuadorensis s* Muir, 1934); in facial view approx. 1.5 times wider at the height of the antennae than at the anterior region; frontoclypeal suture rounded (*P. (E.) speciosa* **sp. nov,** *P. (E.) ecuadorensis* Muir 1934) or straight bent upwards (*P. (E.) fennahi* **sp. nov**)

Thorax. Pronotum narrow, inconspicuous media carina and moderately developed but evanescent submedian carina behind the eyes. Mesonotum with distance between lateral carinae and slightly larger distally than near the pronotum (*P. (E.) fennahi* **sp. nov**), or moderately larger (*P. (E.) speciosa* **sp. nov**, *P. (E.) constellaris* (Walker, 1858), *P. (E.) ecuadorensis s* Muir 1934). Tegmina with few hyaline parts, majoritarily dark yellow (*P. (E.) constellaris* (Walker, 1858), *P. (E.) speciosa* **sp. nov**) or dark brown (*P. (E.) fennahi* **sp. nov**) spots; C5 cell wide near at fork cua1-cua2 (*P. (E.) constellaris* (Walker, 1858), *P. (E.) speciosa* **sp. nov**) short/common (*P. (E.) fennahi* **sp. nov**), C3 cell wide and rounded (*P. (E.) speciosa* **sp. nov**). Hind tibia with 3 lateral spines; 1st tarsomere 7 apical teeth, being 2 lateral larger and 2 teeth moderately large in the middle; 2nd tarsomere with 7 apical teeth (*P. (E.) speciosa* **sp. nov**) or 8 apical teeth (*P. (E.) fennahi* **sp. nov,** *P. (E.) ecuadorensis s* Muir 1934) usually the two outer ones are larger, and the middle ones are approx. the same size, usually with 3 platellae.

Male genitalia. Pygofer bilaterally symmetric, wider apically (*P. (E.) constellaris* (Walker 1858), *P. (E.) speciosa* **sp. nov)**, wider medially (*P. (E.) fennahi* **sp. nov**) or wider basally (*P. (E.) ecuadorensis* Muir, 1934), cone-shaped process rounded apically (*P. (E.) speciosa* **sp. nov**, *P. (E.) ecuadorensis s* Muir 1934, *P. (E.) constellaris* (Walker 1858)) or with cone-shaped process sharp apically (*P. (E.) fennahi* **sp. nov**). Anal segment is moderately large, in dorsal view slightly elevated medially and in lateral view with lateral margins moderately prominent, and ventrally very slightly prominent (*P. (E.) speciosa* **sp. nov**, *P. (E.) constellaris* (Walker 1858)), moderately flattened dorsoventrally with lateral margins weakly prominent (*P. (E.) fennahi* **sp. nov**), or tubular dorsally and ventrally with a third basal tubular and two third excavated (*P. (E.) ecuadorensis s* Muir 1934). Genital styles thin at the base wide distally approx. 3.5 x more long than wide (*P. (E.) speciosa* **sp. nov**), approx. 2.2 times more long than wide *P. Constellaris* (Walker 1858), or very rounded ventrally approx. 1.5 times more long than wide (*P. (E.) fennahi* **sp. nov**). Aedeagus with the three spines from apex of the shaft towards the base of the shaft (*P. (E.) speciosa* **sp. nov**), or towards the flagellum (*P. (E.) constellaris* (Walker 1858), (*P. (E.) fennahi* **sp. nov**), aedeagal shaft with a very larger spine laterally (*P. (E.) ecuadorensis* Muir 1934).

Female genitalia. In lateral view with X-segment moderately large, medially elevated dorsally and distally truncated with ovipositor moderately surpassing the X-segment (*P. (E.) constellaris* (Walker 1858), *P. (E.) speciosa* **sp. nov**); the segment IX is moderately large, in lateral view with lateral border not reaching the middle of the segment ((*P. (E.) constellaris* (Walker 1858), *P. (E.) speciosa* **sp. nov**, *P. (E.) fennahi* **sp. nov**); in caudal view larger and swollen apically (*P. (E.) constellaris* (Walker 1858) or medially (*P. (E.) fennahi* **sp. nov**).

Distribution. BOL, La Paz. ECU, Napo. BRA, Minas Gerais, Bahia, Rio de Janeiro, São Paulo and Paraná states.

Notes. In South America, *P. (E.) speciosa* **sp. nov** is the second species (*Pintalia Constelaris* (Walker, 1858) = *Pintalia Quadrimaculata* Fennah, 1945, by Fennah, 1947) reported to share the following character states: tegmina dark yellow with one black spot with four hyaline spots near to the center of the tegmina; C3 and C5 cells elongated and rounded, C4 narrow. This character is widely observed in South American species, currently with 24 records on INaturalist, distributed in mainly southeastern/southern Brazil, southern Peru, and Ecuador. In addition, *P. (E.) constellaris* (Walker 1858) and *P. (E.) speciosa* **sp. nov** exhibit the pygofer with robust process laterally, apex of the shaft of the aedeagus has three spines moderately large, and medially with two spines in opposite sides, as *P. (E.) fennahi* **sp. nov.** However, *P. (E.) ecuadorensis s* Muir, 1934, grouped with *P. (E.) constellaris* (Walker, 1858) by Fennah 1945c in Ecuadorensis s group, shares with these species only the short anal segment not developed distally (but excavated ventrally) and the genital styles quite wide distally but with the aedeagus differing considerably. *P. (E.) ecuadorensis* Muir, 1934 exhibit one lateral spine occurring the apex the shaft aedeagal very large, reaching the base of the shaft, and possibly it can be better allocated in a group of *P. (Ecuadorensis),* **subgen. nov** separate from *P. (E.) speciosa* **sp. nov**, *P. (E.) constellaris* (Walker, 1858), due to the characteristics of aedeagus, pygofer and styles. *P. (E.) fennahi* **sp. nov** could also be allocated the group of *P. (Ecuadorensis)* due to tegmina and vertex, which is distinct from the other species. However, due to the low number of described species with these characteristics, we prefer not to propose groups in this study.

New species

***Pintalia (E.) speciosa* sp. nov.**
(Figures: 29 A-F; 30 A-G)

Type material. *Holotype*: Male **Brazil, MG**. Santa Barbara municipality, Gand_0073 Cave, (UTM 640305W, 7783515S 23K), 18.iv.2017, (Col. Rabelo et al.,) (ISLA 75686). Holotype condition: dissected, stored in an individual vial in ethanol 70%.

Other material examined. 1♂ same data as male holotype except for, Pains municipally, G. Torre caída Cave, (UTM 436818W, 7746966S 23K), 22.xi.1999, (Col. Ferreira R.L) (ISLA 100961). **Brazil, BA**: 2 ♀ Iuiu municipality, Lapa do Honorato Cave, (UTM 651726W, 8400447S, 23K), 12.ix.2016, (Col. Cardoso R.C) (ISLA 62687); 2 ♀ 12.ix.2016 (Col. Ferreira R. L) (ISLA 100962); 2 ♂ 19.x.2021 (Col. Ferreira R. L.) (ISLA 100963).

Description

Coloration (specimen preserved in 70% ethanol): Strong orange yellow (68) contrasting in some areas with Brilliant Orange Yellow (67) and Deep orange yellow (69), legs Brilliant orange yellow (67) and (principally spines) Deep orange yellow (69).

Body length. Male. 4.050-4.302 mm (n=2).

Head (Figures 29A-C). Vertex (Figure 29A, C): laterally wider, approx. 2.3 times wider (0.559) than medially long (0.238); apical compartment is narrow and laterally larger, approx. 4.0 times wider (0.437) than medially long (0.105); the apical transverse carina (0.413) slightly smaller than the subapical carina (0.437); the angle formed by the caudal border is concave slightly triangular. Frons (Figure 29B): 1.3 times longer (0.976) than wide (0.701), approx.1.5 times wider at the height of the antennae than at the anterior region (0.470); anterior region of the frons is trapezoidal wide and straight apically. Frontoclypeal suture is concave well bent up wards and laterally straight slightly inclined. Post-clypeus is very carinated. Anteclypeus exhibit a distinct median carina apically, rounded close to the frons. Rostrum in ventral view reaching the middle of the abdomen.

Thorax (Figures 29A, C). Pronotum (Figures 29A, C): submedian carinae weakly developed, evanescent behind the eyes; hind margin obtusely angled. Mesonotum (Figure 27A): median carina well developed but evanescent distally; lateral carinae strongly developed. Tegmina (Forewings) (Figure 29D): length (6.593 mm); the tegmina is dark yellow with a dark spot and four hyaline spots; r-m1 occurring before mcu-1, and together to the first MP fork; m-cu1 occurs after the first MP fork; Cells C3 and C5 elongated and rounded, C4 narrow; small and simple tubercles in all veins; petiole in RP3+RP4 moderately developed; 12 apical cells; 7 subapical cells.

Posterior legs (Figure 29E-F): hind tibia (Figure 29E): approx. 2.3 mm, with three spines, the first being at the base of the tarsomere difficult to visualize and six apical teeth according to gender. First tarsomere (Figure 29F) with 7 apical teeth, the two outer teeth

and the two middle teeth are larger. Second tarsomere (Figure 29F) with 7 apical teeth, the two outer ones being larger, and in the middle with approx. the same size, with 3 platellae, one is separated by apical teeth without platellae.

Male genitalia (Figures 30A-H). Pygofer (figures 30E-G): bilaterally symmetric. Wider apically, and with cone-shaped process tilted up laterally, and is rounded apically. Anal segment (Figures 30A-B, H): moderately short; in dorsal view slightly elevated medially with lateral margins slightly curved; in lateral view the lateral margins form two concave lines. Genital styles (Figures 30A-B, D): thin near to the base and distally approx. 3.5 times longer than wide with rounded distal margin; near of base with a small triangular process ventrally. Aedeagus (Figures 30E-G): asymmetric tubular; shaft of the aedeagus with five spines, four are movable; in right lateral view there are four spines, three large and curved spines (1^{st}, 2^{nd}, 3^{rd}) (a)(b)(c), occurs on the apex of the shaft, towards the base, the 4^{th} spine is straight (d), inserted little above of the center on the shaft aedeagal towards to the base. In left lateral view the 5^{th} spine is small (e) and not movable, occurs near the apex of the shaft towards to the flagellum. Flagellum with a spine-like process laterally. Phallotreme covering the flagellum.

Etymology. The specific epithet *speciosa* means "beautiful" or "showy" and refers to the fact that the new species has bright colors.

Diagnosis. *Pintalia (E.) speciosa* **sp. nov.** can be distinguished from other species of the *Pintalia* genus mainly by the three spines laterally at the apex of the shaft aedeagal towards the base of the shaft, and by the unique arrangement of the two other spines in the shaft aedeagal. Additionally, the genital styles are wide and elongated; the Pygofer is larger than wide apically.

Distribution. BRA, MG; Santa Barbara municipally, cave Gand_0073 **(Type Locality)** and Pains municipality**.**

Remarks. Male specimens reported in the *other material examined* exhibit moderate differences with *P. (E.) speciosa* **sp. nov** and should be further evaluated in the future. The specimens collected in Iuiu-BA, exhibit 8 apical teeth on 2^{nd} tarsomere, and without platellae. The ventromedian process of the pygofer is distinct, longer than wide and apically rounded, and the basal opening of the genital styles is also diamond-shaped but slightly more elongated. The shaft aedeagal exhibits three spines apically, however they are larger than in *P. (E.) speciosa* **sp. nov**, and the middle one is the largest (vs. smallest (*P. (E.) speciosa* **sp. nov**), right lateral the spine in the middle of the shaft is short and medially bent (vs. linear and elongated in *P. (E.) speciosa* **sp. nov**), on the left lateral a short spine occurs in the middle of the shaft (vs. almost apically in *P. (E.) speciosa* **sp.**

nov), furthermore in these specimens the spines on the left lateral of the shaft occurs after a sclerotized concave curve that starts almost at the apex of the shaft.

***Pintalia (E.) fennahi* sp. nov.**
(Figures: 31 A-F; 32 A-G, 33A-C)

Type material. Holotype: Male **Brazil, MG**: Prudente de Morais municipality, Icmat-85 (A and B) Cave, (UTM 593122W, 7841934S 23K), 12.xii.2017, (ISLA 100964) (Col. Ativo ambiental et al.). Female with the same data of male holotype except for (ISLA 100965). Holotype condition: dissected, stored in an individual vial in 70% ethanol. *Paratypes*. 2 nymphs with same data of male holotype except for (ISLA 100966)

Description

Color (specimen preserved in 70% ethanol): Dark brown (59) contrasting in some areas with Deep brown (56), Strong yellowish brown (74) and Deep orange yellow (69), legs Strong yellowish brown (74) and (principally spines) Deep yellowish brown (75).

Body length. Male. 4.465 mm (n=1). Female. 5.779 (n=1).

Head (Figures 31A-C). Vertex (Figure 31A, C): approx. 2.5 times wider (0.625) than long (0.245); apical compartment laterally wider, approx. 3.8 wider (0.555) than medially long (0.138); the apical transverse carina (0.520) is evanescent and slightly smaller than the subapical carina (0.555) and is slightly elongated medially; the angle formed by caudal border is concave. Frons (Figure 31B): swollen apically; 1.4 times longer (1.125) than wide (0.756), and 1.5 times wider at the height of the antennae than at the anterior region (0.495); in facial view anterior region of the frons is curved frontally towards from the vertex; and median carina weakly developed, almost disappearing. Frontoclypeal suture is straight well bent up wards. Post-and Anteclypeus with median carina well developed. Rostrum in ventral view surpassing the hind coxae.

Thorax (Figures 31A, C). Pronotum (Figures 31A, C): submedian carinae weakly developed, evanescent behind the eyes; hind margin obtusely angled. Mesonotum (Figure 31A): median carina well developed but evanescent or absent distally; lateral carinae strongly developed. Tegmina (Forewings) (Figure 31D): length (6.916 mm); the tegmina is dark brown with there are three dark spots in the prenodal region between the R and A1 veins and two in pcc cell; r-m1 occurring before mcu-1, and together to the first MP fork; m-cu1 occurs after the first MP fork; Cells C3 and C5 are common, not elongated (vs. *P. (E.) speciosa* **sp. nov** and *P.(E.) constellaris* (Walker, 1858); C2a small; C5a cell is present; simple tubercles in all veins; petiole in RP3+RP4 moderately developed; 12 apical cells; 7 subapical cells.

Posterior leg (Figures 31E-F)*:* Hind tibia (Figure 31E): approx. 2.3 mm. With three lateral spines and six apical teeth, with as provide for the genus. First tarsomere (Figure 31F) with 7 apical teeth, the two outer teeth and two teeth in the middle are larger. The second tarsomere with 7 apical teeth, the two outer ones being larger, and in the middle with approx. the same size, with 3 platellae together.

Male Genitalia (Figures 32A-G). Pygofer (Figures 32A-C, G): bilaterally symmetrical, distal margins is slightly; with cone-shaped process tilted up laterally and is sharp apically. Anal segment (Figures 32A-C): short and flattened dorsoventrally, with lateral margins weakly developed. Genital styles (Figures 32A-B, G): long and well expanded apically with curved distal margin; two very small triangular processes occur ventrally near to the base. Aedeagus (Figures 32D-F): asymmetric tubular; shaft of the aedeagus exhibit five spines, being three curved spines (1^{st}, 2^{nd}, 3^{rd}) (a)(b)(c) at the apex of the shaft of the aedeagus towards the flagellum; the 4^{th}, and 5^{th}, spines (d)(e), are short and straight, occur on opposite sides, slightly above the middle of the aedeagal shaft. The flagellum is small and without spines. Phallotreme laterally.

Female genitalia (Figures 33A-C). The segment X (Figures 33A, C): moderately long; in lateral view is narrow and flat ventrally with lateral margin moderately developed, in ventral view carinated medially; the epiproct and paraproct is flattened dorsoventrally; in dorsal view the paraproct is very small and rounded. Segment IX (Figures 33A-B): in ventral view is swollen medially, and smaller apically; in lateral view with lateral margins evanescent before to the middle. Ovipositor (Figures 33, A-C): in sabre-shaped (curved upwards), slightly surpassing or not surpassing the segment X.

Etymology. The specific epithet *fennahi* is a tribute to author Ronald G. Fennah, who made major contributions to the genre *Pintalia* Stål, 1862.

Diagnosis. *Pintalia (E.) fennahi* **sp. nov** can be distinguished from the other species of the subgenus by the dark coloration of the body and tegmina, and because of the swollen anterior region of the vertex, with the evanescent apical transversal carina and array of five aedeagus spines.

Distribution. BRA, MG; Prudente de mores municipality, Cave Icmat-85 **(Type Locality)**.

***Pintalia (Caudata)* Santos et al., 2021, subgen. nov.**

Type species: *P. (C.) painensis* **sp. nov**.

Description. This subgenus can be distinguished mainly by characters of the male genitalia. However, some other characters may be useful for identification. The vertex is

moderately large, with apical transverse carina smaller than the subapical carina; the apical compartment is large, wider than long but is moderately long medially; the caudal border is triangular but slightly concave laterally, and with small basal emargination; in facial view with apical transverse carina straight. Frons approx. 1.9-2.4 times wider at the height of the antennae than at the anterior region; the frontoclypeal suture is straight bent up wards. Tegmina (forewings) with pt large and sub rectangular, weakly, or well angled distally; fork of ScP+RA and RP moderately ahead of fork CuA1 and CuA2; rm-1 slightly ahead, together, or slightly after to first MP fork; mcu-1 after to first MP fork; Hind wing with RP bifid, MP trifid with petiolate anastomosis in MP3+CuA1 distally forked, CuA1 and CuA2 bifid. In ventral view, males exhibit moderately large pregenital sternite, larger medially, and is weakly or not evanescent in the middle. Hind tibia exhibit 3-4 lateral spines, the spines closest to the femur are well small, and 6 apical teeth as provide for the genus. First tarsomere with 7 apical teeth without platellae or setae; second tarsomere with 8 apical teeth, and with 1-3 platellae, sometimes it is absent or in a smaller number on one of the legs.

Male genitalia. The Pygofer in lateral view can exhibit a process laterally, but it is usually absent; when present, it is laterally flattened (thin) vs. broad in *P. dorensis* **sp. nov** *Ecuadorensis* **subgen. nov;** in lateral view usually wider slightly above the height of the apex of the genital styles; in ventral view, the ventromedian process is triangular usually as wide as long. The anal segment is long, tubular dorsally and excavated ventrally, developed (deflexed) and flattened distally with apex truncate and irregular, usually straight laterally and slightly asymmetrical in most species; in dorsal view, occurs a narrowing near the base but gradually elongates again to the apex; The epiproct and paraproct are short; in dorsal view the epiproct is triangular, and laterally exhibit two small bent down border; the paraproct is rounded, narrow laterally and slightly larger than the epiproct distally. Genital styles are moderately or weakly wide distally, ventrally is excavated and with small bent borders to the ventral region that usually larger near to the base, on apex and dorsally; the basal opening of styles is usually moderately small, and diamond shaped. The aedeagus display 5-7 spines; the shaft aedeagal is tubular and usually wider/swollen apically near to flagellum; 3-4 spines occur on the shaft aedeagal; usually a long or wider spine occurs laterally on the apex of the shaft aedeagal; ventral ridge absents. Flagellum usually with 2-4 spines in right lateral. Phallotreme in left lateral.

Female genitalia. The X-segment is long, in dorsal view rounded medially, with apex truncated; in lateral view with lateral border slightly projected and straight, and ventrally is produced two third basal and a third apical excavated and apically produced

again; the epiproct and paraproct are thin and short; the epiproct is triangular in dorsal view with lateral border near to the base slightly developed and bent down; the paraproct in dorsal view is rounded. The segment IX is truncated, usually with rounded lateral border and irregular; in caudal view, it shows straight carinas moderately distant from the margin, closer to the genital segment, and distant medially or close to the ovipositor. Ovipositor is large and in sabre-shaped (curved upwards) surpassing the segment X.

Morphology. Body length: 3.9 -5.3 ♂ mm (n=18). 5.0 -5.8 mm ♀ (n=6).

Head. Vertex with apical compartment quadratic and large, in dorsal view with apical transverse carina usually almost straight and slightly irregular, totally developed (*P. (C.) painensis* **sp. nov**, *P. (C.) lundi* **sp. nov**, *P. (C.) montalvaniensis* **sp. nov**), or slightly evanescent laterally (*P. (C.) dorensis s* **sp. nov**, *P. (C.) muiri* **sp. nov**); the subapical carina can be concave (*P. (C.) dorensis s* **sp. nov**, *P. (C.) muiri* **sp. nov**) or straight forward bent (*P. (C.) painensis* **sp. nov**, *P. (C.) lundi* **sp. nov**, *P. (C.) montalvaniensis* **sp. nov**); in facial view approx. 1.9-2.4 times wider at the height of the antennae than at the anterior region of the frons.

Thorax. Pronotum narrow, inconspicuous media carina and moderately developed but evanescent submedian carina behind the eyes. Tegmina (forewings) mostly hyaline with a dark brown spots, with four rounded spot in nodal region (*P. (C.) painensis* **sp. nov**, *P. (C.) montalvaniensis* **sp. nov**) or with one irregular spot (*P. (C.) dorensis s* **sp. nov**, *P. (C.) muiri* **sp. nov**) or two irregular spots (*P. (C.) lundi* **sp. nov**); rm-1 ahead to first fork MP (*P. (C.) painensis* **sp. nov**) together (*P. (C.) dorensis s* **sp. nov**, *P. (C.) lundi* **sp. nov**, *P. (C.) muiri* **sp. nov**) or slightly after (*P. (C.) montalvaniensis* **sp. nov**) and mcu-1 occurred slightly after to first MP fork (*P. (C.) dorensis s* **sp. nov**, *P. (C.) lundi* **sp. nov**, *P. (C.) muiri* **sp. nov**, *P. (C.) montalvaniensis* **sp. nov**). Hind tibia with three lateral spines (*P. (C.) dorensis* **sp. nov**, *P. (C.) lundi* **sp. nov**) or four lateral spines (*P. (C.) painensis* **sp. nov**, *P. (C.) muiri* **sp. nov**, *P. (C.) montalvaniensis* **sp. nov**); 2nd tarsomere with two apical teeth external slightly larger, and two medially with approx. the same size; 1st tarsomere with 1-2 lateral apical teeth well larger (*P. (C.) painensis* **sp. nov**, *P. (C.) dorensis s* **sp. nov**, *P. (C.) lundi* **sp. nov)** or slightly larger (*P. (C.) muiri* **sp. nov**, *P. (C.) montalvaniensis* **sp. nov)** and with 1-3 platellae.

Male genitalia. Pygofer bilaterally symmetric, laterally it can present arounded thin process developed (*P. (C.) dorensis* **sp. nov**), very large and rounded (*P. (C.) muiri* **sp. nov**) or moderately rounded (*P. (C.) painensis* **sp. nov**, *P. (C.) lundi* **sp. nov**, *P. (c.) montalvaniensis* **sp. nov**). Anal segment in dorsal view, very narrow near to the base (*P.*

(c.) dorensis **sp. nov**, *P. (C.) painensis* **sp. nov**) or slightly narrow (*P. (C.) lundi* **sp. nov**, *P. (C.) montalvaniensis* **sp. nov**, *P. (C.) muiri* **sp. nov**). Genital styles moderately wide distally (*P. (C.) dorensis* **sp. nov**, *P. (C.) montalvaniensis* **sp. nov**) or weakly wide distally (*P. (C.) painensis* **sp. nov**, *P. (C.) lundi* **sp. nov**, *P. (C.) muiri* **sp. nov**); the basal opening of styles is usually moderately small and diamond-shaped (*P. (C.) painensis* **sp. nov**, *P. (C.) lundi* **sp. nov**, *P. (C.) dorensis* **sp. nov**, *P. (C.) montalvaniensis* **sp. nov)** or weakly distinct, slightly rounded laterally and triangular elongated apically (*P. (C.) muiri* **sp. nov)**. Aedeagus with a large spine on the right side of the apex of shaft aedeagal (*P. (C.) painensis* **sp. nov**, *P. (C.) lundi* **sp. nov**, *P. (C.) muiri* **sp. nov**, *P. (C.) dorensis* **sp. nov**) or a large spine on the left lateral of the apex of shaft aedeagal (*P. (C.) montalvaniensis* **sp. nov**); in left lateral with one spine (*P. (C.) painensis* **sp. nov**, *P. (C.) lundi* **sp. nov**, *P. (C.) muiri* **sp. nov**, *P. (C.) montalvaniensis* **sp. nov**) or two spines (*P. (C.) dorensis* **sp. nov**); in right lateral view with one short spine (*P. (C.) lundi* **sp. nov**, *P. (C.) montalvaniensis* **sp. nov**, *P. (C.) dorensis* **sp. nov**) or two short spines (*P. (C.) painensis* **sp. nov**). Flagellum with two spines (*P. (C.) muiri* **sp. nov**, *P. (C.) lundi* **sp. nov**), being one of them bifid (*P. (C.) lundi* **sp. nov**), with three spines (*P. (C.) painensis* **sp. nov**, *P. (C.) dorensis* **sp. nov**) or four spines (*P. (C.) montalvaniensis* **sp. nov**).

Female genitalia. The female genitalia are very similar between species with little change in size of the segment IX and X.

Distribution. BRA. Minas Gerais estate.

Notes. Fennah 1945c grouped some species due to the anal segment developed distally, bent down (deflexed) in approx. 90° (e.g., bicaudata group), bent (deflexed) in approx. 45° (e.g., albolineata group), and to the shape of the genital styles. Here we have grouped all the new species with distally developed anal segment, with spines on the flagellum and genital styles weakly or moderately wide distally. A review of the species described by Muir 1934, and Fennah 1945c is indicated to properly allocate them to subgenus or new genera. Some species deposited in ISLA may have a morphology very similar to the morphology described for *Pintalia (Caudata)* **subgen. nov.** however the flagellum is spineless, usually completely covered by phallotreme.

New species

***Pintalia (C.) painensis* sp. nov.**
(Figures: 34 A-F; 35A-G; 36 A-C)

Type material. *Holotype*: Male **Brazil, MG**. Pains municipality, AGR030 Cave, (UTM 429594W, 7752810N, 23K), 12-17.xii.2015, (Col. Spelayon et al.) (ISLA 51218);

Female same data as male holotype except for, Divina cave, 20.ix.2003 (Col. Ferreira R.L) (ISLA 100971). Holotype condition: not dissected, stored in an individual vial in ethanol 70%. *Paratypes*. 1♂ (dissected) same data as male holotype except for, Faz. Baú, MIC_002 Cave (UTM 437656W, 7738366N, 23K), 10-11.xii.2014, (Col. Spelayon et al.) (ISLA 43260). 1♂ same data as male holotype except for, Cave gruta dos canudos (UTM 437021W, 7746967N 23K), 10.x.2000, (Col. Ferreira R. L) (ISLA 100970); 1♂ same data as male holotype except for, Lapa do Tamboril cave, (Col. Ferreira R. L) (ISLA 100972).

Other material examined. Brazil, MG: Prudente de Morais municipality, 1♂ and 1♀ ICMAT_0089 Cave, (UTM 592775W, 7841320N), 25.ix.2018, (Col. Ativo ambiental et al.) (ISLA 100967); 2♂ 2♀ ICMAT-71 Cave (UTM 593096W 7841912N), 27.xi.2017, (Col. Ativo ambiental et al.) (ISLA 100968). 3♂ Lagoa santa municipality, cave Lapa da Várzea (UTM 610200W, 7835522N, 23K), 06.x.2012 (Col. Ferreira R.L) (ISLA 3536). 1♂ and 1♀, Arcos municipality, Arco do Índio cave (UTM 437129W, 7753132S, 23K), 29.i.2006, (Col. Ferreira R.L) (ISLA 100969). 6♂ and 3♀, Curvelo municipality, Lapa do Saco Curto cave (UTM 562577W 7935990N), 17.i.2015, (Col. Rabelo, L.M) (ISLA 75685).

Description.

Coloration (specimen preserved in 70% ethanol): Strong orange yellow (68) contrasting in some areas with Deep Orange Yellow (69) and Brilliant orange yellow (67), legs principally Deep orange yellow (69), and Brilliant orange yellow (67).

Body length. Males. 4.381-4.757 mm (n=4). Females. 5.451-5.564 mm (n=2).

Head (Figures 34A-C). Vertex (Figure 34A, C): 1.5 times wider (0.487) than long (0.310); apical compartment is moderately large, approx. 2.9 times wider (0.374) than medially long (0.127); the apical transverse carina (0.331) smaller than the subapical carina (0.374); the angled formed by caudal border is triangular slightly concave. Frons (Figure 31B): 1.6 times longer (1.195) than wide (0.732), and approx. 2.0 times wider at the height of the antennae than at the anterior region of the frons (0.350). Frontoclypeal suture straight moderately bent upwards. Postclypeus (Figure 34B), with median carina weakly developed or evanescent Anteclypeus (Figure 34B), with median carina moderately developed, sometimes evanescent near frontoclypeal suture. Rostrum in ventral view surpassing slightly the base of the abdomen.

Thorax (Figures 34A, C). Pronotum (Figures 34A, C): Submedian carinae well developed, but slightly evanescent behind the eyes; hind margin straight obtusely angled or rectangular. Mesonotum (Figure 34A): median carina well developed but evanescent

or absent distally; lateral carinae strongly developed. Tegmina (Forewings) (Figure 34D): length (7.348 mm), hyaline with brown spots, two curved spots in pcc, three also curved spots of increasing size between fork A1/A2 and SCP+R, four round spots in the post nodal region between RP1 and MP3, transversal sloping spot in the center of the tegmina connecting the SCP+RA fork and the posterior cubital area; r-m1 and mcu-1 occurring together, and before to the first MP fork; simple tubercles in all veins more visible on the A1/A2 fork; petiole in RP3+RP4 moderately developed; 12 apical cells; 7 subapical cells.

Posterior leg (Figure 34E-F): The hind tibia (Figure 34E), with approx. 2.5 mm; has four lateral spines, the two closest to the femur being small, and six apical teeth, with as provide for the genus. First tarsomere (Figure 34F) with 7 apical teeth of approx. the same size, two external lateral is larger. Second tarsomere (Figure 34F) with 8 apical teeth, the two external ones are large (one larger) and the middle ones are gradually smaller, and sometimes with 3 large platellae, one is separated by apical teeth, but sometimes without platellae in one of the legs.

Male genitalia (Figures 35A-G). Pygofer (Figures 35A-C, G): bilaterally symmetric; in lateral view without processes; ventromedian process as provided for the subgenus. Anal segment (Figures 35A-C, G): tubular and distally developed (deflexed), bent in 90°approx; in dorsal view well narrow near to the base and broad distally; in lateral view, wider near the base; the distal region is moderately concave; the distal border is thin and well asymmetrical; the epiproct and paraproct are short, as provide for subgenus. Genital styles (Figures 35A-B, G): in lateral view, not much wider in the apical region than the base; the distal margin is curved, and a triangular process occurs ventrally near the base. Aedeagus (Figures 35D-F): asymmetrical tubular, with seven spines and only one is movable. Shaft of the aedeagus with four spines in right lateral view, the 1st spine is stout and curved (movable) (a) occurs on the apical portion of the shaft; below, the 2nd spine is small (b) is near the center of the shaft towards the flagellum; the 3rd spine is also small (c) and is inserted in the central/ventral region of the shaft aedeagal; the 4th spine is small and slightly curved (d), occurs on the left side in the apical portion of the aedeagal shaft. The flagellum has three spines, all on the right margin, the 5th is small (e), occurring at the base of the flagellum, the 6th is a slightly larger (f), inserted ahead and more ventrally, and the 7th spine is large (g) and occurs in the apical portion of the flagellum. Phallotreme laterally.

Female genitalia (Figures 36A-C). The segment X (Figures 36A, C) considerable long; in lateral with lateral margin weakly developed; in dorsal view is slightly rounded; the epiproct and paraproct is flattened dorsoventrally; in dorsal view the paraproct is very

small and rounded. Segment IX (Figures 36A-B): ovipositor (Figures 36A-C): in sabre-shaped (curved upwards), surpassing the segment X

Etymology. The specific epithet *painensis* was due to the type locality, municipality of Pains (MG), recognized by the large number of caves within its limits.

Diagnosis. *Pintalia (C.) painensis* **sp. nov** can be distinguished from other species of the genus Pintalia by the occurrence of a robust and curved spine at the apex of the shaft aedeagal and the unique arrangement of other six spines in the aedeagus.

Distribution. BRA, MG; Pains, AGR030 Cave **(Type locality)**, Prudende de Morais and Lagoa da Prata municipalities.

***Pintalia (C.) dorensis* sp. nov.**
(Figures: 37A-F; 38 A-G)

Type material. *Holotype*: Male **Brazil, MG**: Dores de Guanhães, DGN_02 Cave, (UTM 721790W 780121S, 23K), 31. viii. 2018, (Col. Rabelo et al.) (ISLA 66226). Holotype condition: The male holotype is intact and preserved in a vial with 70% ethanol. *Paratypes*: 1♂ same data of the Male holotype except for (ISLA 75690).

Description

Coloration (preserved specimen): Deep orange (51) contrasting in some areas with Deep Orange Yellow (69) and principally legs Brilliant orange yellow (67).

Body length. Male. 4.139-5.342 mm (n=2).

Head (Figures 37A-C). Vertex (Figure 37A, C): 1.8 times wider (0.506) than long (0.280); apical compartment is moderately large, approx. 3.2 times wider (0.408) than medially long (0.125); the apical transverse carina (0.358) smaller than the subapical carina (0.408); the angled formed by caudal border is moderately triangular. Frons (Figure 37B): 1.5 times longer (1.187) than wide (0.782), and approx. 2.0 times wider at the height of the antennae than at the anterior region (0.373). Frontoclypeal suture is straight and well bent upwards. Postclypeus (Figure 37B), with median carina developed or moderately developed. Anteclypeus (Figure 37B), with median carina moderately developed. Rostrum in ventral view surpassing slightly the base of the abdomen.

Thorax (Figures 37A, C). Pronotum (Figures 37A, C): submedian carinae weakly developed slightly irregular and evanescent behind the eyes; hind margin obtuse or obtusely angled. Mesonotum (Figure 37A): median carina well developed but evanescent or absent distally; lateral carinae strongly developed. Tegmina (Forewings) (Figure 37D): length (6.500 mm), hyaline with brown spots, two curved spots in pcc, two also curved spots of increasing size between fork A1/A2 and SCP+R, one large round spots in the

post nodal region between RP1 and MP4, transversal sloping spot developed in the center of the tegmina connecting the SCP+RA fork and the posterior cubital area; rm-1 occurring near the first fork MP and mcu-1 occurring slightly after the fork; simple tubercles in all veins more visible on the A1/A2 fork; petiole in RP3+RP4 moderately developed; 12 apical cells; 7 subapical cells.

Posterior legs (Figure 37E-F): Hind tibia (Figure 37E), approx. 2.2 mm. with 3 spines laterally, the two in the middle of the hind tibia are usually smaller, and six apical teeth, with as provide for the genus. First tarsomere with 7 apical teeth, two external lateral is larger and two in the middle is slightly smaller. Second tarsomere with 8 apical teeth, the two external ones are large (one larger) and the middle ones are gradually smaller, with 3 large platellae, one is separated by apical teeth without platellae.

Male Genitalia (Figures 38A-G). Pygofer (Figures 38A-C, G) bilaterally symmetric, in lateral view slightly concave dorsally and moderately straight distally, elongated process laterally with apical border well rounded and bent inward to genital capsule; ventromedian process as provided for the subgenus. Anal segment (Figures 38A-C, G): tubular and distally developed (deflexed), bent in 90°approx; in dorsal view is well narrow and asymmetrical near to the base and wide distally; in lateral view, slightly wider near the base; the distal region is thin and asymmetrical, well concave and narrow medially; the epiproct and paraproct are short, as provide for subgenus. Genital styles (figures 38A-B, G): in lateral view, moderately wider apically and narrow near the base; the dorsal margin is straight and ventral margin is curved. Aedeagus (Figures 38D-F): asymmetric tubular, with seven spines, six are movable. Shaft of the aedeagus exhibit four spines; in right lateral view the 1st spine is longer and curved (a) occurs on the apical portion of the shaft; below, the 2nd spine is small (b) near the center of the shaft towards the base; in left lateral view, the 3rd spine is slightly larger and movable (c) and is inserted in the apical region of the aedeagal shaft towards the ventral region; the 4th spine (d) is slightly below, and is approx. the same size as the third spine, however it is towards to flagellum. The flagellum has three spines, all on the right margin and after the middle of the flagellum, the 5th spine is short and curved (e) occurring at the middle of the flagellum; the 6th spine is short and straight (f) inserted ahead and more dorsally, and the 7th spine slightly longer and curved (g) occurs in the apical portion of the flagellum. Phalotreme laterally.

Etymology. The specific epithet *dorensis* refers to the type locality, municipality of Dores de Guanhães (MG).

Diagnosis. *Pintalia (C.) dorensis* **sp. nov.** can be distinguished from other species of the genus *Pintalia* mainly by exhibiting three spines in the medial/apical region of the flagellum, in addition to four other spines and too by the Pygofer with a rounded and bent process laterally.

Distribution. BRA, MG; Dores de Guanhães, DGN 02 cave **(Type locality)**.

***Pintalia (C.) lundi* sp. nov.**
(Figures: 39 A-F; 40 A-G; 41A-C)

Type material. *Holotype*: Male **Brazil, MG**. Lagoa Santa municipality, Helictites Cave (UTM 609077W, 7836837N, 23K), 11.x.2011, (Col. Ferreira R. L) (ISLA 100973); Female same data as male holotype except for Lapa da Varzea Cave, (UTM 610200W, 7835522N, 23K), 06.x.2012, (Col. Ferreira R.L.) (ISLA 100974). Holotype condition: not dissected, stored in an individual vial in ethanol 70%. *Paratypes*. 1♂ (dissected) same data as male holotype except for, G. Tuneis Cave (UTM 609040W, 7836792N, 23K), 10.x.2011, (ISLA 100975); 2♂ and 2♀ same data as female holotype (ISLA 3536) (Col. Rabelo et al.).

Other material examined. **Brazil, MG**: Itacarambi municipality, 1♂ Lapa d´Água do João Ferreira Cave, (UTM 593308W, 8340410N, 23K), 25.i.2015 (ISLA 100976) (Col. Rabelo et al.).

Description

Coloration (preserved specimen): Strong orange yellow (68) contrasting few in some areas with Deep orange yellow (69) and Brilliant orange yellow (67), legs majority light orange yellow (70) some few areas with Light yellow (86).

Body length. Male. 4.096-4.869 mm (n=5). Female. 5.085-5.118mm (n=2).

Head (Figures 39A-C). Vertex (Figure 39A, C): 1.5 times wider (0.476) than long (0.310); apical compartment is moderately large, approx. 2.6 times wider (0.372) than medially long (0.139); the apical transverse carina (0.338) smaller than the subapical carina (0.372); the angled formed by caudal border well triangular. Frons (Figure 39B): 1.5 times longer (1.158) than wide (0.752); approx. 2.2 times wider at the height of the antennae than at the anterior region of the frons (0.327); in facial view anterior region of the frons is trapezoidal and slightly elevated medially. Frontoclypeal suture is straight weakly bent upwards. Postclypeus (Figure 39B) with median carina weakly developed or evanescent Anteclypeus (Figure 39B) with median carina moderately developed or weakly developed. Rostrum in ventral view surpassing slightly the base of the abdomen.

Thorax (Figures 39A, C). Pronotum (Figures 39A, C): submedian carinae developed but slightly irregular and evanescent behind the eyes; hind margin obtusely angled. Mesonotum (Figure 39A): median carina weakly developed and evanescent or absent distally; lateral carinae well developed. Tegmina (Forewings) (Figure 39D): length (6.626 mm), hyaline with brown spots, two curved spots in pcc, three also curved spots of increasing size between fork A1/A2 and SCP+R, the two near fork A1/A2 is connected, inconspicuous spot in the post nodal region between RP1 and MP4, transversal spot weakly developed in the center of the tegmina connecting the SCP+RA fork and the posterior cubital area; rm-1 occurring together the first fork MP and mcu-1 occurring slightly after the fork; simple tubercles in all veins, slightly more visible on the A1/A2 fork; petiole in RP3+RP4 moderately developed; 12 apical cells; 7 subapical cells. Rostrum in ventral view surpassing slightly the base of the abdomen.

Posterior legs (Figure 39E-F): The hind tibia (Figure 39E) approx. 2.2 mm, with 3 spines laterally, the first at the base of the tarsomere being difficult to see, and six apical teeth, with as provide for the genus. First tarsomere (Figure 39F) with 7 apical teeth, two external lateral is larger and two in the middle is slightly smaller. Second tarsomere (Figure 39F) with 8 apical teeth, the two external ones are bigger (one larger) and the middle ones are gradually smaller, with 3 large platellae one is separated by apical teeth without platellae.

Male Genitalia (Figures 40A-G). Pygofer (Figures 40A-C, G) bilaterally symmetric, in lateral view dorsally slightly concave and straight distally; the ventromedian process as provided for the subgenus. Anal segment (Figures 40A-C, G):t ubular and distally developed (deflexed), bent in 90°approx; slightly asymmetric dorsally; weakly narrow near base and broad distally; in lateral view, wider near the base and with straight ventral border (asymmetrical); the distal region is asymmetric and thin, weakly concave and slightly narrow medially; the epiproct and paraproct as provided for the subgenus. Genital styles (Figures 40A-B, G): in lateral view, not much wider in the apical region than narrow near the base; curved distal margin and with small triangular process ventrally near the base. Aedeagus (Figures 40D-F): asymmetric tubular, with five movable spines, one is bifid. Shaft of the aedeagus exhibit three spines; in right lateral view the 1st spine is longer and curved (a) occurs on the right apical portion of the shaft; below, the 2nd spine is slightly smaller (b) near the center of the shaft slightly curved towards the base; in left lateral view, the 3rd spine is small (c) and occurs in the apical region of the aedeagal shaft towards the base. The flagellum has two spines, the 4th spine is bifid and longer (d) occurs near of the base, and towards to ventral region to flagellum,

the 5th spine is short (e) and occurs in the apical portion of the flagellum. Phallotreme laterally.

Female genitalia (Figures 41A-C). The segment X (Figures 41A, C); considerably long; in lateral with lateral margin weakly developed; in dorsal view is slightly rounded; the epiproct and paraproct is flattened dorsoventrally; in dorsal view, the paraproct is very small and rounded. Segment IX (Figures 41A-B). Ovipositor (Figures 41, A-C): in sabre-shaped (curved upwards), strongly surpassing the segment X

Etymology. The specific epithet *lundi* due to name of the Danish researcher Peter Wilhelm Lund. Dr. Lund had a great influence on the understanding of the Brazilian Pleistocene period from an infinity of fossils discovered in Brazilian caves, being considered the precursor of the Speleology and Paleontology sciences in Brazil.

Diagnosis. *Pintalia (C.) lundi* **sp. nov.** can be distinguished from other species of the *Pintalia* genus mainly by the occurrence of a bifid spine at the base of the flagellum, facing the ventral region transversally and by the other four spines of the aedeagus.

Distribution. BRA, MG; Lagoa Santa and Itacarambi municipality, Helictites Cave **(Type Locality)**.

***Pintalia (C.) montalvaniensis* sp. nov**
(Figures: 42 A-F; 43 A-G; 44 A-C)

Type material. Holotype: Male **Brazil, MG**: Montalvânia municipality, Fosséis Cave (UTM 573822W, 8417268N, 23K), 28.xi.2016, (Col. Ferreira R.L), (ISLA 75691). Female same data as male holotype except for (ISLA 100977). Holotype condition: not dissected, stored in an individual vial in ethanol 70%. *Paratypes*. 2♂, 1♀ and 2 nymph's same data as male holotype except for (ISLA 100978).

Description

Coloration (preserved specimen): Strong yellowish brown (74) contrasting in some areas with Deep orange yellow (69), Strong orange yellow (68) and Brilliant orange yellow (67), legs Moderate orange yellow (71) with some area's Light orange yellow (70).

Body length. Male. 4.072-4.596 mm (n=3). Female. 5.446-5.885 mm (n=2).

Head (Figures 42A-C). Vertex (Figure 42A, C): 1.4 times wider (0.501) than long (0.345); apical compartment is moderately large, approx. 2.7 times wider (0.360) than medially long (0.131); the apical transverse carina (0.316) smaller than the subapical carina (0.360); the angled formed by caudal border is triangular slightly concave. Frons (Figure 42B): 1.5 times longer (1.279) than wide (0.811), and approx. 2.4 times wider at the height of the antennae than at the anterior region of the frons (0.338). Frontoclypeal

suture is straight moderately bent upwards. Anteclypeus (Figure 42B), with median carina well developed; Postclypeus (Figure 42B), with median carina moderately developed. Rostrum in ventral view surpassing slightly the base of the abdomen.

Thorax (Figures 42A, C). Pronotum (Figure 42A, C): submedian carinae developed but slightly irregular and evanescent behind the eyes; hind margin obtusely angled or rectangular. Mesonotum (Figure 42A): median carina well developed but evanescent or absent distally; lateral carinae well developed. Tegmina (Forewings) (Figure 42D): length (7.287 mm), hyaline with brown spots, two curved spots in pcc, three also curved spots of increasing size between fork A1/A2 and SCP+R, the two near fork A1/A2 is connected, four rounded spot in the post nodal region between RP1 and MP4, the spot in RP region is larger, the transversal sloping spot weakly developed in the center of the tegmina connecting the SCP+RA fork and the posterior cubital area; rm-1 and mcu-1 occurring after the first fork MP; simple tubercles in all veins, slightly more visible on the A1/A2 fork; with punctual anastomosis in RP3+RP4; 12 apical cells; 7 subapical cells.

Posterior leg (Figure 42E-F): Hind tibia (Figure 42E) approx. 2.4 mm, with four spines laterally, the first at the base of the tarsomere being very small, and six apical teeth, with as provide for the genus. First tarsomere (Figure 42F) with 7 apical teeth, approx. the same size, but two in the middle is slightly larger. Second tarsomere (Figure 42F) with 8 apical teeth, the two external ones are slightly large (one larger) and the middle ones are gradually smaller, with 1-2 platellae;

Male Genitalia (Figures 43A-G). Pygofer (Figures 43A-C, G): bilaterally symmetric; in lateral view slightly concave dorsally and straight distally. Anal segment (Figures 43A-C, G): tubular and developed distally (deflexed) bent in approx. 90°, slightly asymmetrical distally. In dorsal view weakly narrow near base and wide distally; in lateral view slightly narrow near to the base; the distal region is thin and asymmetric, larger distally and well concave; slightly larger on left lateral that the right lateral. The epiproct and paraproct are short as provide for subgenus. Genital styles (Figures 43A-B, G): in lateral view, moderately wider apically and narrow near the base; the dorsal margin is straight, and the ventral margin is curved and with small triangular process in ventral region near to the base. Aedeagus (Figures 43D-F): asymmetric tubular, with seven spines, and only one is no movable. The shaft of the aedeagus has three spines; in right lateral view occurs two small spines, the 1st is small (a) and is inserted on the apex of the aedeagal shaft towards the ventral region and 2nd spine is smaller and no movable (b), occurs near the center of the shaft, in left lateral view the 3rd spine is movable, long and curved (c), occurs in the apex of the shaft. The flagellum has four spines, all on the right

margin the 4th is small (d) and occurs at the base of the flagellum; on the apical portion of the flagellum occurs three spines, the 5th and 6th (e)(f) spines are together, and 7th spine is small (g) and occurs slightly above; the 6th spine is slightly larger than others. Phallotreme laterally.

Female genitalia (Figures 44A-C). The segment X (Figures 44A, C); considerably long; in lateral with lateral margin weakly developed; in dorsal view is slightly rounded; the epiproct and paraproct is flattened dorsoventrally; in dorsal view the paraproct is very small and rounded. Segment IX (Figures 44A-B). Ovipositor (Figures 44A-C): in sabre-shaped (curved upwards), strongly surpassing the segment X

Etymology. The specific epithet *montalvaniensis* due to the type locality, municipality of Montalvânia (MG).

Diagnosis. *Pintalia (c.) montalvaniensis* **sp. nov** can distinguished from other species of the genus *Pintalia* by, mainly, by the three spines at the apex of the flagellum, the middle being larger and more robust, and by exhibiting a single long and movable spine on the left side of the shaft aedeagal.

Distribution. BRA, MG; Montalvânia municipality, Fosséis cave **(Type Locality)**.

***Pintalia (C.) muiri* sp. nov.**
(Figures: 45 A-F; 46 A-G)

Type material. *Holotype*: Male **Brazil, MG**. Dores de Guanhães municipality, G. Energia Cave-SPT002 (UTM 718204W, 7896396N, 23K), 11-12.xii.2015, (Col. Spelayon et al.) (ISLA 45532). Holotype condition: not dissected, stored in an individual vial containing ethanol 70%. *Paratypes*. 1♂ same data as male holotype except for Cave-08, (UTM 718137W, 7890794N, 23K) 30.i.-03-ii.2017, (Col. Spelayon et al.) (ISLA 52291); 1♂ same data as male holotype except for DGN02 Cave, (UTM 721790W, 7890121N, 23K), 31.x.2018, (Col. Rabelo et al.) (ISLA 75684).

Other material examined. **Brazil, MG**: São sebastião do Maranhão municipality, 1♂ Boa vista Cave, (UTM 764786W, 8012307N, 23K), 11.i.2018, (Col. Rabelo et al.) (ISLA 100979).

Description.

Color (specimen preserved in 70% ethanol): Strong Orange Yellow (68) contrasting in some areas with Deep orange yellow (69) and Strong Yellowish Brown (74), the legs are principally light yellow (86) and moderate yellow (87).

Body length. Male. 3.999-4.320 mm (n=4).

Head (Figures 45A-C). Vertex (Figure 45A, C): approx. 1.6 times wider (0.413) than long (0.260); apical compartment is moderately large, approx. 2.7 times wider (0.354) than medially long (0.130); the apical transverse carina (0.319) smaller than the subapical carina (0.354); the angled formed by caudal border is well triangular. Frons (Figure 42B): 1.6 times longer (1.1097) than wide (0.667), and approx. 1.9 times wider at the height of the antennae than at the anterior region (0.352). Frontoclypeal suture is slightly concave and weakly bent upwards. Anteclypeus (Figure 42B), with median carina moderately developed; Postclypeus (Figure 45B), with median carina moderately developed. Rostrum in ventral view surpassing slightly the base of the abdomen.

Thorax (Figures 45A, C). Pronotum (Figures 45A, C): submedian carinae weakly developed, slightly evanescent and irregular behind the eyes; the hind margin is obtuse or obtusely angled. Mesonotum (Figure 45A): median carina well developed but evanescent or absent distally; lateral carinae moderately developed. Tegmina (Forewings) (Figure 45D): length (6.158 mm), hyaline with brown spots, two curved spots in pcc, two also curved spots of increasing size between fork A1/A2 and SCP+R, one inconspicuous spot in the post nodal region between RP1 and MP1, transversal sloping spot in the center of the tegmina connecting the SCP+RA fork and the posterior cubital area; rm-1 occurring together the first fork MP and mcu-1 occurring slightly after; simple tubercles in all veins more visible on the A1/A2 fork; petiole in RP3+RP4 weakly developed; 12 apical cells; with 7 subapical cells, rarely 8 in one of the tegmina (Figure 45D).

Posterior legs (Figure 45E-F): hind tibia (Figures 45E) with approx. 2.1 mm. With four spines laterally, the first at the base of the tibia being very small, and six apical teeth, with as provide for the genus. First tarsomere (Figures 45F) with 7 apical teeth, approx. the same size, but two in the middle is slightly larger. Second tarsomere (Figures 43F) with 8 apical teeth, the two external ones are slightly large (one larger) and the middle ones are gradually smaller, with 3 large platellae one is separated by apical teeth without platellae.

Male Genitalia (Figures 46A-G). Pygofer (Figures 46A-C, G): bilaterally symmetric, in lateral view slightly concave dorsally and straight distally. Anal segment (Figures 46A-C, G): tubular and distally developed (deflexed), bent in 45°approx. The distal region is slightly concave with distal border rounded. In dorsal view, moderately narrow near base and wider distally; in lateral view that wide at base as distally; the epiproct and paraproct are short as provide for subgenus. Genital styles (Figures 44A-B, G). In lateral view it is weakly expanded apically and long, not much wider apically than at the base; the dorsal margin is straight, and the ventral margin is curved and with small

triangular process in ventral region near to the base; the basal opening is, slightly rounded laterally and triangular elongated apically. Aedeagus (Figures 46E-F): asymmetric tubular, with six spines. The shaft of the aedeagus has four spines; in right lateral view with three spines, the 1st spine is well long and curved (a), and occurs on the apical portion of the shaft, reaching the base; below are two spines of approx. the same size, the 2nd spine is moderately long (b) occurs towards the flagellum and the 3rd spine is slightly smaller (c), occurs towards the base of the shaft; in left lateral view the 4th spine usually is moderately large (d) and occurs below the apex of the shaft. The flagellum has two spines, all on the right margin, the 5th spine is small (e) and occurs at the base of the flagellum, and the 6th spine is slightly larger and curved (f) and occurs apically. Phallotreme laterally.

Etymology. The specific epithet *muiri* is a tribute to author Frederic Muir, who made major contributions to the genre *Pintalia* Stål, 1862.

Diagnosis. *Pintalia (C.) muiri* **sp. nov.** can be distinguished from other species of the genus *Pintalia* by presenting a very long spine at the apex of the aedeagal shaft almost reaching the base, and just below it with two non-movable spines with close origins but in opposite directions. In addition, the distal region of the anal segment is moderately developed and bent (deflexed) at approx. 45°.

Distribution. BRA, MG; Dores de Guanhães and São Sebastião do Maranhão municipality, G. Energia Cave-SPT002 **(Type Locality)**.

Remarks. The holotype exhibits right tegmina with MP1 bifid and MP3+4 trifid as Figure 45D.

Occurrence data and distribution

Pintalia Stål, 1862 was originally described for Brazil (Stål 1862). However, this genus presents species occurring in much part of the New World, from Chile (e.g., *Pintalia fasciolaris* (Blanchard, 1852)) to the USA (e.g., *Pintalia delicata* (Fowler, 1904)). According to the taxonomic literature records, *Pintalia* presents 81 species distributed in 20 political regions (Figures 47, 49). However, some species described still in the XIX and early XX centuries are only known for the country where they were collected, since that is the only informed type locality in most old description (e.g., type-serie Stål, 1862) or present inaccurate or difficult to verify data about the region where they were found (e.g., *P. fuscipennis* Muir, 1934). Many databases provide coordinates associated with *Pintalia*. For the distribution map here presented (Figure 49), 1870 records were selected, belonging to three different sources.

Based on reported locations from the literature, we obtained 148 records with an approximate location for the closest vegetation patch (when possible), another 559 records were obtained from the material deposited in the ISLA collection, and the remaining records were obtained from of database INaturalist (1163). All records used in this study were verified and validated by the authors or through images and/or reliable identification of curators.

According to our data, *Pintalia* Stål, 1862 species occur in 28 political regions of the New World (Figure 47). Although it exhibits a wide distribution, some patterns can be observed among the raised records here. According to the Köppen-Geiger classification (1900, 1918, 1927, 1936) (Peel et al., 2007), which is recognized worldwide (Goldscheider et al., 2020), in all Americas, *Pintalia* can occur in 16 climatic regions (Figure 48 - NW). However, the species are mainly observed in regions with temperate and tropical climates, totaling 1739 records in seven categories (Figure 48 - NW). In temperate regions, most records are for areas with no dry season at any time of the year (Cfa, Cfb) (874) followed by areas with dry season in winter (*Cwa, Cwb*) (87). In regions of tropical climate, most of the records are for areas with dry season in winter (*Aw*) (479), followed by areas with high levels of precipitation throughout all year (*Af, Am*) (299). In South America, most records are for the savanna climate with drier season in winter (*Aw*) (430) (Figure 48 – AS). However, it is important to stand out that the distributional patterns in South America is biased, since most of the data collected for South America are from the Brazil and for the ISLA collection (which only accounts with specimens collected in caves). However, it is possible to observe a strong relationship between the surveyed records with karst areas and/or areas of cave occurrences not only in Brazil, but also throughout the New World (Figure 49).

Of the total records, 795 are superimposed with karst areas and/or the occurrence of caves, being 508 only in South America, 197 in North America and 90 in Central America. The areas of occurrence of caves are only better evaluated in Brazil and in the USA, indicating, at least in part, the reason why regions outside these countries have few overlapping records with karst areas. In addition, although most of the records are not superimposed with the regions of occurrence of caves, it is possible to notice that they are close to such regions. Furthermore, those records far from karst areas are in regions of humid forests and/or with high levels of humidity and precipitation, as in areas of Humid subtropical climate (*Cfa*) in North America, and climates Equatorial (*Af*) and Monsoon (*Am*) in South America.

For South America, there are 790 records, distributed in twelve climate regions (Figure 48 – AS) and twelve countries (Figure 47). The country with the highest number of records was Brazil (621). Brazil has records distributed in three forest domains, the Cerrado (Brazilian Savanna - 300), Amazonia (176) and Atlantic Forest (144), and eight climatic regions (Figure 48 - BRA). The climate with the highest number of records in Brazil was Savanna climate with dry season in winter (*AW*) (419), followed by Monsoon climate (*Am*) (85) and Humid subtropical climate influenced by monsoons (*Cwa*) (57). In total, 501 records are superimposed with areas of occurrence of caves in Brazil, most of them for carbonate rocks (301), followed by ferruginous rocks (119), and ferruginous with another lithology, for example + siliclastic (41) and + carbonate (15). The Brazilian state with the highest number of records was Minas Gerais.

Of the total records, 378 were obtained for the Minas Gerais state, distributed in two forest domains, the Cerrado (286) and the Atlantic Forest (92), and three climatic regions *Aw* (316), *Cwa* (54) and *Cwb* (8) (Figure 48 – MG). In total, for Minas Gerais state, 362 records were superimposed with areas of occurrence of caves, most of them in carbonate rocks (296), followed by ferruginous rocks (21), ferruginous + siliclastic (18) and ferruginous + carbonate (15). All the new species herein described were found in caves in the state of Minas Gerais (MG).

Among the subgenera that we are proposing to allocate the new species, *P. (Ecuadorensis)* **subgen. nov** presents the greatest distribution and exhibit 20 records distributed in three South American countries (BRA, PER, ECU), and in six climatic regions (*Af, Am, Aw, Cfa, Cfb, Cwa*). In Brazil, it has records distributed in four climatic regions (*Aw, Cfa, Cfb, Cwa*) and six states (SP, RJ, PR, SC, MG, BA). Although it exhibits a wide distribution in South America, few specimens of *P. (Ecuadorensis)* **subgen. nov,** are deposited in the ISLA collection, and from the total of records, only three are superimposed with areas of cave occurrences, two in carbonate lithology regions and one in ferriferous lithology.

P. (Pictipennis) **subgen. nov** presents records for the Minas Gerais and Rio de Janeiro states, while *P. (Caudata)* **subgen. nov** so far has only been registered in Minas Gerais state. Possibly these subgenrra have a wider distribution, which can be expanded with the proper allocation of the species already described and/or the description of new species. *P. (Caudata)* **subgen. nov** was only recorded for one climatic region (*Aw*) (18), being most of the records overlapped with carbonate lithology areas (15). *P. (Pictipennis)* **subgen. nov** was registered for three climatic regions (*Cwa, Aw, Cwb*), with most records (25) for the humid subtropical climate (*Cwa*). Regarding the lithology of the caves, *P.*

(Pictipennis) **subgen. nov,** showed the greatest overlap for areas of ferruginous lithology (24).

Ecology and habitat

Pintalia is a large genus that can be found throughout most of the New World (Figure 47), exhibiting most records for temperate climate regions. However, in Brazil, there is a high number of records in caves of regions with a tropical savanna climate and greater drought in winter (*Aw*) (Figure 48 - BRA). Possibly this pattern is in order to avoid low levels of humidity and high temperatures in the epigeal environment, that in periods marked by drought significantly alters the phytophysiognomy of the local vegetation.

Subterranean habitats have in common the annual average temperatures that vary less than in the epigean environment, high humidity, and permanent absence of sunlight (Gilbert et al., 1994, Culver & Pipan 2014-2018). In this scenario, the permanent absence of sunlight gives these environments a lack of primary autotrophic producers such as plants and algae, causing most of the energy available in these environments to come from the epigean environment, in the form of sediments carried by rain and roots from of epigean vegetation (Stone et al., 2012).

Pintalia Stål, 1862 is a Cixiidae, and has an intrinsic ability to colonize subterranean habitats. The nymphs of almost all species of this family live on or near the ground, feeding on the xylem of roots from epigean vegetation (Howarth, 2012). In cave regions, many roots grow into the interconnected spaces of the soil, following nutrients and in search of water, thus providing food resources for many Cixiidae, which establish themselves along a subterranean gradient (Howarth, 2012-2019). *Pintalia* nymphs do not have adaptations for burrowing, such as the first modified pair of legs observed in some species of Cixiidae (Myers, 1929; Emeljanov, 2002). Therefore, the nymphs of *Pintalia* use small spaces and fractures in the rock to walk on roots that often reach the deep interior of caves.

In many countries, there are reports of cixiids that evolved totally isolated (allopatry) within subterranean habitats, these species usually are associated with the hypothesis of Relict Climatic (CRH). According to this theory, the displacement of species into subterranean cavities occurs due to extreme climatic events, which deplete viable conditions for the species to complete all or part of the life cycle in the epigean environment, for example during the *Last Glacial Maximum* (LGM).

However, in the last decades, a phenomenon initially observed in species of insular planthoppers of the temperate zone, has been gaining strength to explain the speciation

of cave dwellers in the tropics (Howarth 2019). According to this hypothesis, the Adaptive Shifts (ASH) occurs when individuals from an epigean population, while exploring a new habitat and/or resource, establish different populations along an underground gradient. If these individuals can feed and reproduce, over a long time, the new populations may diverge in behavioral, physiological, and morphological aspects (parapatry). Extrinsic factors, that is, those imposed on organisms by the environment and that lead them to migrate and carry out part, or the entire life cycle within the caves, are little explored for most species in this theory, and were never explored for species of *Pintalia* Stål, 1862.

Regions with seasonal climate marked by long droughts, high temperatures or even fires like those that occur periodically in the Cerrado domain of Brazil (Miranda et al., 2009; Gomes et al., 2018), and with the occurrence of caves and small spaces interconnected in the soil are a good environmental refuge for specimens of the genus *Pintalia* Stål, 1862. With the increase in temperature and consequent loss of moisture and leaves of vegetation due to drought, specimens of *Pintalia* possibly shelter in subterranean environments, in order to avoid adverse conditions in the epigean habitats, which, could compromise the *fitness* of species more adapted to mild climate regions. In this context, the dry diagonal of South America could partially explain the large number of species of *Pintalia* observed in regions with occurrence of caves in the savanna climate in Brazil.

In South America, the Dry Diagonal, or Savanna Corridor, comprises the Caatinga, Cerrado (Brazil) and Chaco (Argentina) domains. This formation is also recognized as an important biogeographical barrier for species from the Amazon and Atlantic Forest. Many hypotheses of past forest connections between these two domains have been suggested in recent decades (Vanzolini, 1963, Haffer, 1969-2008, Prado e Gibbs, 1993, Sobral et al., 2015). Sobral et al., 2015 showed that these connections occurred simultaneously in different locations in the past. Places where these connections occurred in the past are a source of endemism for many groups, and possibly refer to the origin of some obligatory troglobitic fulgoroidea in Brazil.

In Brazil, all three troglobitic species of fulgoroidea occur in savanna climate regions, two of which are in places of connections inferred by Sobral et al., 2015, between Atlantic Forest and Amazon during the last LGM, *Kinnapotiguara troglobia* (Hoch and Ferreira, 2013) (Connection: NE) and *Iuiuia Caeca* Hoch and Ferreira, 2016 (Connection: NE, CE/NW). *Ferricixius davidi*, Hoch and Ferreira, 2012 presents as the type locality the MP8 cave in the “Quadriltero ferrifero” (Iron quadrangle) (MG), which is

characterized by the high-altitude subtropical climate (Cwb), with greater drought in winter, lasting 3 to 4 months per year (Borsali, 2012).

The Iron Quadrangle, located in southeastern Brazil, was characterized by extensive grasslands during the Last Glacial Maximum (LGM) (Behling, 2003, Cecchet, 2015). Grasses have short roots that hardly reach the caves interior. Although no study has been done entirely in this meaning, possibly, possibly, populations of *Ferricixius davidi* isolated themselves after this glaciation scenario and initiated speciation through parapatry processes in Adaptive Shifts (ASH) (Howarth, 2019), due to less severe processes that modified vegetation and climate of region. In this context, although no species of *Pintalia* Stål, 1862 with with incipient troglomorphisms are known, it is possible to expect them to occur, since many species share the same habitat and conditions experienced by some obligate troglobitic Fulgoroidea in Brazil.

Most of the species herein described can be classified as Subtroglophiles, that is, species that can establish populations inside caves, but that depend on the epigean habitat at some point to complete their life cycle, either for food or reproduction. However, *P. (P.) minima* **sp. nov** which has as type locality a cave located at the Iron Quadrangle, is possibly an Eutroglophilous species, as it exhibits different populations with different levels of character reduction, such as body size, veins of the tegmina and distal teeth of the tibia and posterior tarsomeres (see Remarks of *P. (P.) minima* **sp.n**). Perhaps these characters are the first incipient troglomorphisms observed in *Pintalia* Stal, 1862 and should be further evaluated.

Discussion

Pintalia Stål, 1862 is a complex group. Defined by basal traits, it exhibits various forms of characters suggested for identification. Therefore, it is a possibly polyphyletic group and the construction of subgenera to allocate new species is recommended to homogenize the information and facilitate future phylogenetic work. For this, we recommended the use of putative characters. Here we suggest characters that evince synapomorphies in *Pintalia* Stål, 1862, and that can be useful for the recognition and proposal of new subgenera (Table 1). Based on these characters we propose the three first subgenera of *Pintalia* Stål, 1862.

P. (Caudata) **subgen. nov** and *P. (ecuadorensis)* **subgen. nov** share a few characteristics of the male genitalia, head, hind legs, and hind wings. The basal opening of the genital styles is diamond-shaped in both subgenera, however *P. (Caudata)* **subgen. nov** exhibits the moderately short and poorly apically expanded genital styles, and *P. (ecuadorensis)* **subgen. nov** the genital styles are large and very expanded apically. In

addition, the two subgenera show short epiproct and paraproct not developed distally, platellae on the second tarsomere of the hind leg, and apical transverse carina the same size or smaller than the subapical carina, although in *P. (ecuadorensis)* **subgen. nov** the vertex is wider and the platellae is larger. In addition, the two subgenera exhibit petiolate anastomosis in MP3+CuA1 of the hindwings, as *P. lateralis* Stål, 1862 (type), *P. ustulata* Stål, 1862, *P. fraterna* Stål, 1862.

P. (Caudata) **subgen. nov** can be distinguished from the other subgenera described here mainly by the anal segment developed distally and bent between 45º and 90º, being that in dorsal view is narrow near the base. The aedeagal shaft is tubular and apically wider, and the flagellum usually with spines and Phallotreme laterally. Furthermore, in lateral view the pygofer is quadratic and rounded in the distal/dorsal region and without cone-shaped processes as in *P. (ecuadorensis)* **subgen.n**.

P. (ecuadorensis) **subgen. nov,** can be distinguished from the other subgenera mainly by the short anal segment, not developed distally, and by exhibiting in most species three long spines at the apex of the shaft aedeagal. The genital styles in lateral view are distally wide. The pygofer exhibit cone-shaped processes laterally, this process is large and robust in caudal view. Many records in the INaturalist distributed in South America exhibit the conspicuous tegmina pattern similar to in *P. (E.) constellaris* (Walker, 1858) and *P. (E.) speciosa* **sp. nov**, these species in addition to the spot pattern exhibit also large C3 and C5 cells. Although it shares many male genital characteristics with these species *P. (E.) fennahi* **sp. nov** is unusual because of the vertex and tegmina, being is the first of the described type.

P. (Pictipennis) **subgen. nov** is the most distinct among the subgenera proposed here and can be distinguished by short anal segment (not developed distally) with paraproct and sometimes epiproct developed distally. The genital styles in lateral view are distally wide, and in ventral view exbibit basal opening large, laterally concave, and apically triangular. The aedeagal shaft is tubular with ventral ridge developed. The apical transverse carina in facial view is concave, and in dorsal view is the same size or larger to subapical carina. The tegmina exhibit punctual anastomosis between RA+RP1 and the hind wings exhibit MP trifid with complete anastomosis of MP3+CuA1. The species described here exhibit different levels of asymmetry, however two species of the *(Pictipennis)* **subgen. nov** exhibit significant asymmetry patterns.

Asymmetry is common in male genitalia of many Fulgoromorpha (Huber et al., 2007), and especially in Cixiidae (e.g., Rahman et al., 2012; Zhi et al., 2018; Bahder et al., 2020). Muir, 1934 observed asymmetry in the anal segment of species of *Pintalia*

Stål, 1862. Another asymmetry common is in the number of platellae of the second tarsomere of the hind legs, which sometimes are small or absent in one of the legs, as in *P. (C.) painensis* **sp. nov**. Differences in the number of cross-veins between tegminae are also very common in *Pintalia* Stål, 1862 and may be a difficulty for researchers unfamiliar with the group. Here, two described species are strongly asymmetrical. *P. (P.) minima* **sp. nov** and *P. (P.) magnaepiprocti* **sp. nov**, which exhibit all parts of the genital segment strongly asymmetrical. These species also exhibit asymmetry in the lateral carinae of the frons, and in some specimens from different populations in the number of teeth of the second and first tarsomere of hind legs (right and left). This might indicate they are cryptic species or very old populations undergoing adaptive shifts, and therefore populations at risk due to the low number of specimens and threats to their habitats.

Recent evidence indicates that we are experiencing the sixth mass extinction (Cowie, 2022). In this case, many invertebrates may be disappearing without leaving any traces or being collected, and in other cases never described for lack of corresponding paratypes. We suggest that, in cases of species with threatened habitats, after exhaustive searches in the type locality, the description of monotype species is carried out, and so to fill gaps in the knowledge of invertebrates and better assess the degree of threat.

Brazilian caves are under strong threat due to Decree 10,935/2022, recently published by the Federal Government of Brazil (Ferreira et al., 2022). The decree, made without consulting researchers, allows projects to irreversibly impact natural underground cavities across the country, even caves categorized of maximum relevance, biological, archaeological, and geological, among other diverse attributes. Caves are essential for many species of *Pintalia* Stål, 1862 to complete the life cycle, and if these environments are massively destroyed, several species of *Pintalia* Stål, 1862 may disappear in the very near future.

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References

Bahder, B. W., Barrantes, E. A. B., Echavarria, M. A. Z., Mou, D. F., Helmick, E. E., & Bartlett, C. R. (2020) A new species of planthopper in the genus Haplaxius (Hemiptera: Auchenorrhyncha: Fulgoroidea: Cixiidae) on palms in Costa Rica and a new country record for Haplaxius skarphion. *Zootaxa*, *4767*(4), 543-552.

Bartlett, C. R. (2020) (and updates). Planthoppers of North America (accessed jan, 2021). https://sites.udel.edu/planthoppers/.

Behling, H. (2003) Late glacial and Holocene vegetation, climate and fire history inferred from Lagoa Nova in the southeastern Brazilian lowland. *Vegetation History and Archaeobotany*, v. 12, n. 4, p. 263-270.

Borsali, E. F. (2012). A flora vascular endêmica do Quadrilátero Ferrífero, Minas Gerais, Brasil: levantamento das espécies e padrões de distribuição geográfica.

Bourgoin T. (2021) FLOW (Fulgoromorpha Lists on The Web): a world knowledge base dedicated to Fulgoromorpha. Version 8, updated [date]. http://hemiptera-databases.org/flow/

Bourgoin, T., & Szwedo, J. (2008) The 'cixiid-like'fossil planthopper families. *Bulletin of Insectology*, 61(1), 107-108.

Brożek, J.; Bourgoin, T. (2013) The phylogenetic information carried by a new set of morphological characters in planthoppers: the internal mouthpart structures and test in the Cixiidae model (Hemiptera: Fulgoromorpha). *Zoomorphology*, 132(4) 403-420.

Cecchet, F. A. (2015) Análise de fitólitos aplicada a reconstrução paleoambiental (vegetação e clima) na superfície incompletamente aplainada VI–Campo Erê (SC) no pleistoceno tardio.

Ceotto, P., Kergoat, G. J., Rasplus, J. Y., & Bourgoin, T. (2008) Molecular phylogenetics of cixiid planthoppers (Hemiptera: Fulgoromorpha): New insights from combined analyses of mitochondrial and nuclear genes. *Molecular Phylogenetics and Evolution*, 48(2), 667-678.

Ceotto, P.; Bourgoin, T. (2008) Insights into the phylogenetic relationships within Cixiidae (Hemiptera: Fulgoromorpha): cladistic analysis of a morphological dataset. *Systematic Entomology*, 33(3) 484-500.

Cowie, R. H., Bouchet, P., & Fontaine, B. (2022) The Sixth Mass Extinction: fact, fiction or speculation?. *Biological Reviews*.

Emeljanov, A.F. (2002) Contribution to classification and phylogeny of the family Cixiidae (Hemiptera, Fulgoromorpha). *Denisia*,

Fennah, R. G. (1945). The Fulgoroidea, or lanternflies, of Trinidad and adjacent parts of South America. *Proceedings of the United States National Museum*.

Ferreira, R. L., Bernard, E., da Cruz Júnior, F. W., Piló, L. B., Calux, A., Souza-Silva, M., ... & Frick, W. F. (2022) Brazilian cave heritage under siege. *Science*, *375*(6586), 1238-1239.

Goldscheider, N., Chen, Z., Auler, A. S., Bakalowicz, M., Broda, S., Drew, D., & Veni, G. (2020) Global distribution of carbonate rocks and karst water resources. *Hydrogeology Journal*, 28(5), 1661-1677.

Gomes, L., Miranda, H. S., & da Cunha Bustamante, M. M. (2018) How can we advance the knowledge on the behavior and effects of fire in the Cerrado biome?. *Forest Ecology and Management*, *417*, 281-290.

Haffer, J. (1969). Speciation in Amazonian Forest Birds: Most species probably originated in forest refuges during dry climatic periods. *Science*, *165*(3889), 131-137.

Haffer, J. (2008). Hypotheses to explain the origin of species in Amazonia. *Brazilian Journal of Biology*, *68*(4), 917-947.

Hoch H. (1994) Homoptera (Auchenorrhyncha Fulgoroidea). *Encyclopaedia biospeologica*, v. 1, p. 313-325.

Hoch H. (2002) Hidden from the light of day: planthoppers in subterranean habitats (Hemiptera: Auchenorrhyncha: Fulgoromorpha). *Denisia*.

Hoch H; Asche, M. (1993). Evolution and speciation of cave-dwelling Fulgoroidea in the Canary Islands (Homoptera: Cixiidae and Meenoplidae). *Zoological Journal of the Linnean Society*, v. 109, n. 1, p. 53-101.

Hoch, H., Bourgoin, T., Faille, A., & Soulier-Perkins, A. (2017) A new species of Bennini (Hemiptera, Cixiidae) from granitic subterranean environment in Vietnam, an under-investigated biotope. In *Annales Zoologici* (Vol. 67, No. 1, pp. 1-12). Museum and Institute of Zoology, Polish Academy of Sciences.

Hoch, H; Ferreira, R. (2016). Iuiuia caeca gen. n., sp. nov., a new troglobitic planthopper in the family Kinnaridae (Hemiptera, Fulgoromorpha) from Brazil. *Deutsche Entomologische Zeitschrift*, v. 63, p. 171.

Hoch, H; Mühlethaler, R; Wessel, A. (2013) Acoustic communication in the subtroglophile planthopper Trigonocranus emmeae Fieber, 1876 (Hemiptera: Fulgoromorpha: Cixiidae: oecleini). *Acta Musei Moraviae, Scientiae Biologicae (Brno)*, *98*(2), 155-162.

Holzinger, W. E., Emeljanov, A. F., & Kammerlander, I. (2002). *The family Cixiidae Spinola 1839 (Hemiptera: Fulgoromorpha)-a Review*. *Denisia.*

Howarth F.G. (2004) Hawaiian Islands: biospeleology. In: Gunn J (ed) Encyclopedia of caves and karst science. *Library of Congress Cataloging-in-Publication Data*. pp 863–867

Howarth FG; Hoch H. (2005) Adaptive shifts. In: Culver DC, White WB (eds) Encyclopedia of caves. *Elsevier Academic Press, Burlington, MA*, pp 17–24. www.books.elsevier.com

Howarth, F. G. (1972). Cavernicoles in lava tubes on the island of Hawaii. *Science*, *175*(4019), 325-326.

Howarth, F. G. (1981). Community structure and niche differentiation in Hawaiian lava tubes. *US/IBP synthesis series*.

Howarth, F. G. (1987). The evolution of non-relictual tropical troglobites. *International Journal of Speleology*, *16*(1-2), 1-16.Huber, Bernhard A.; Sinclair, Bradley J.; Schmitt, Huber, B. A., Sinclair, B. J., & Schmitt, M. (2007). The evolution of asymmetric genitalia in spiders and insects. *Biological Reviews*, *82*(4), 647-698..

Howarth, F. G. (1993) High-stress subterranean habitats and evolutionary change in cave-inhabiting arthropods. *The American Naturalist*, 142, S65-S77.

Howarth, F. G. (2019) Adaptive shifts. In Encyclopedia of caves (pp. 47-55). *Academic Press*.

Kramer, J. P. (1983) Taxonomic study of the planthopper family Cixiidae in the United States (Homoptera: Fulgoroidea). *Transactions of the American Entomological Society*, 1-57.

Kunz, G., & Holzinger, W. E. (2022) A new Pintalia species from Costa Rica (Hemiptera: Fulgoromorpha: Cixiidae). *Cicadina*, 21, 1-9.

Latreille P. A. (1804) Histoire naturelle, générale et particulière des Crustacés et des Insectes. 12: 424 pp. [310].

Metcalf Z. P. (1938) The Fulgorina of Barro Colorado and other parts of Panama. *Bulletin of the Museum of Comparative Zoology at Harvard College*. Cambridge, Mass 82: 277-423.

Miranda, H. S., Sato, M. N., Neto, W. N., & Aires, F. S. (2009) Fires in the cerrado, the Brazilian savanna. In *Tropical fire ecology* (pp. 427-450). *Springer*, Berlin, Heidelberg.

Muir, F. (1934) The genus Pintalia Stål (Homoptera, Cixiidae). *Transactions Of The Royal Entomological Society Of London*, *82*(2), 421-441.

Myers, J. G. (1929) Observations on Two Remarkable Cixiid Plant-Hoppers (Homoptera) from Cuba. *Psyche*, 36(4), 283-292.

Prado, D. E., & Gibbs, P. E. (1993) Patterns of species distributions in the dry seasonal forests of South America. *Annals of the Missouri Botanical Garden*, 902-927.

Rahman, M. A., Kwon, Y. J., & Suh, S. J. (2012) Sexual dimorphism documented in Reptalus iguchii (Matsumura)(Hemiptera: Fulgoromorpha: Cixiidae) with a description of males. *Entomological Research*, *42*(1), 35-43.

SKET, B. (2008) Can we agree on an ecological classification of subterranean animals?. *Journal of Natural History*, v. 42, n. 21-22, p. 1549-1563.

Stål, C. (1862) Bidrag till Rio Janeiro-trakens Hemipt er fauna. II. Handl. *Svenska Vet. Akad*. 3 (6), l-75.

Szwedo, J., Bourgoin, T., & Lefebvre, F. (2004) *Fossil Planthoppers (Hemiptera: Fulgoromorpha) of the world: An annotated catalogue with notes on Hemiptera classification*. Museum and Institute of Zoology, Polish Academy of Sciences.

Urban, J. M., & Cryan, J. R. (2007) Evolution of the planthoppers (Insecta: hemiptera: Fulgoroidea). *Molecular Phylogenetics and Evolution*, *42*(2), 556-572.

Vanzolini, P. E. (1963) Problemas faunisticos do Cerrado, p. 307–320. In: Ferri, M. G. (ed.), *Simpósio sôbre o Cerrado*. São Paulo, Universidade de São Paulo, 469 p.

Zhi, Y., Yang, L., Zhang, P., & Chen, X. S. (2018). Two new species of genus Oecleopsis Emeljanov from China, with descriptions of female genitalia of five species (Hemiptera, Fulgoromorpha, Cixiidae). *ZooKeys*, (768), 1.

List of Figures

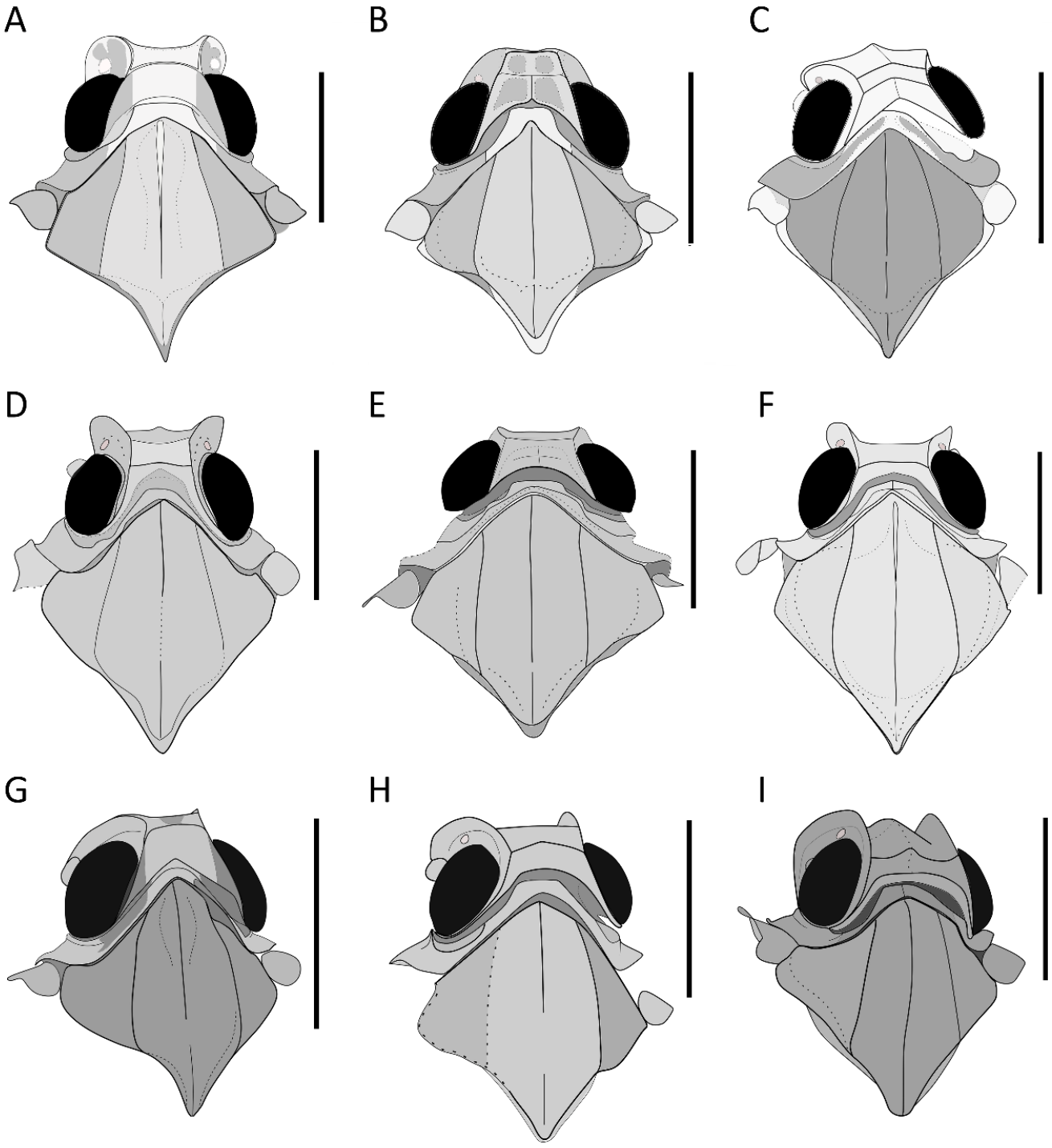

FIGURE 1: *Head Pintalia types Stål, 1862: A, P. lateralis Stål, 1862; B, P. consobrina Stål, 1862; C, P. fasciatipennis Stål, 1862; D, P. fraterna Stål, 1862; E, P. inortata Stål, 1862; F, P. obscuripennis Stål, 1862; G, P. pictipennis Stål, 1862; H, P. proxima Stål, 1862; I, P. ustulata Stål, 1862.*

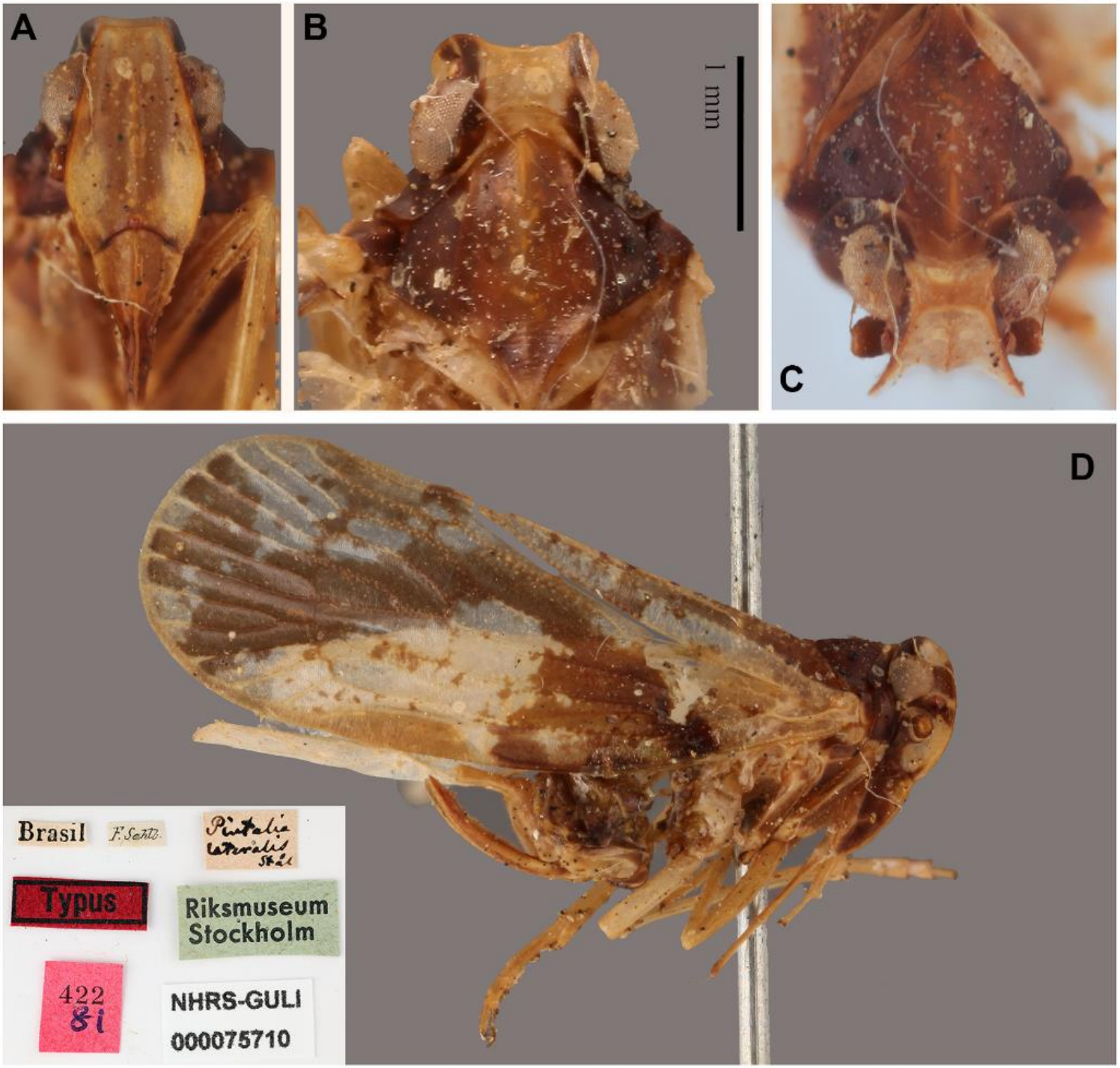

FIGURE 2. *Pintalia lateralis* Stål, 1862: A-C head; D habitus.

FIGURE 3. *Pintalia lateralis* Stål, 1862: A ventral view; B posterior leg.

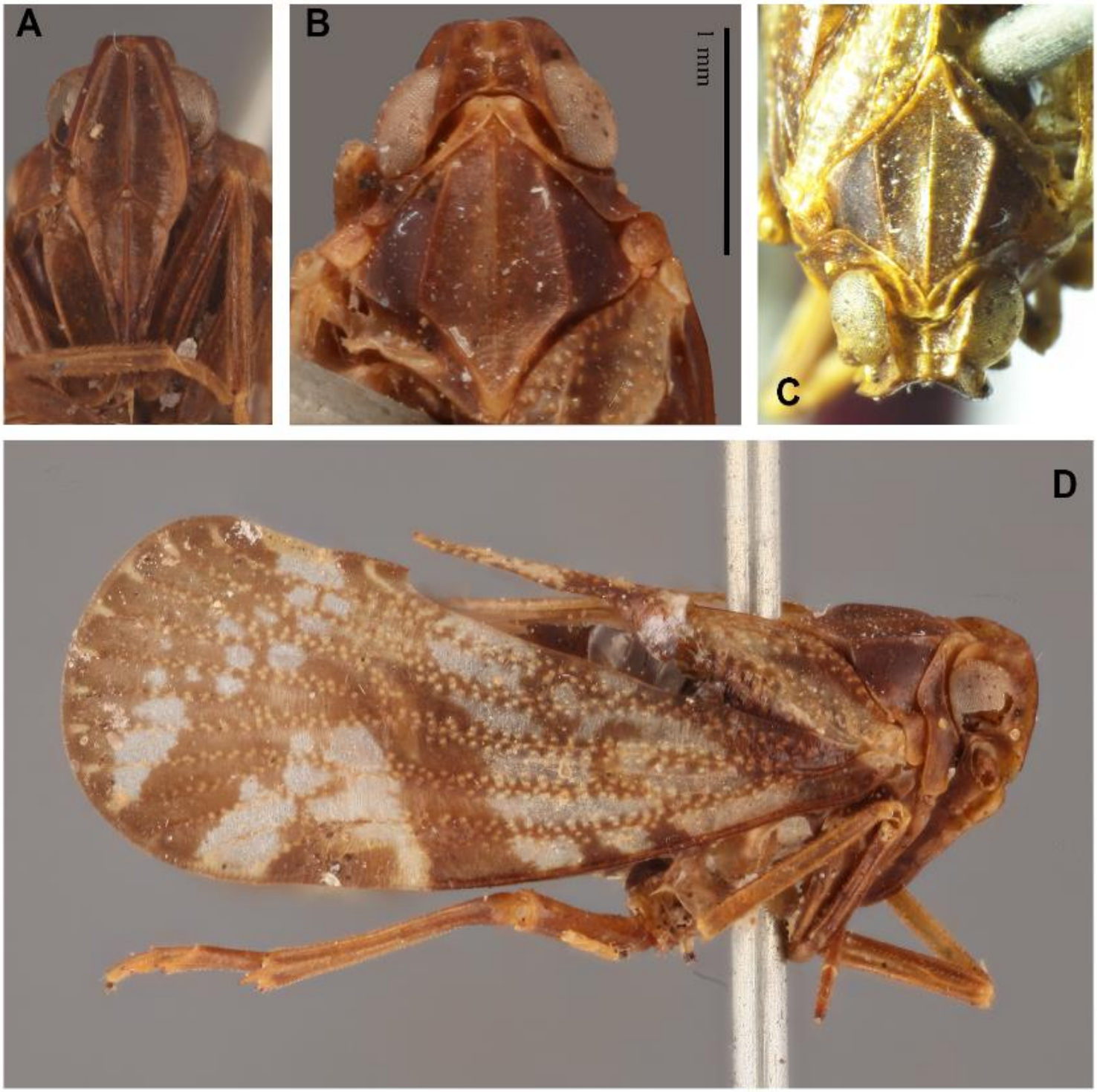

FIGURE 4. *Pintalia consobrina* Stål, 1862: A-C head; D habitus.

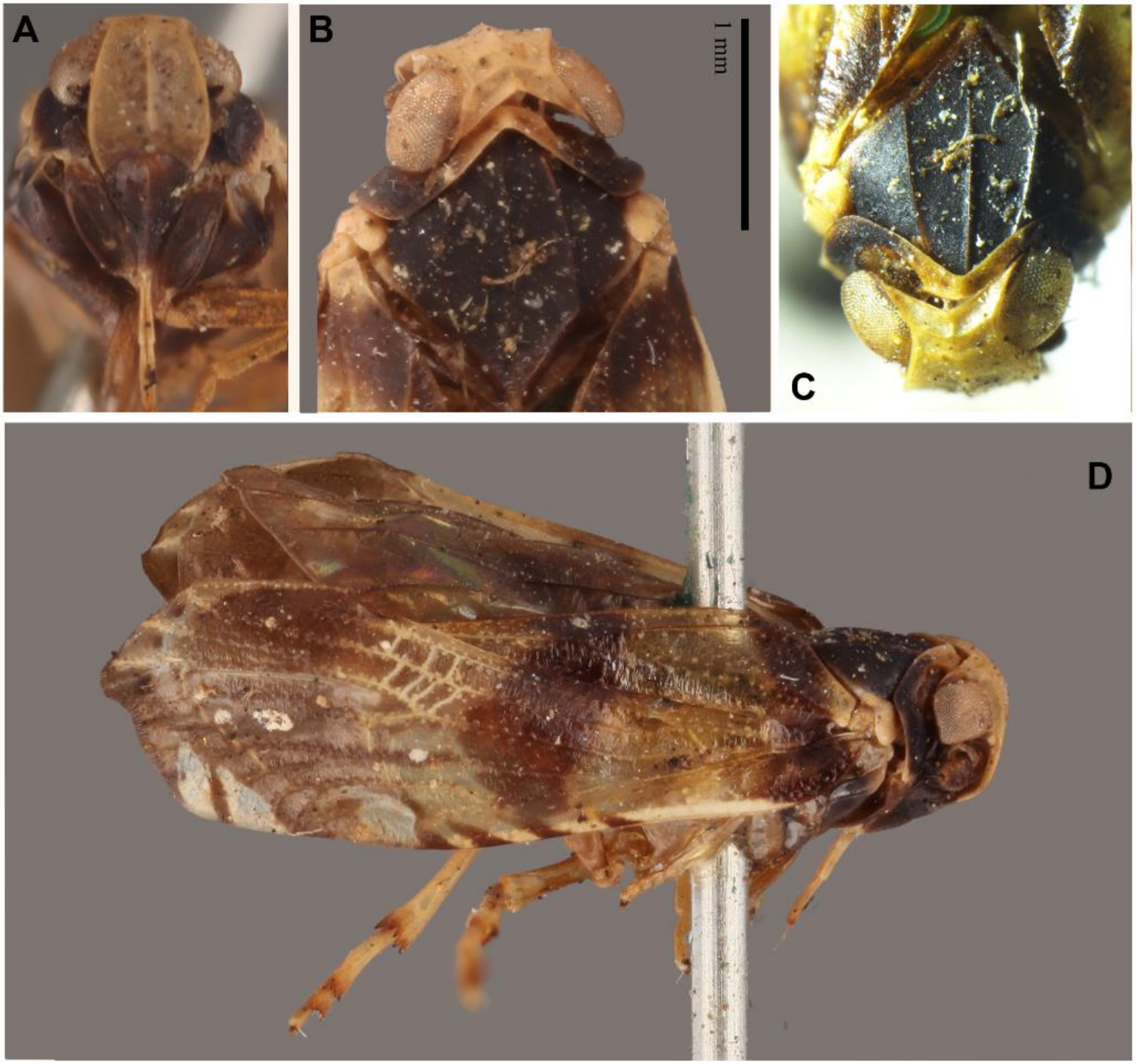

FIGURE 5. *Pintalia fasciatipennis* Stål, 1862: A-C head; D habitus.

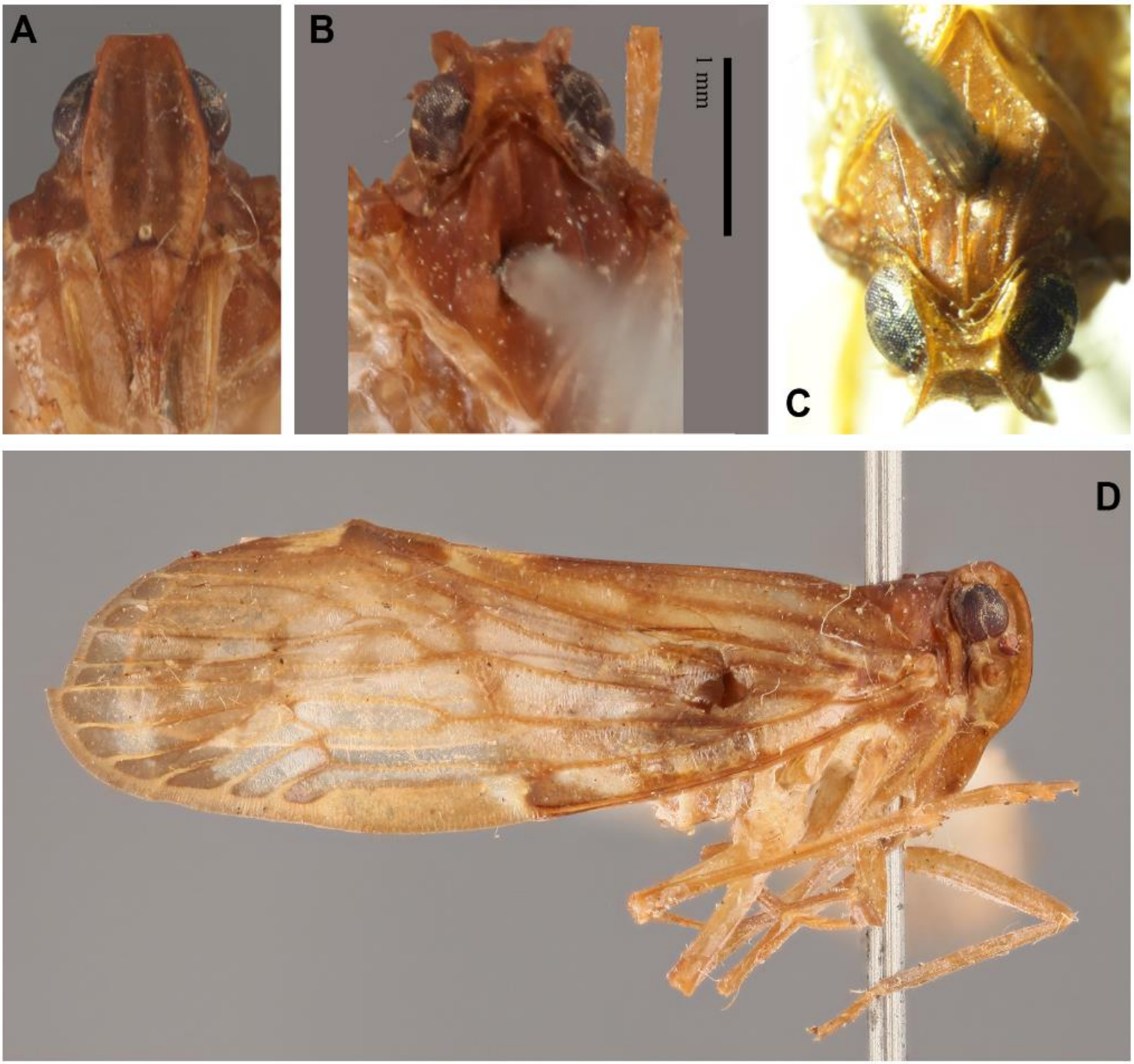

FIGURE 6. *Pintalia fraterna* Stål, 1862: A-C head; D habitus.

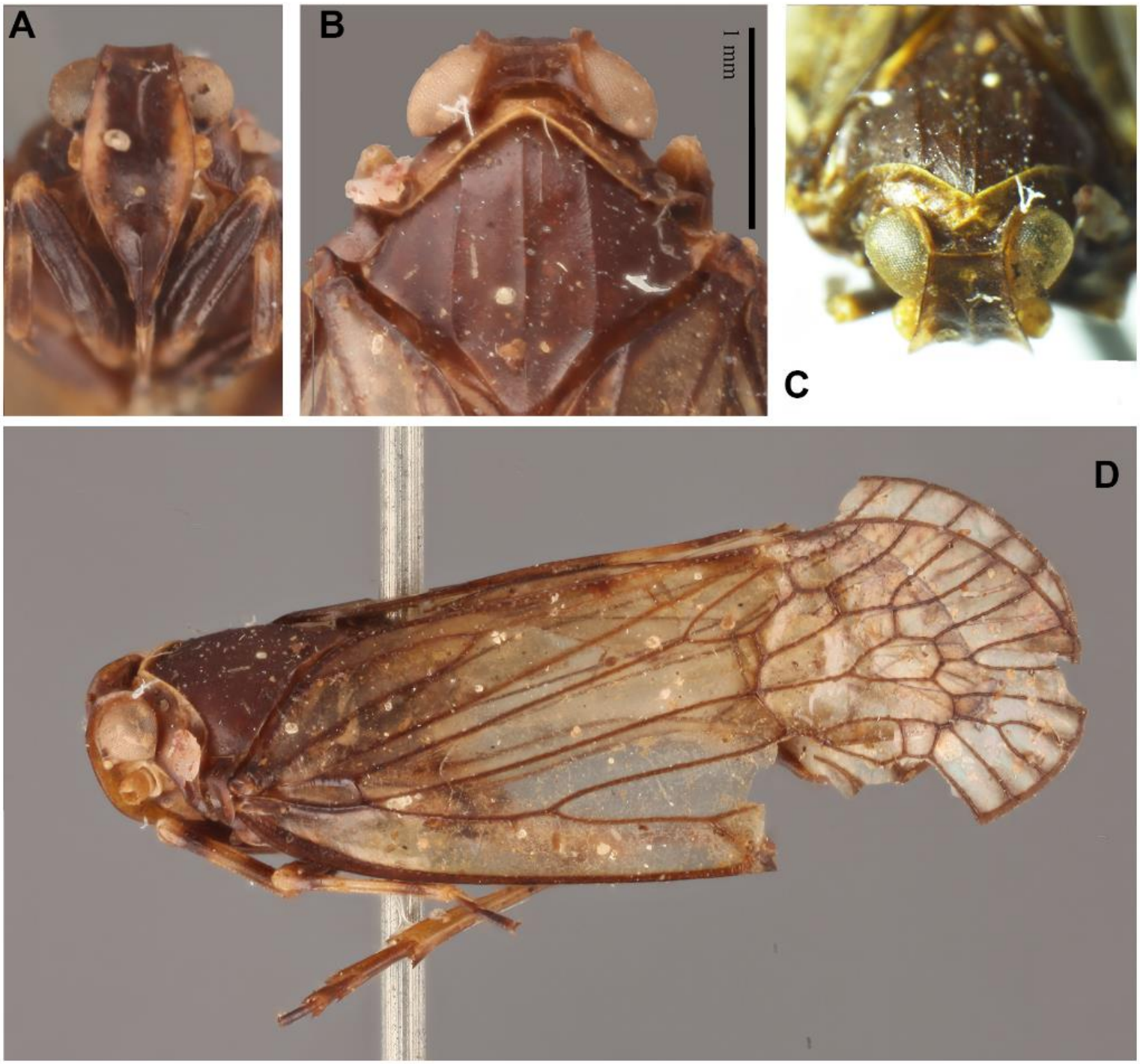

FIGURE 7. *Pintalia inortata* Stål, 1862: A-C head; D habitus.

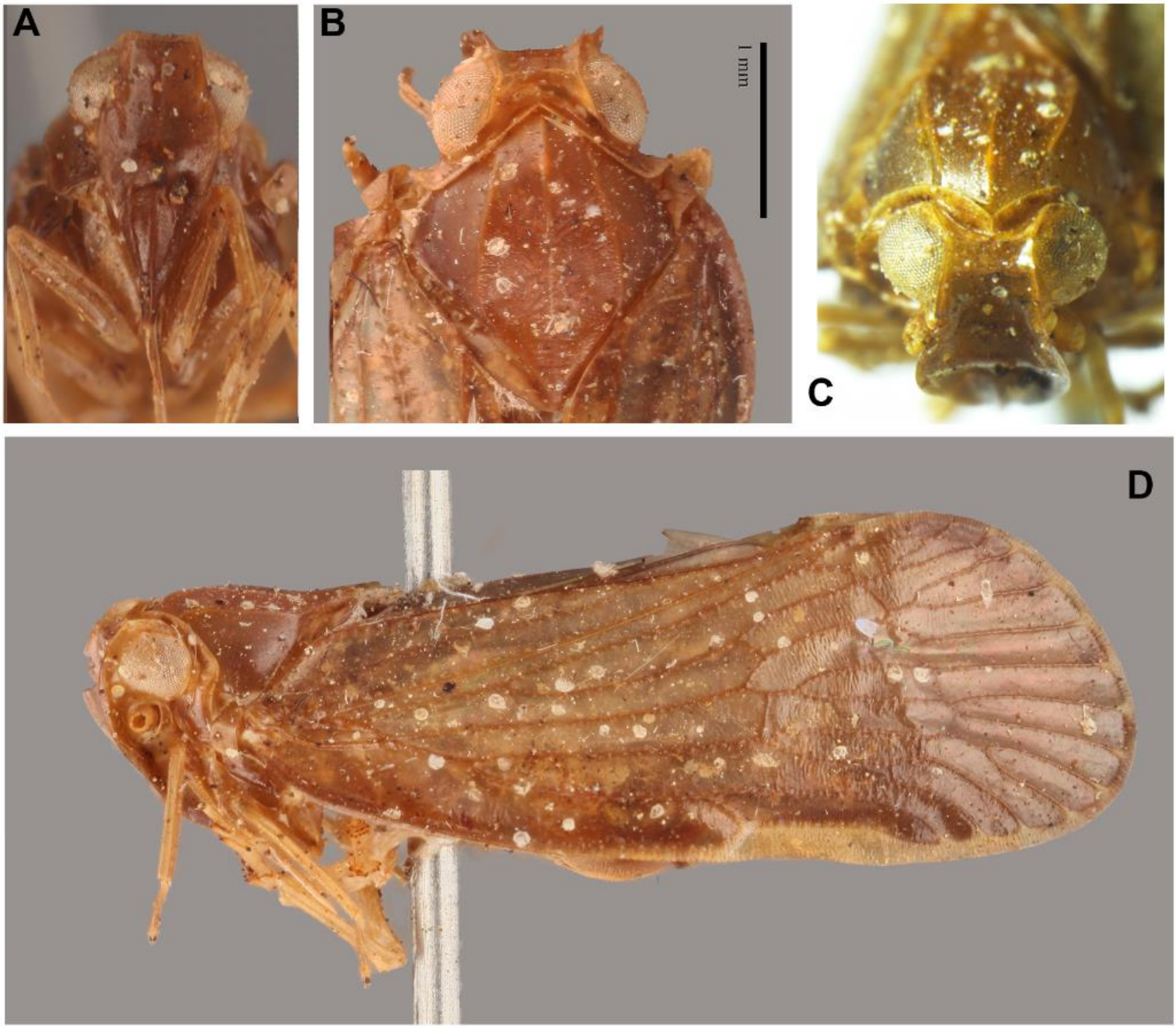

FIGURE 8. *Pintalia obscuripennis* Stål, 1862: A-C head; D habitus.

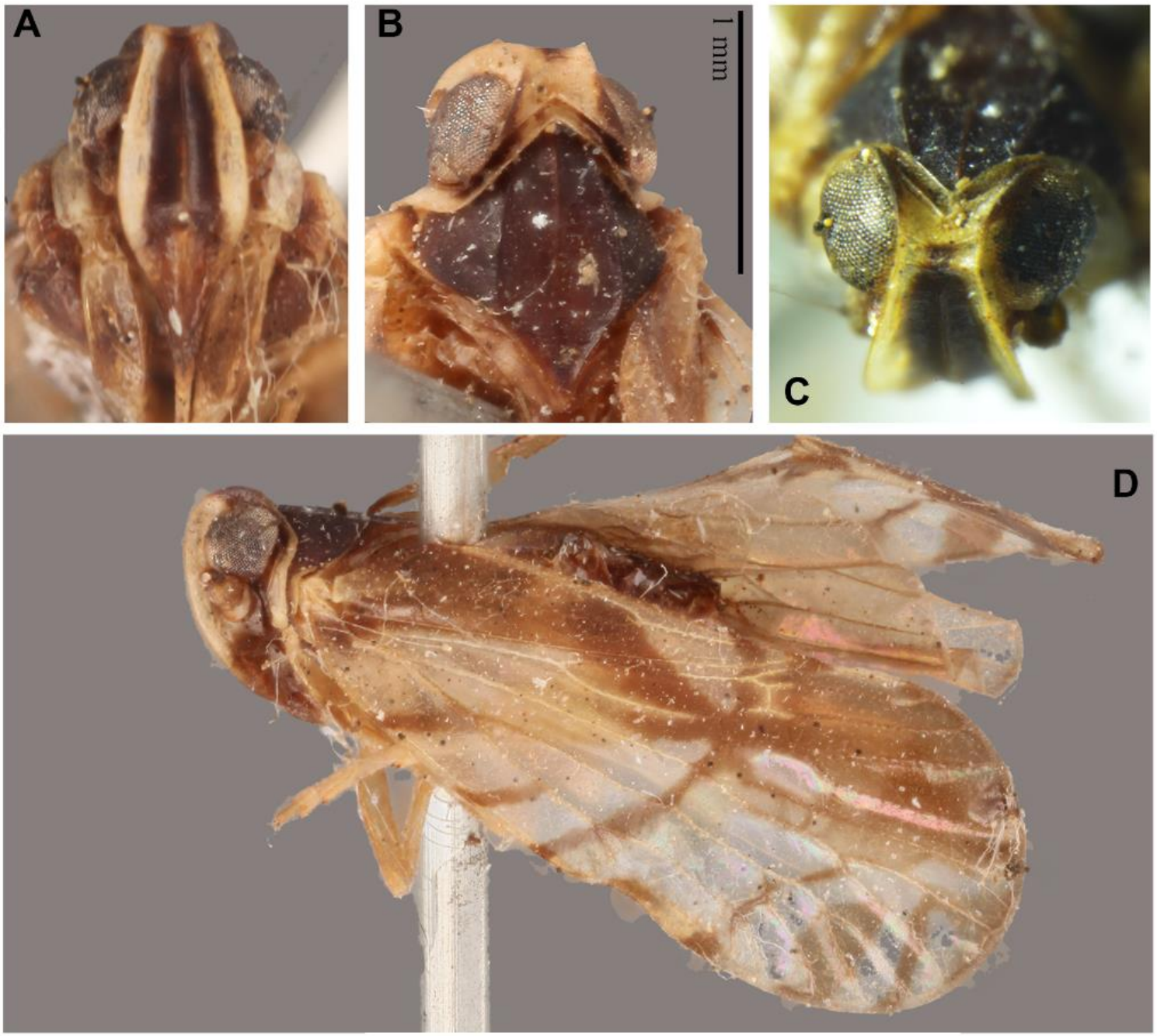

FIGURE 9. *Pintalia (p.) pictipennis* Stål, 1862: A-C head; D habitus.

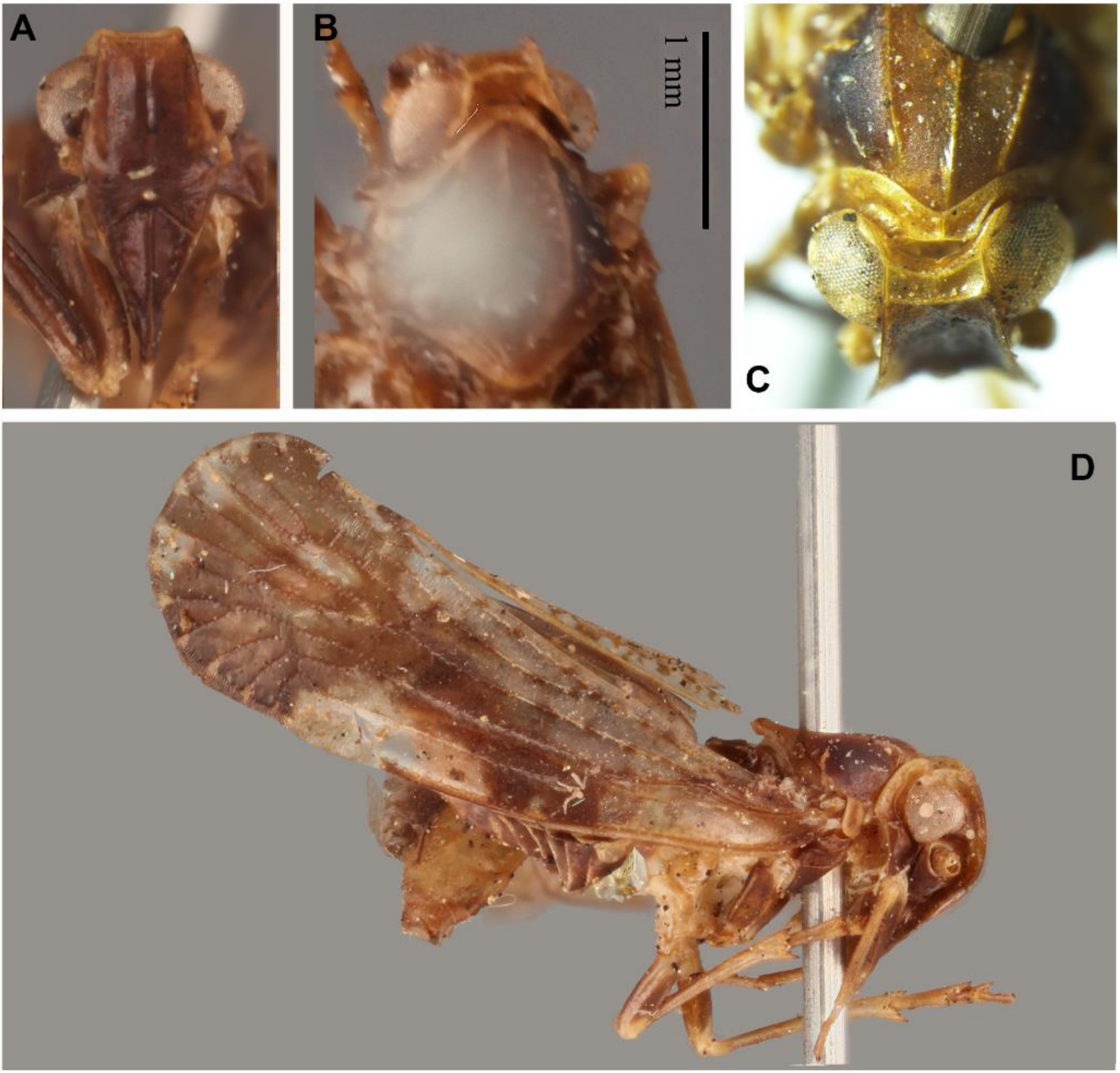

FIGURE 10. *Pintalia proxima* Stål, 1862: A-C head; D habitus.

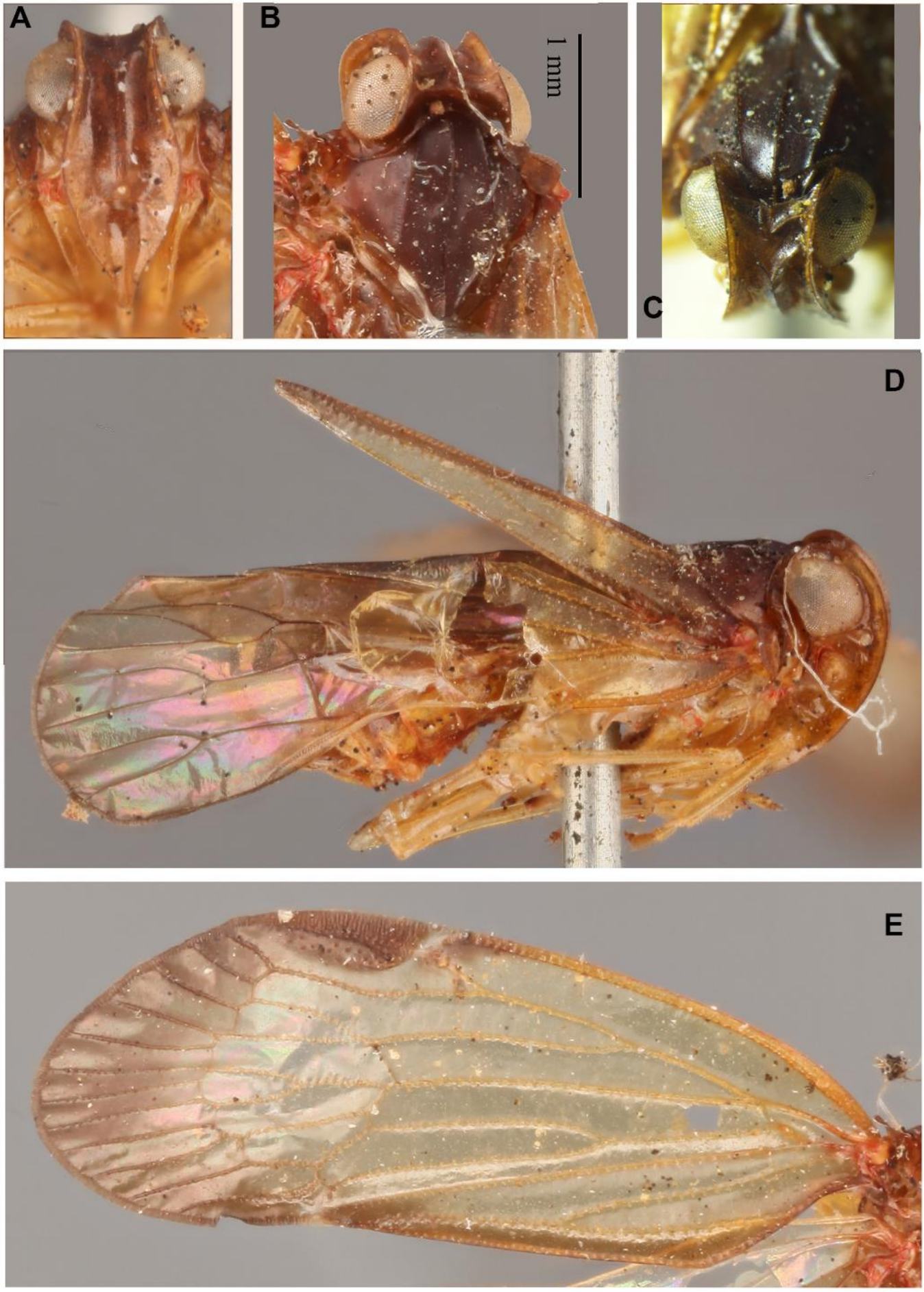

FIGURE 11. *Pintalia ustulata* Stål, 1862: A-C head; D habitus; E Tegmina (forewings).

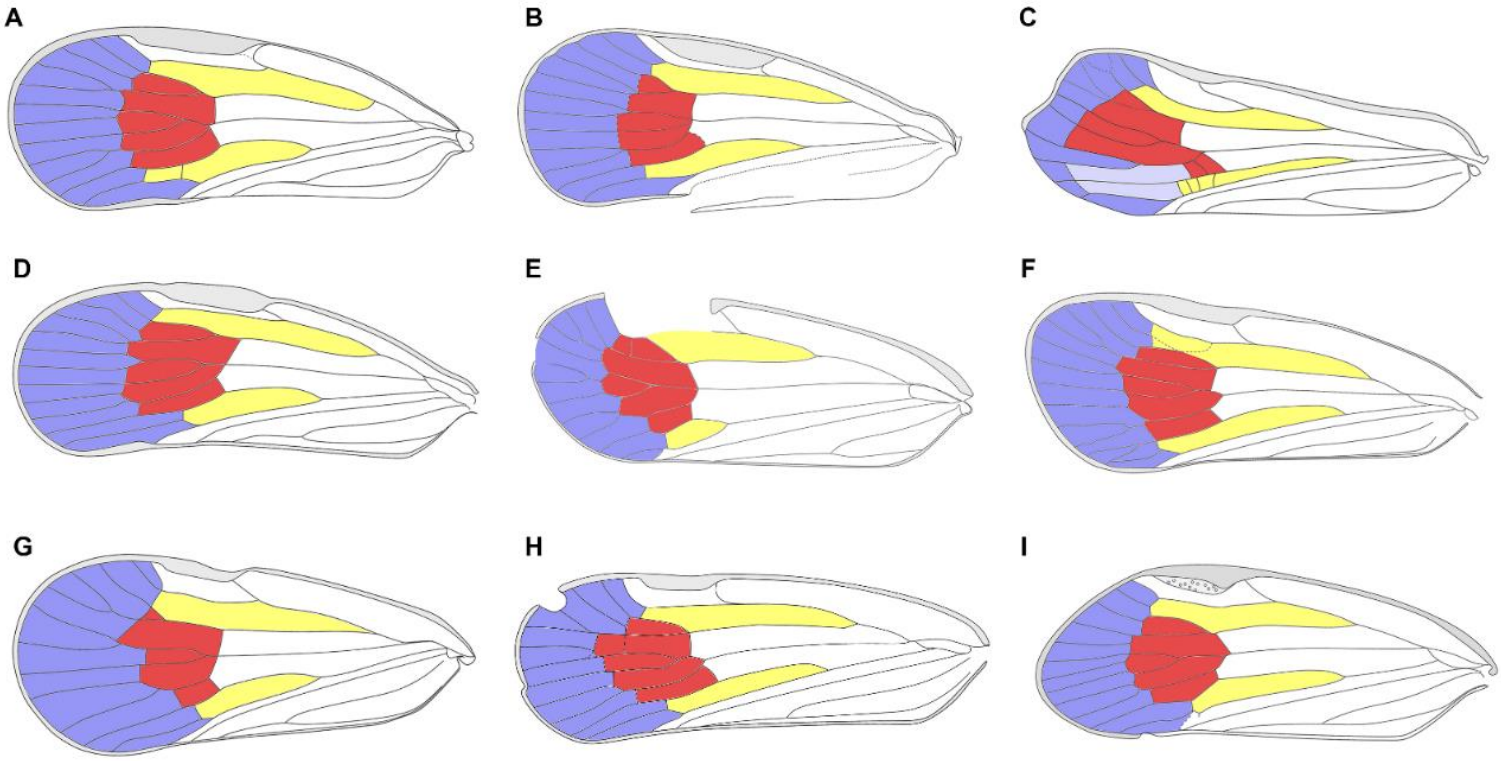

FIGURE 12. Tegmina cells patterns from the species described by Stål, 1862: A) *Pintalia lateralis*; B) *Pintalia consobrina*; C) *Pintalia fasciatipennis*; D) *Pintalia fraterna*; E) *Pintalia inortata*; F) *Pintalia obscuripennis*; G) *Pintalia pictipennis*; H) *Pintalia proxima*; I) *Pintalia ustulata*. Nodal cells (apical) (blue cells), cells difficult to identify (light blue), central prenodal cells (red cells) and lateral prenodal cells (yellow).

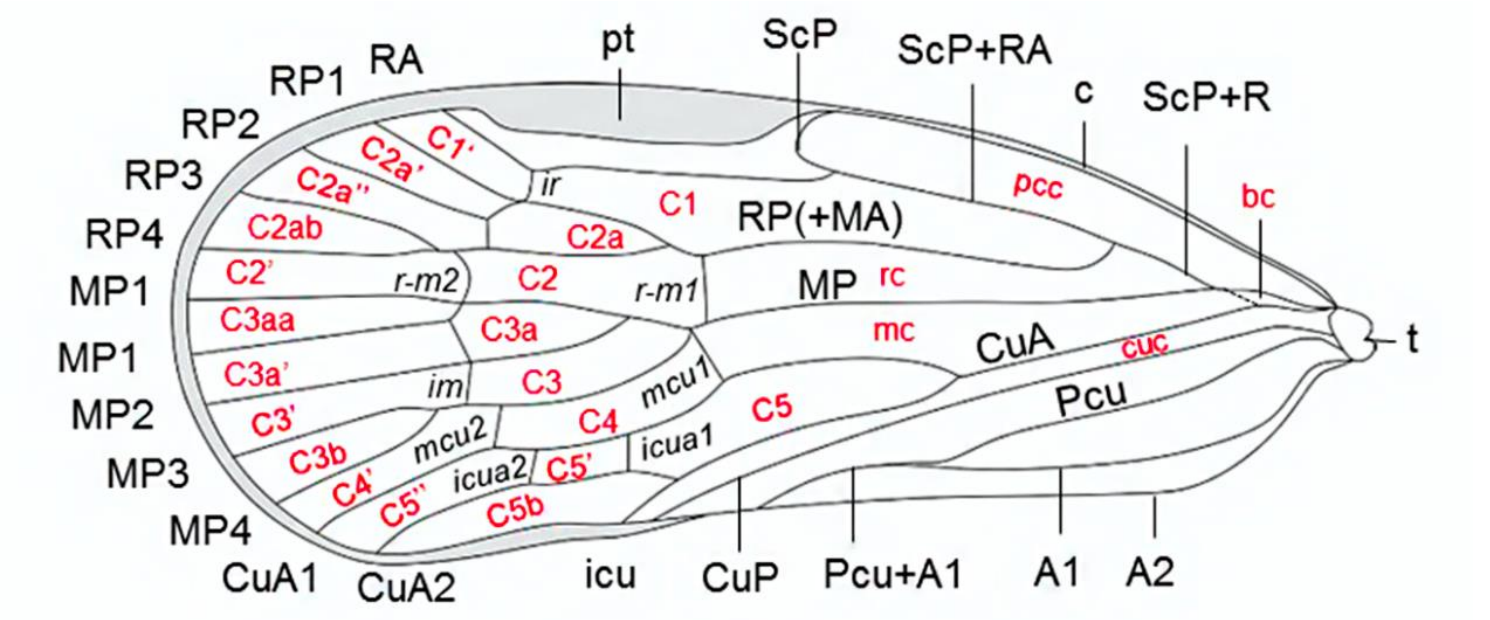

FIGURE 13. *Pintalia lateralis* Stål, 1862 tegmina (forewings): abbreviations of the cell names (red letters), longitudinal veins (black capital letters) and crossveins (in italic).

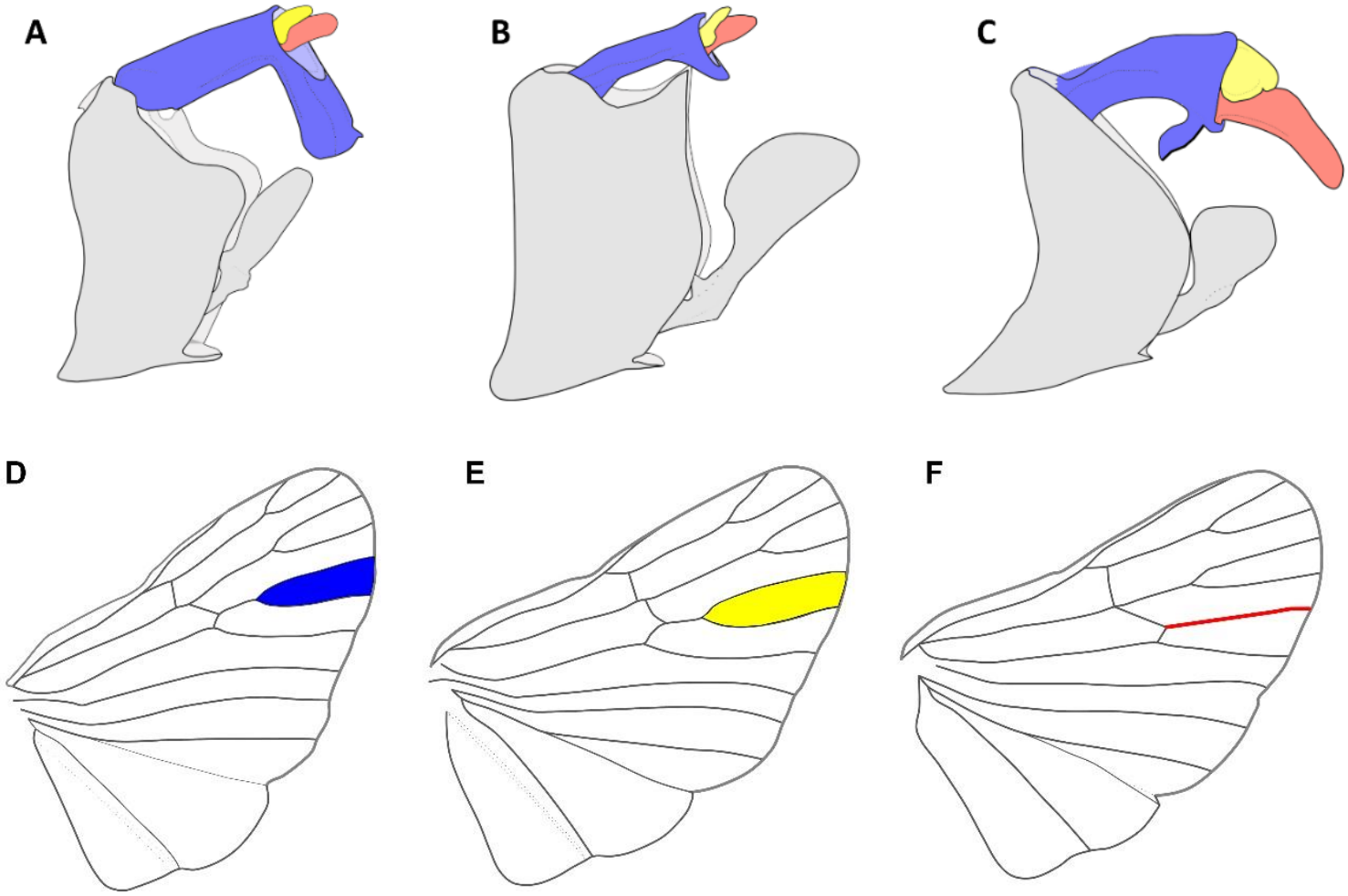

FIGURE 14. *Pintalia (Caudata)* **subgen. n** (A, D); *Pintalia (Ecuadorensis)* **subgen. n** (B, E); *Pintalia (Pictipennis)* **subgen. n** (C, F). Color figures, Genital segment (figures 14 A-C): Anal segment = Blue, Epiproct = Yellow, Paraproct = Red. Hind wing (figures 14 D-F): Petiolate anastomosis in MP3+CuA1 distally forked, *Pintalia (Caudata)* **subgen. n** = Blue, *Pintalia (Ecuadorensis)* **subgen. n** = Yellow, complete anastomosis between MP3+CuA, *Pintalia (Pictipennis)* **subgen. n** (Red).

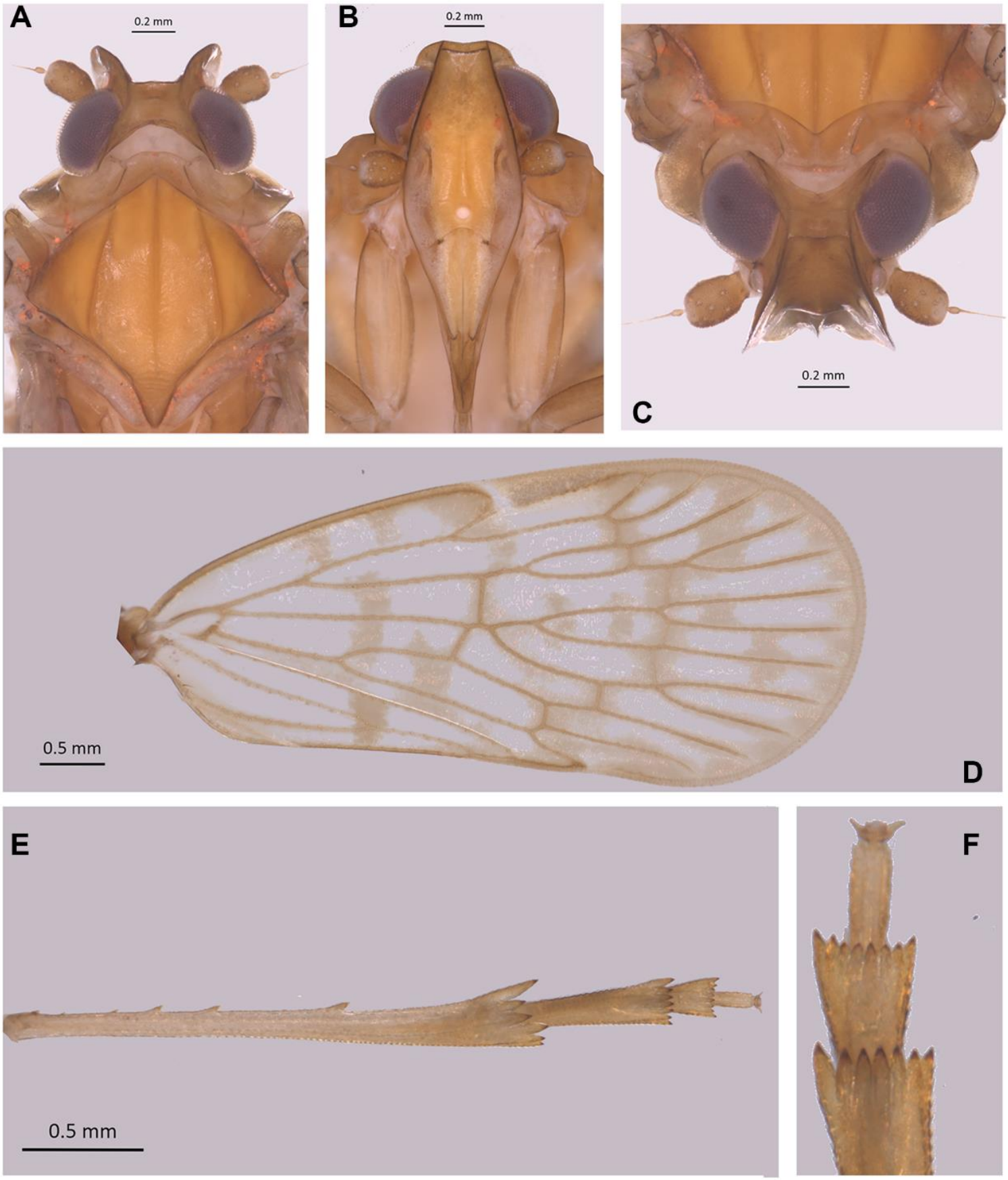

FIGURE 15. *Pintalia (P.) minuta* **sp. nov**: A-C head; D tegmina (forewings); E posterior leg; F tarsomeres.

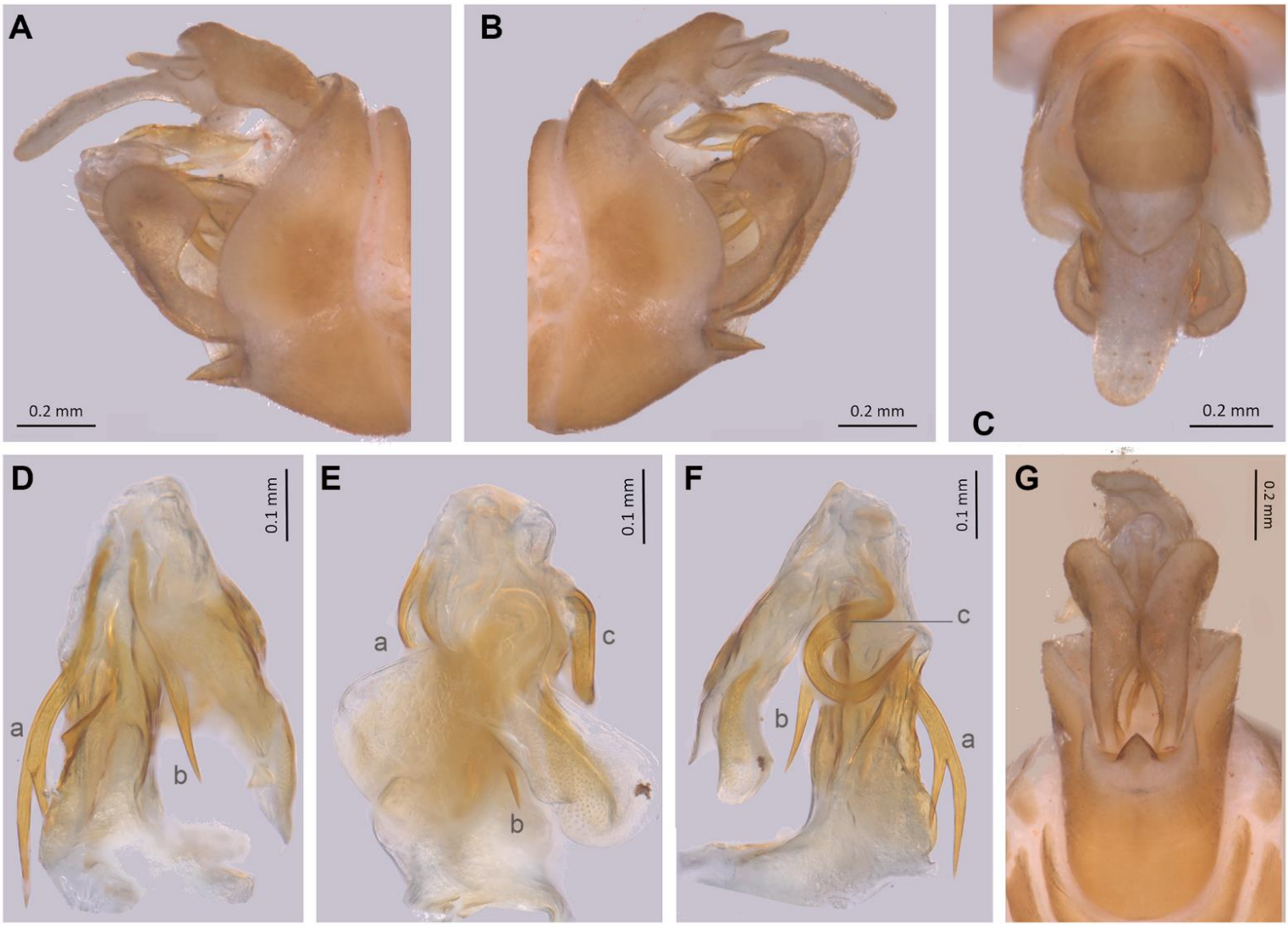

FIGURE 16. *Pintalia (P.) minuta* **sp. nov**, male genitália: A genital capsule right lateral; B genital capsule left lateral; C genital capsule dorsally; D aedeagus right lateral; E aedeagus frontally; F aedeagus left lateral; G genital capsule ventrally.

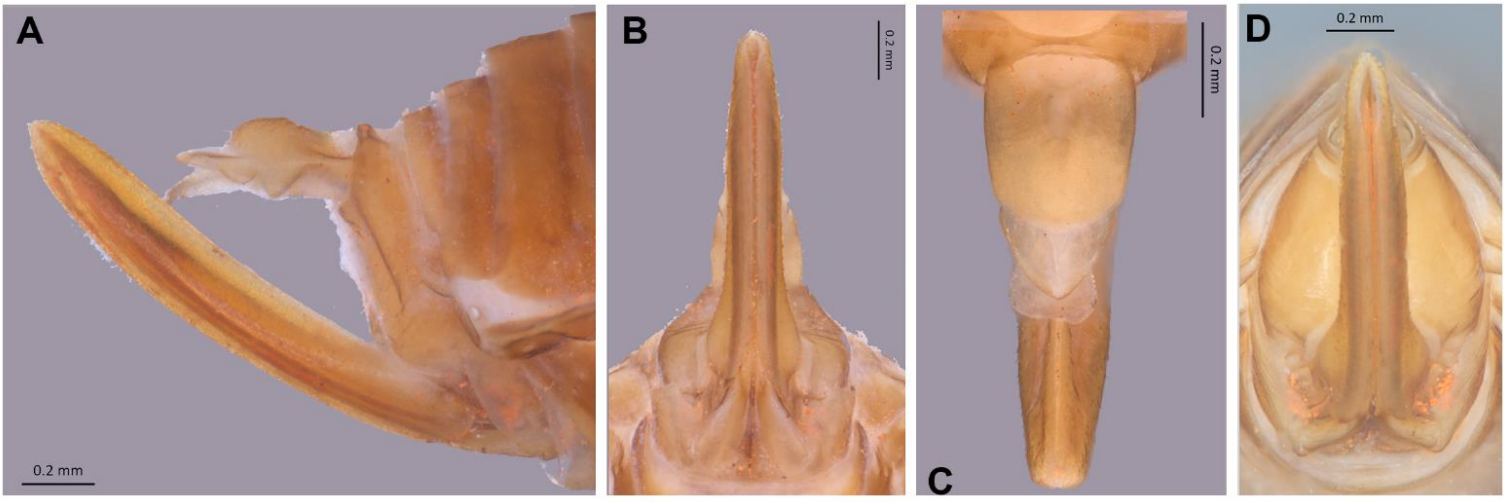

FIGURE 17. *Pintalia (P.) minuta* **sp. nov**, female genitália: A right lateral; B ventral view; C dorsal view; D caudal view.

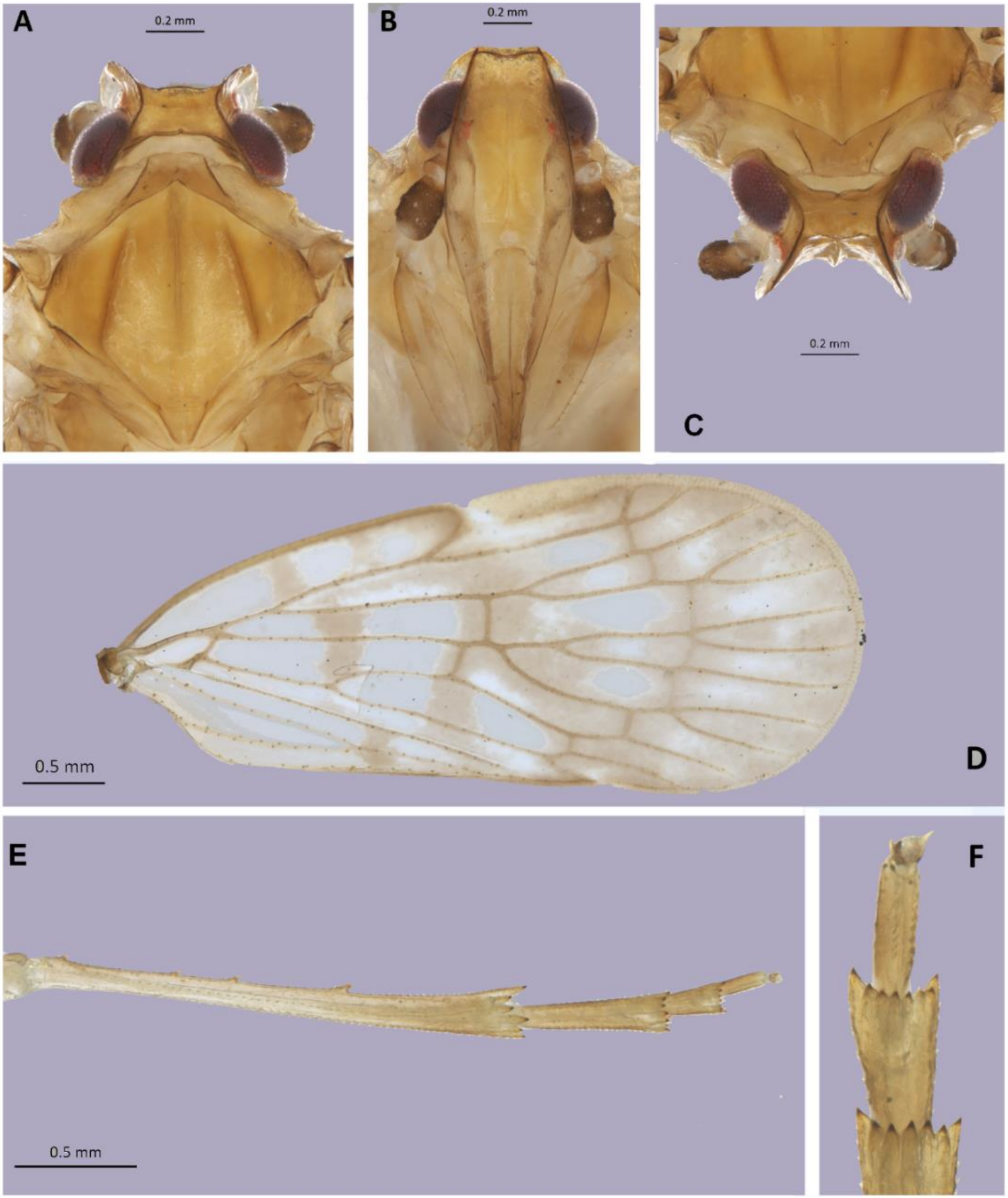

FIGURE 28. *Pintalia (P.) minima* **sp. nov**: A-C head; D tegmina (forewings); E posterior leg; F tarsomeres.

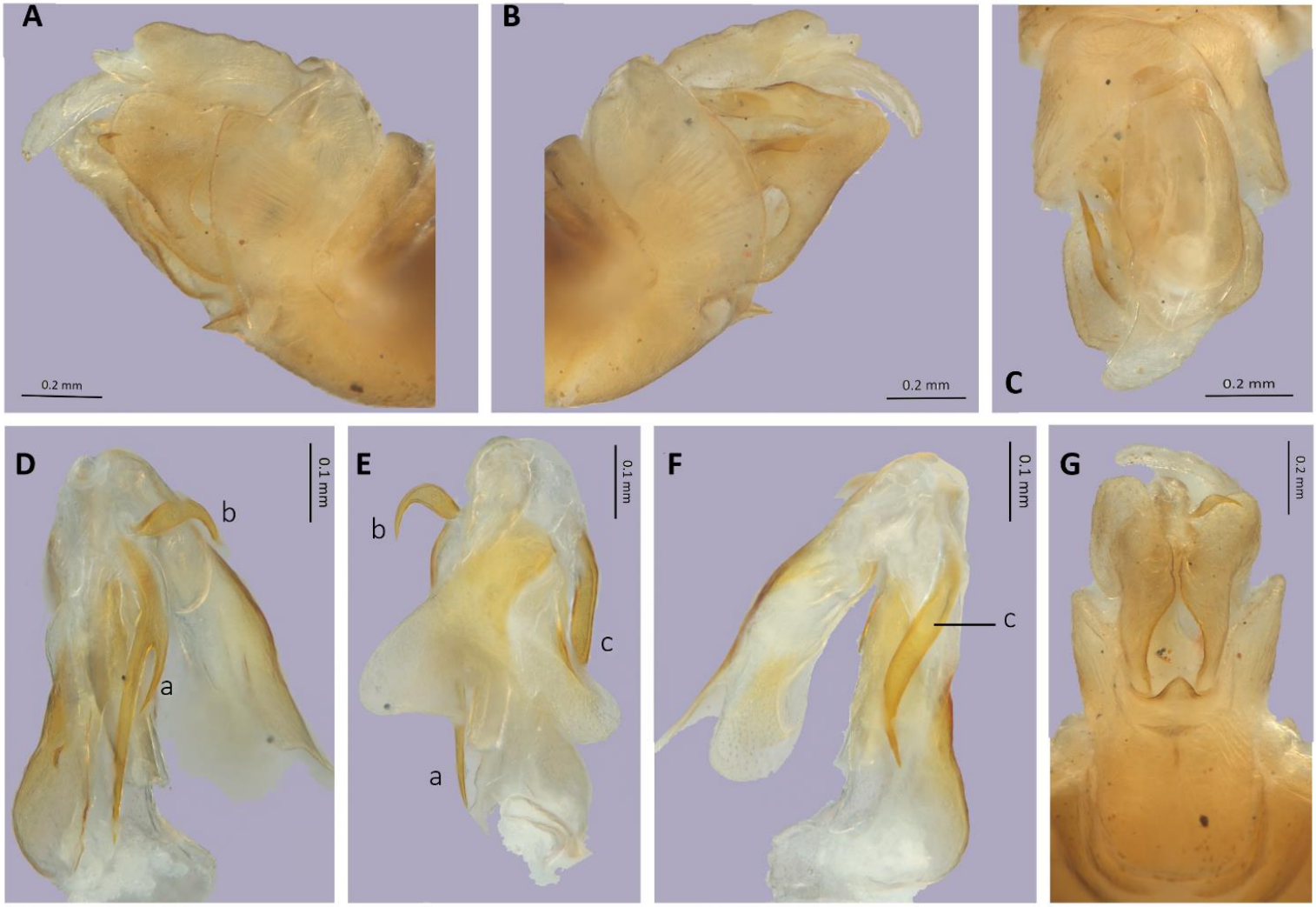

FIGURE 19. *Pintalia (P.) minima* **sp. nov**, male genitália: A genital capsule right lateral; B genital capsule left lateral; C genital capsule dorsally; D aedeagus right lateral; E aedeagus frontally; F aedeagus left lateral; G genital capsule ventrally.

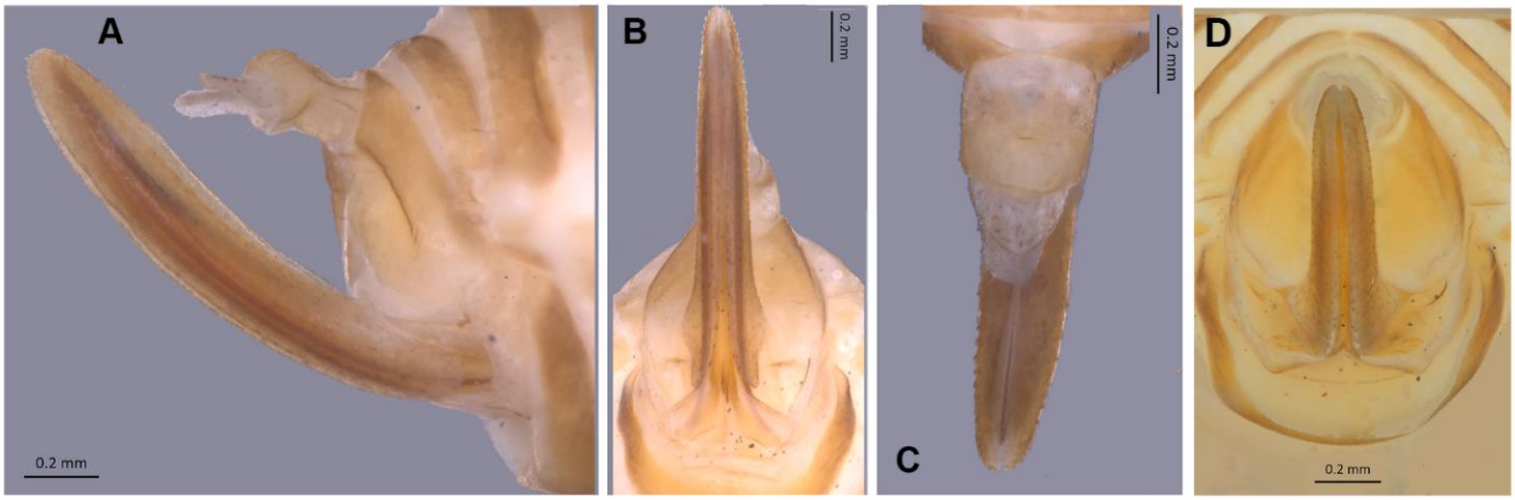

FIGURE 20. *Pintalia (P.) minima* **sp. nov**, female genitalia: A right lateral; B ventral view; C dorsal view; D caudal view.

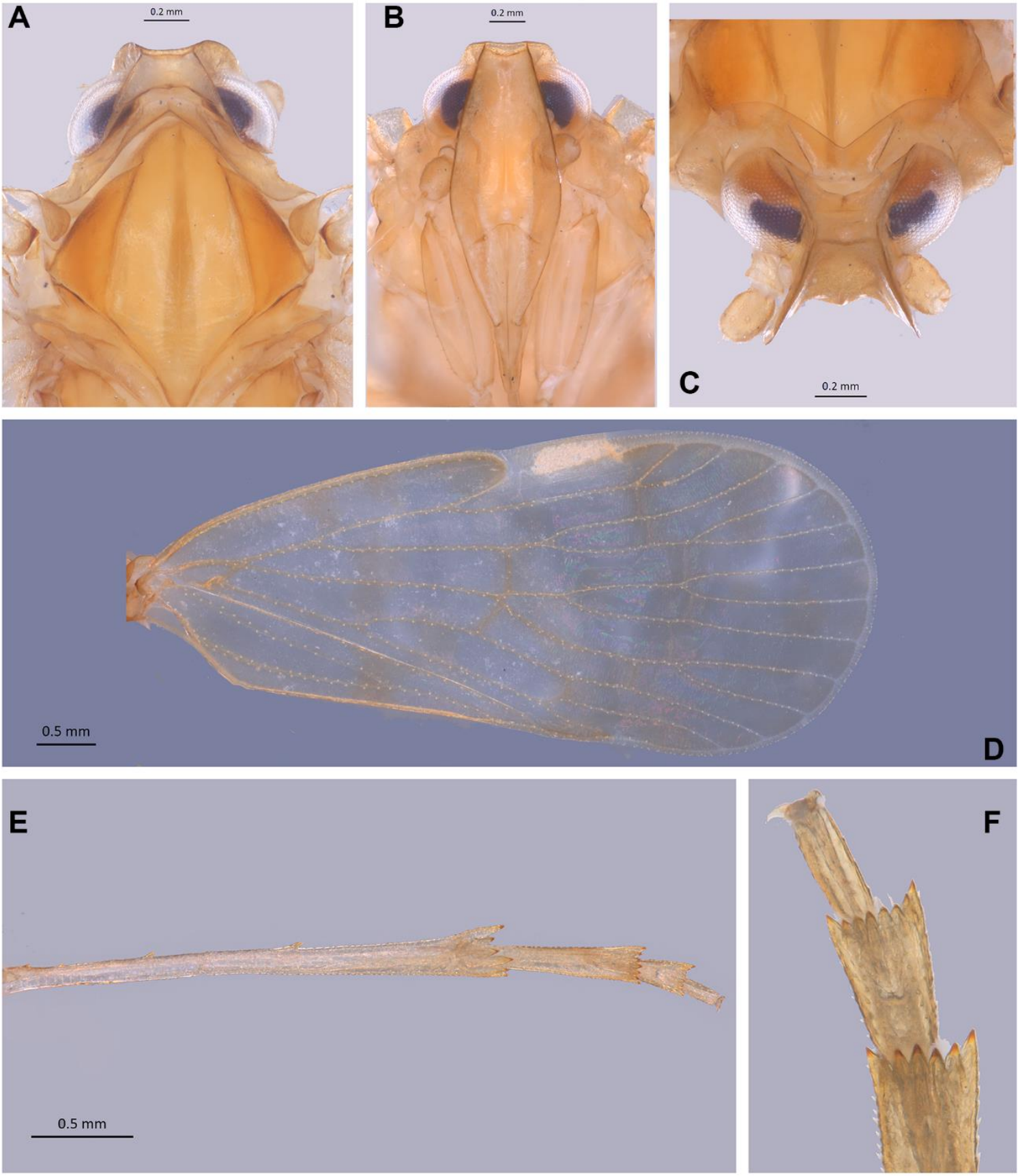

FIGURE 21. *Pintalia (P.) magnaepiprocti* **sp. nov**: A-C head; D tegmina (forewings); E posterior leg; F tarsomeres.

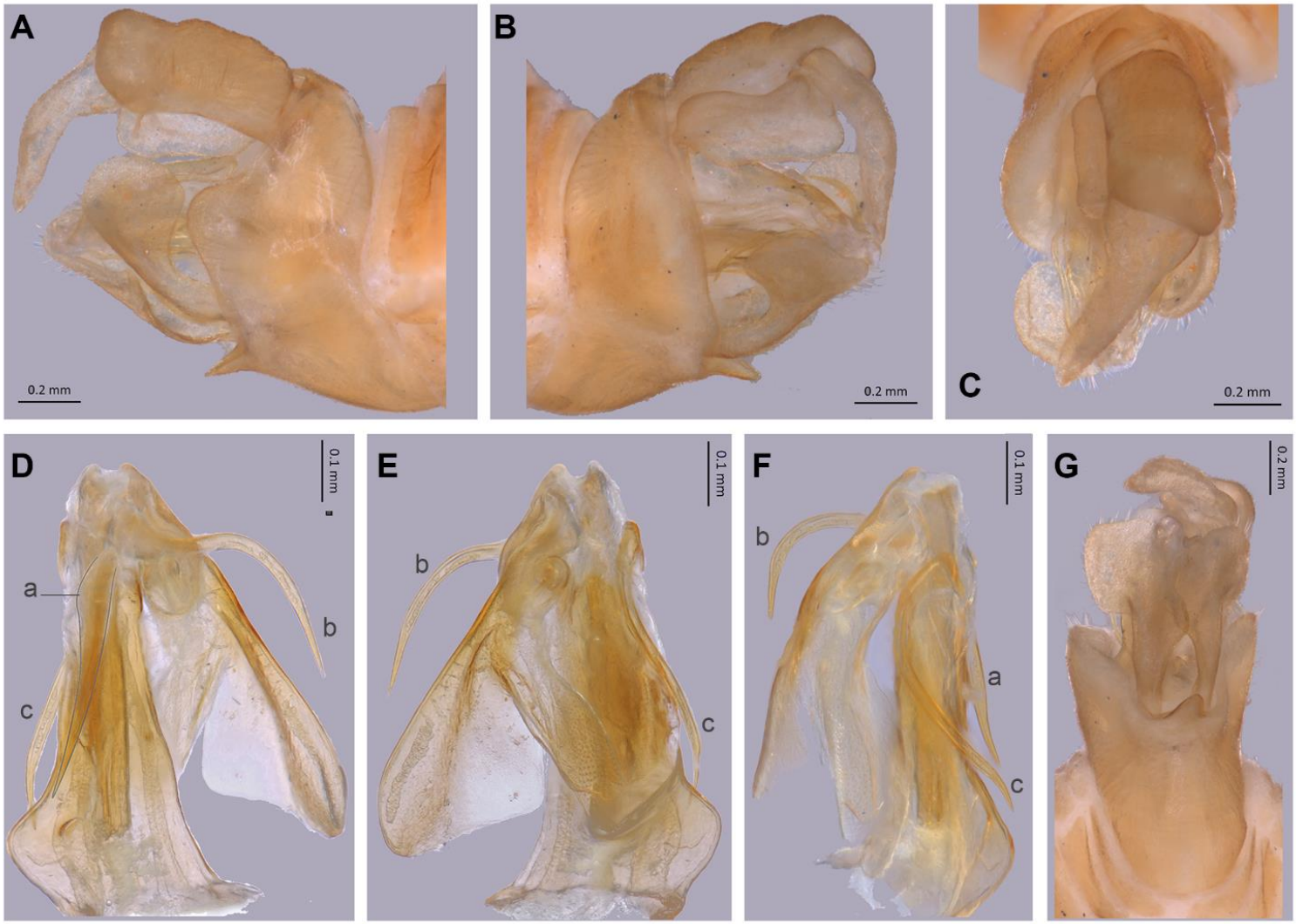

FIGURE 22. *Pintalia (P.) magnaepiprocti* **sp. nov**, male genitalia: A genital capsule right lateral; B genital capsule left lateral; C genital capsule dorsally; D aedeagus right lateral; E aedeagus frontal; F aedeagus left lateral; G genital capsule ventrally.

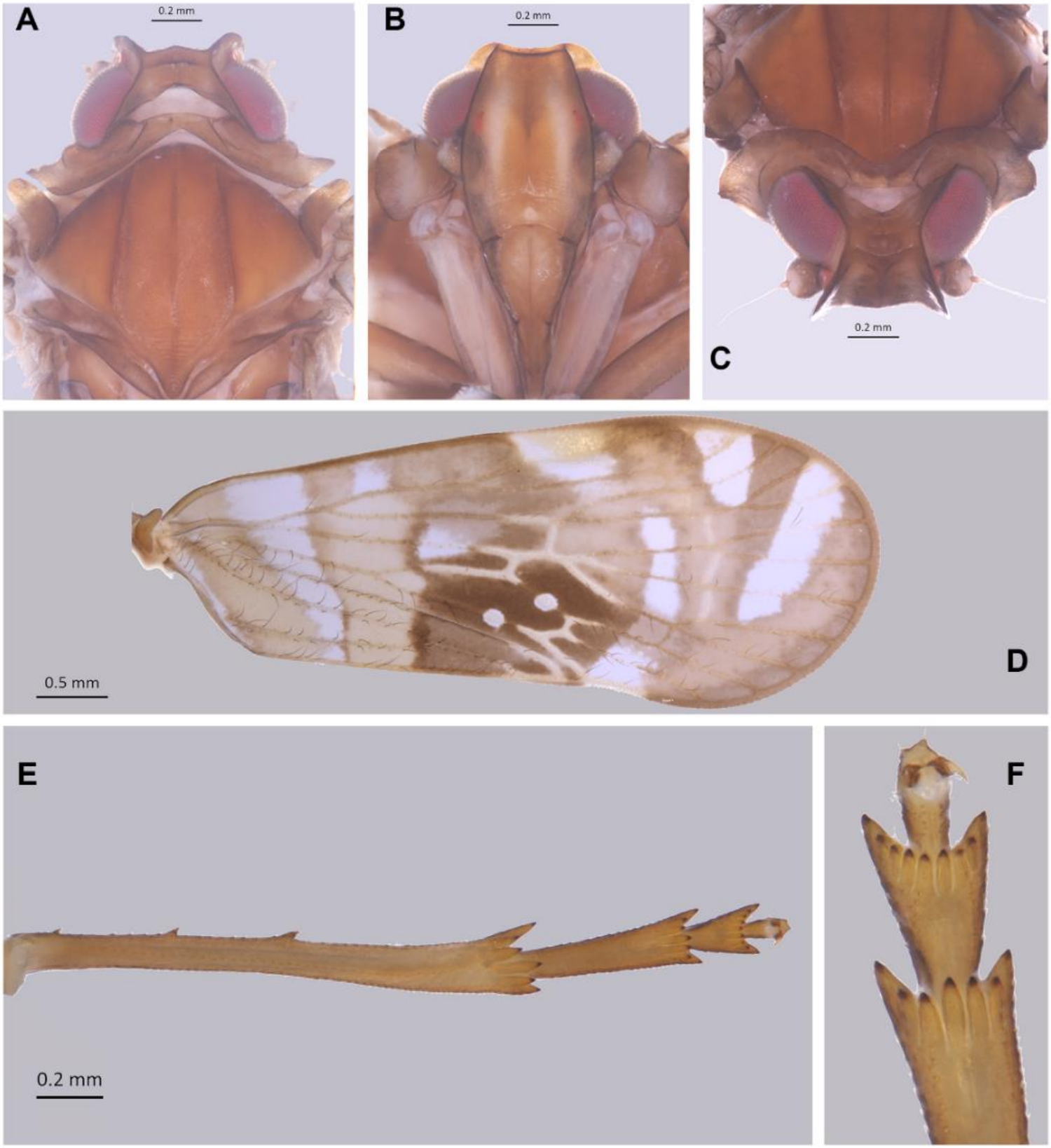

FIGURE 23. *Pintalia (P.) serratilis* **sp. nov**: A-C head; D tegmina (forewings); E posterior leg; F tarsomeres.

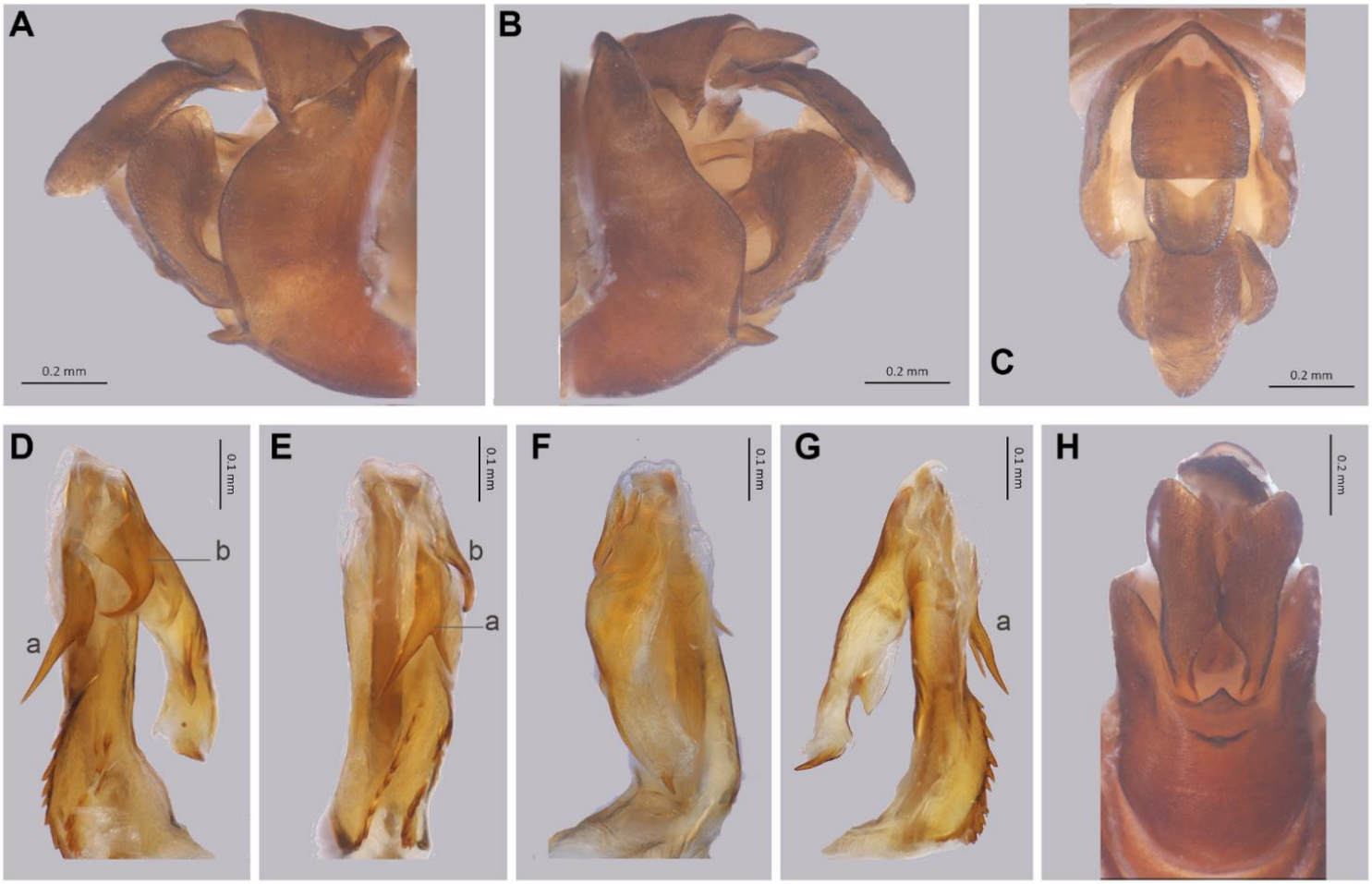

FIGURE 24. *Pintalia (P.) serratilis* **sp. nov**, male genitalia: A genital capsule right lateral; B genital capsule left lateral; C genital capsule dorsally; D aedeagus right lateral; E aedeagus dorsally; F aedeagus frontally; G aedeagus left lateral; H genital capsule ventrally.

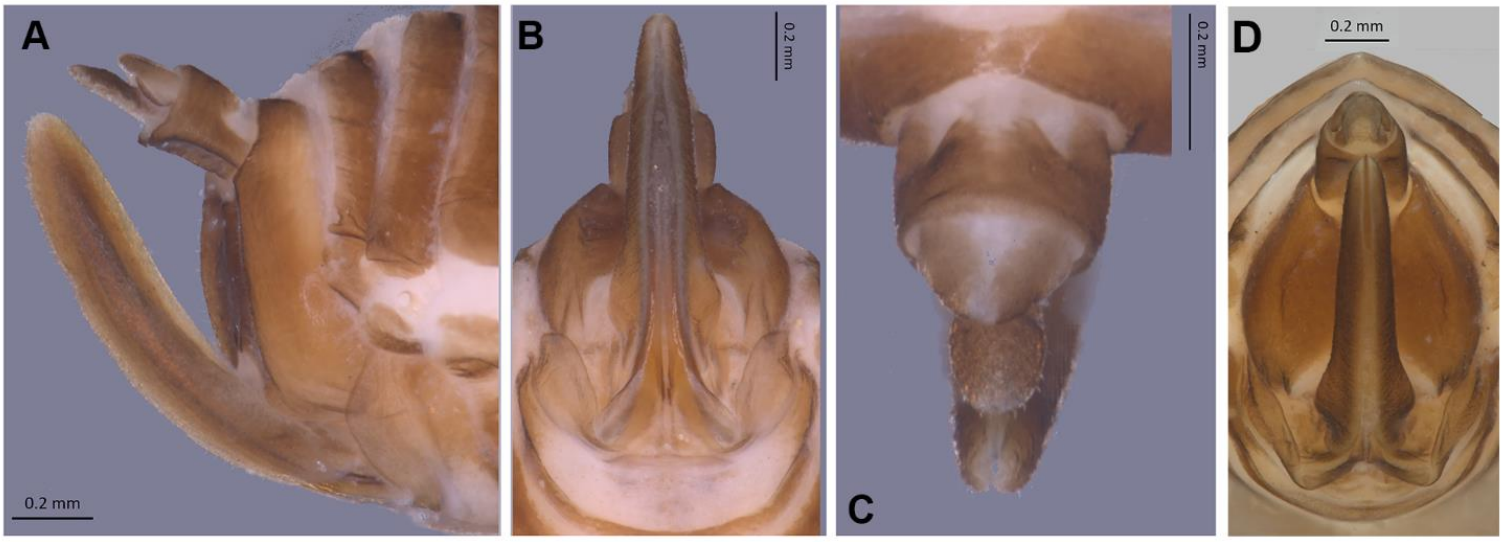

FIGURE 25. *Pintalia (P.) serratili***s sp. nov**, female genitalia: A right lateral; B ventral view; C dorsal view; D caudal view.

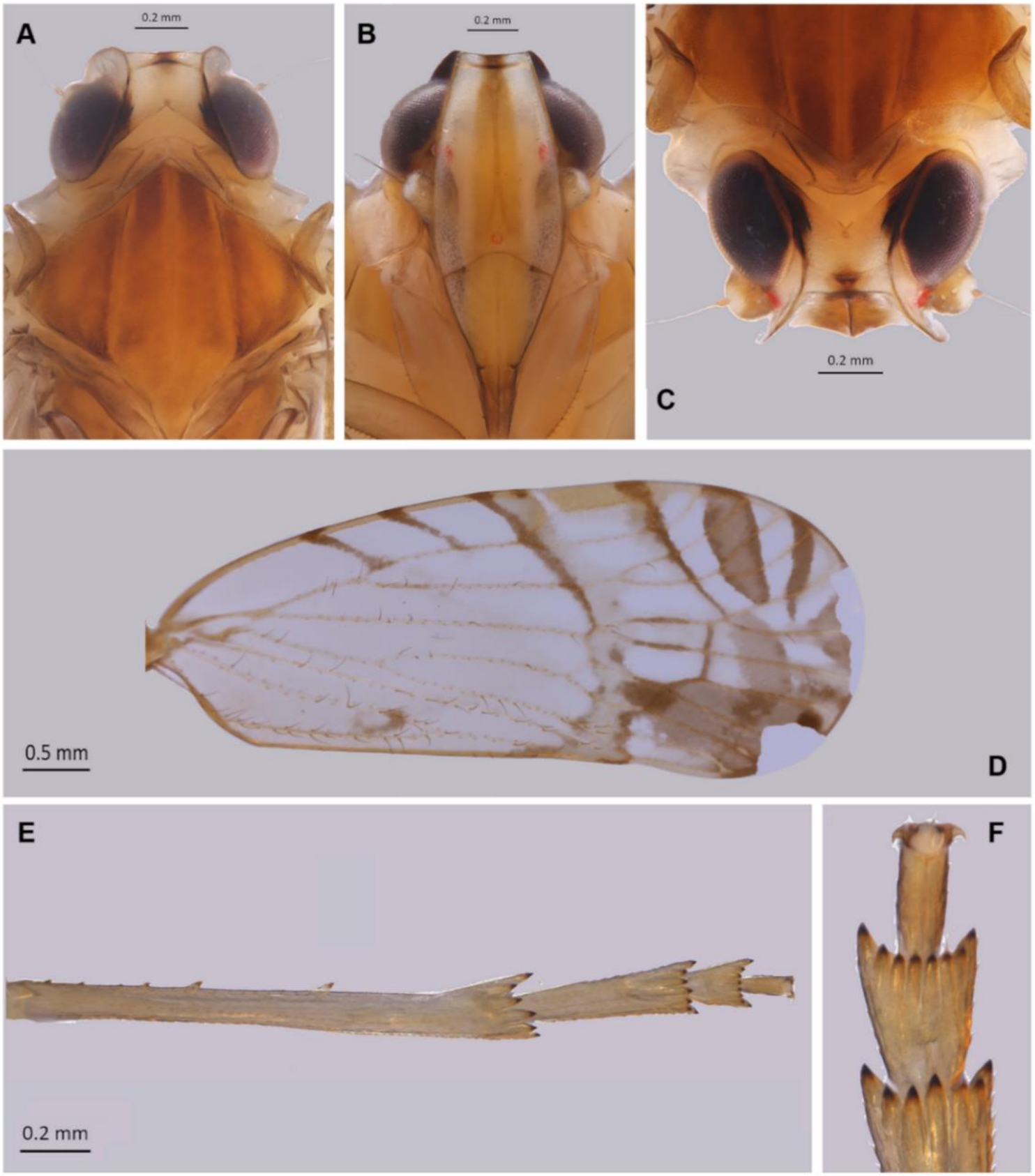

FIGURE 26. *Pintalia (P.) stali* **sp. nov**: A-C head; D tegmina (forewings); E posterior leg; F tarsomeres.

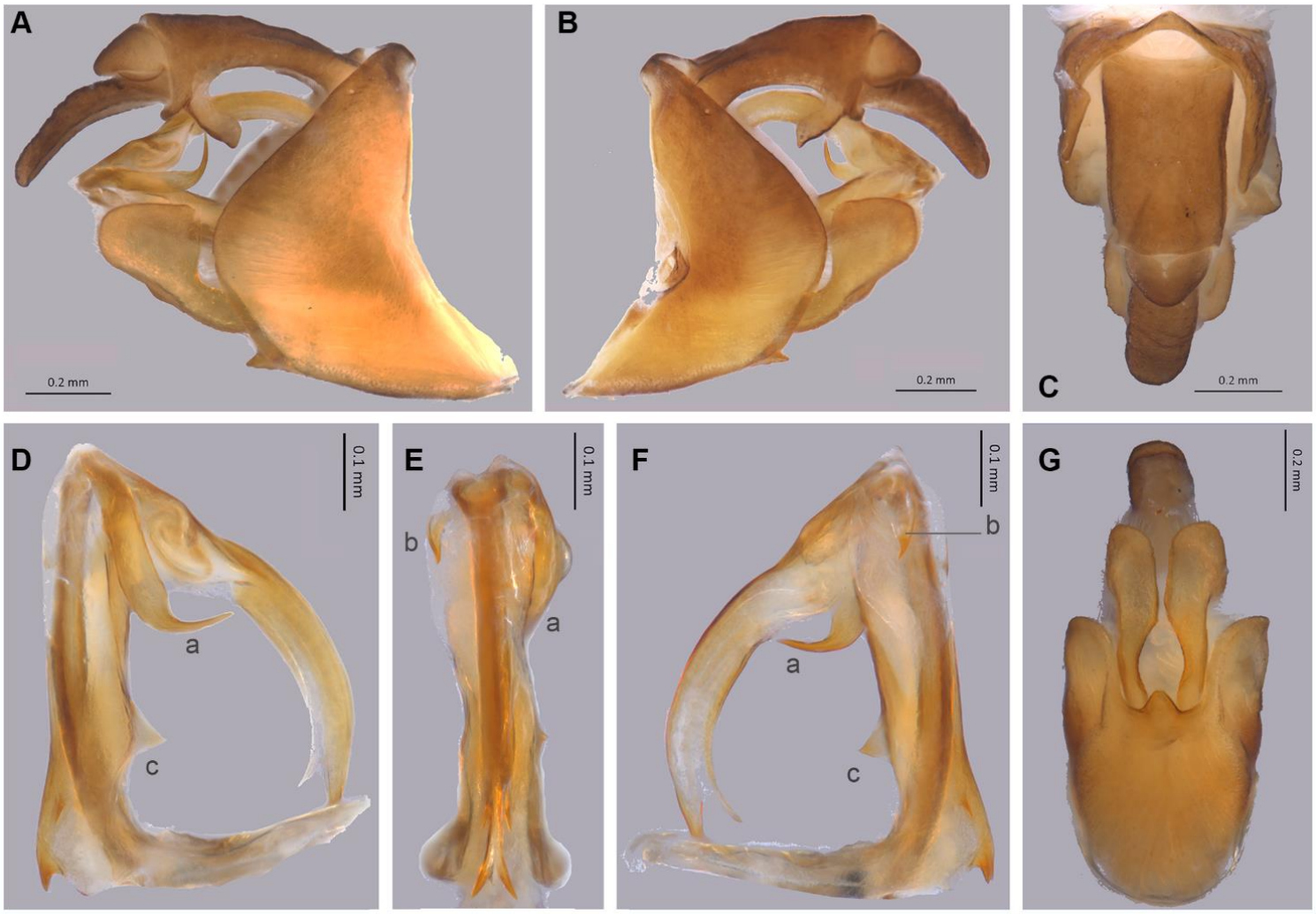

FIGURE 27. *Pintalia (P.) stali* **sp. nov**, male genitália: A genital capsule right lateral; B genital capsule left lateral; C genital capsule dorsally; D aedeagus right lateral; E aedeagus dorsally; F aedeagus left lateral; G genital capsule ventrally.

FIGURE 28. *Pintalia (P.) stali* **sp. nov**, female genitalia: A right lateral; B ventral view; C dorsal view; D caudal view.

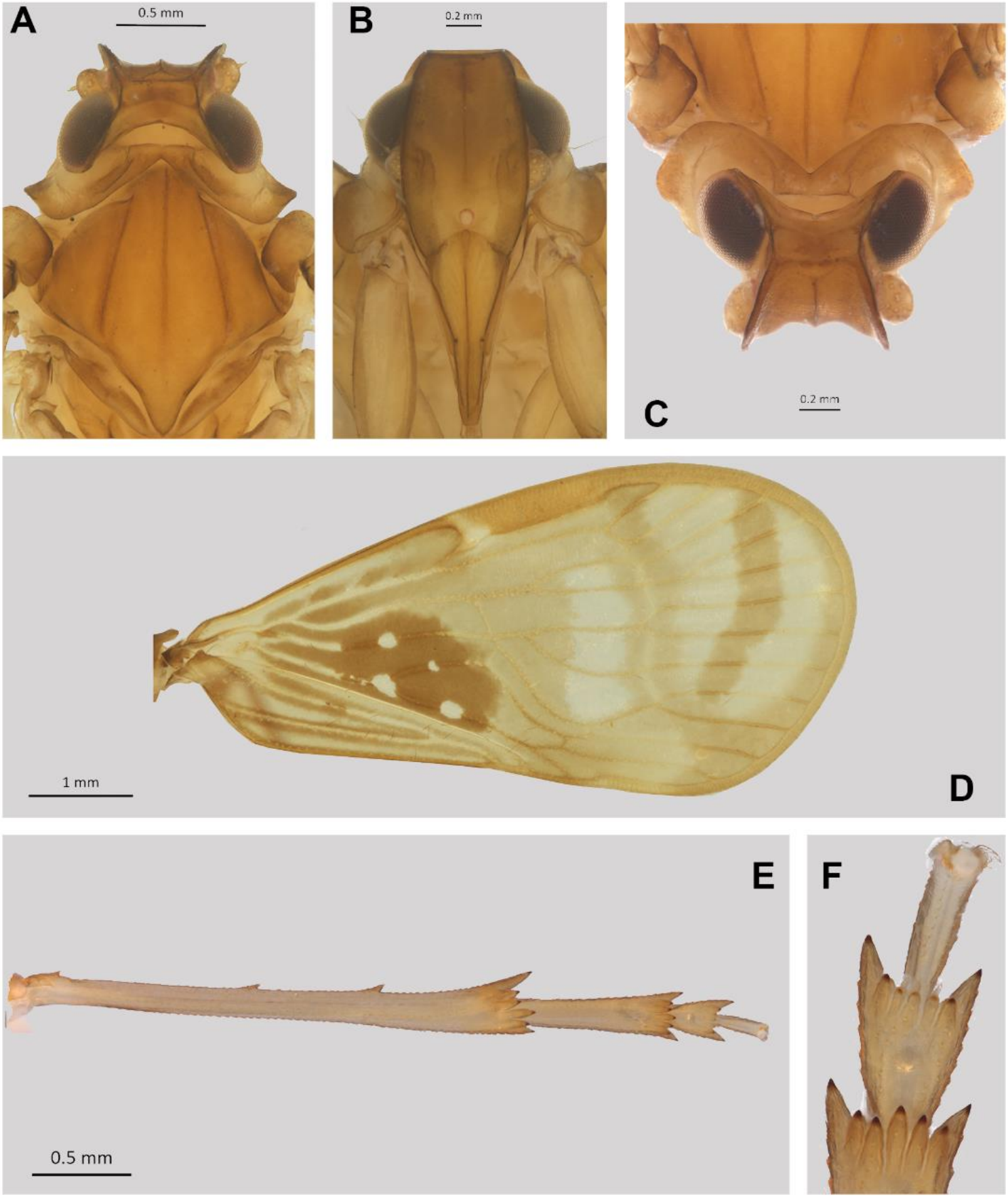

FIGURE 29. *Pintalia (E.) speciosa* **sp. nov**: A-C head; D tegmina (forewings); E posterior leg; F tarsomeres.

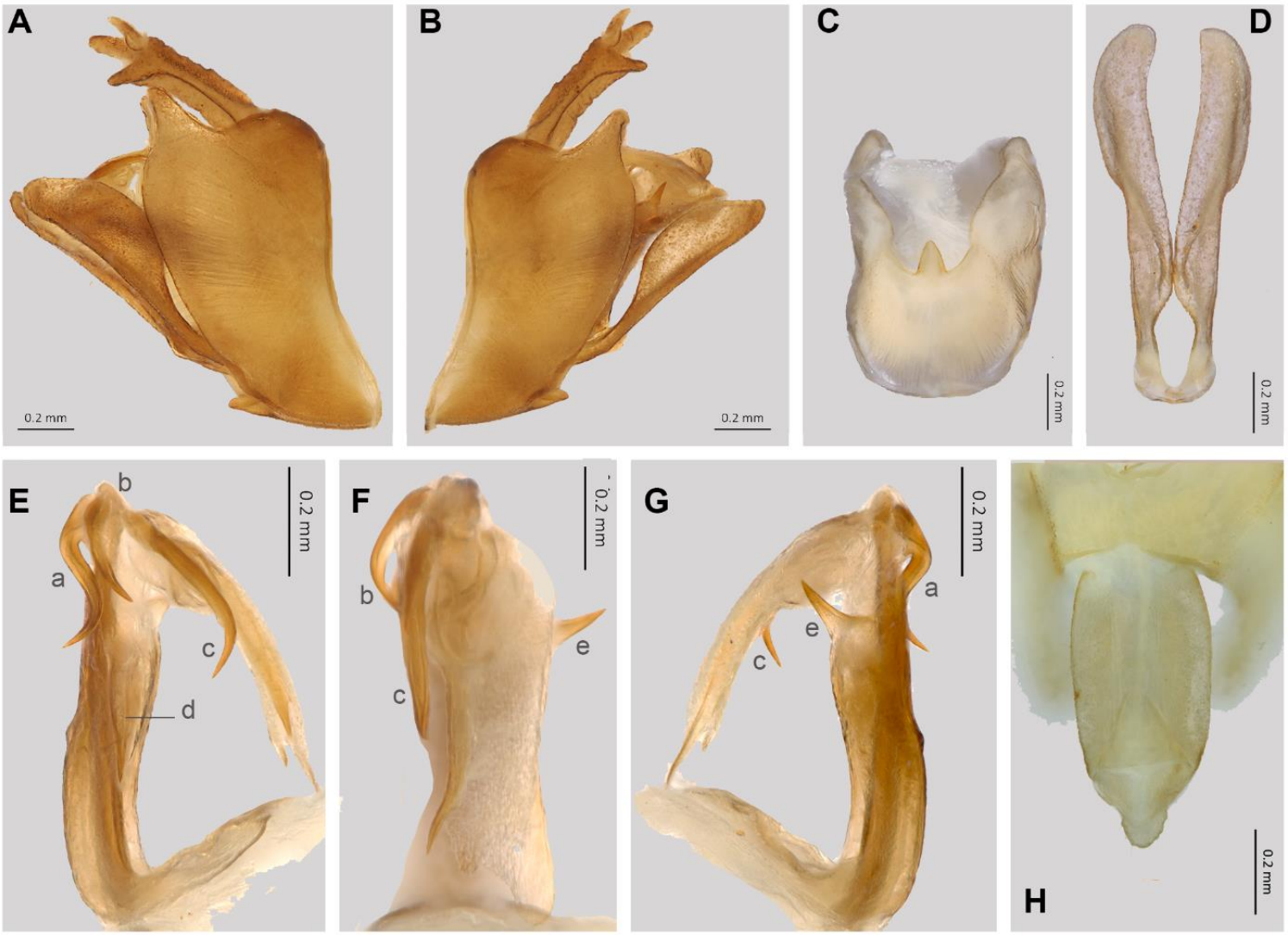

FIGURE 30. *Pintalia (E.) speciosa* **sp. nov**, male genitalia: A genital capsule right lateral; B genital capsule left lateral; C pygofer dorsally; D genital styles ventrally; E aedeagus right lateral; F aedeagus frontally; G aedeagus left lateral; H anal segment dorsally.

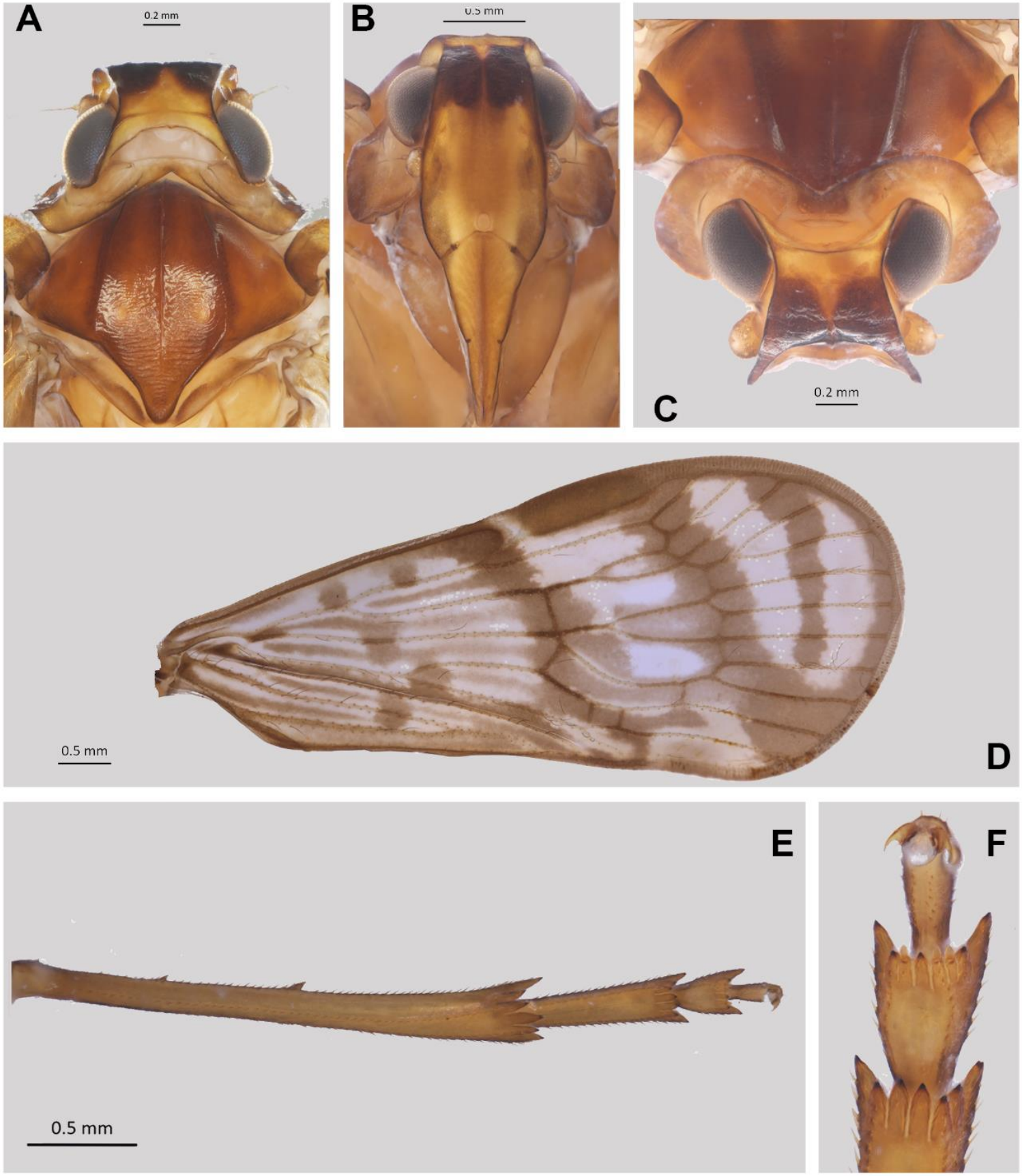

FIGURE 31. *Pintalia (E.) fennahi* **sp. nov**: A-C head; D tegmina (forewings); E posterior leg; F tarsomeres.

FIGURE 32. *Pintalia (E.) fennahi* **sp. nov**, male genitalia: A genital capsule right lateral; B genital capsule left lateral; C genital capsule dorsally; D aedeagus right lateral; E aedeagus dorsally; F aedeagus left lateral; G genital capsule ventrally.

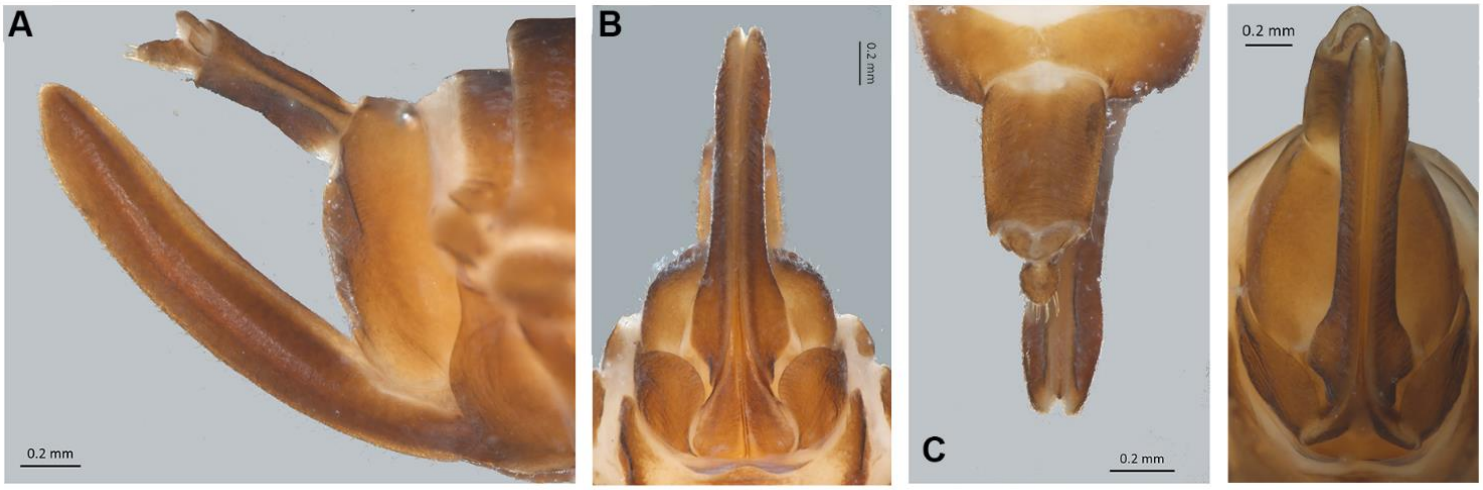

FIGURE 33. *Pintalia (E.) fennahi* **sp. nov**, female genitalia: A right lateral; B ventral view; C dorsal view; D caudal view.

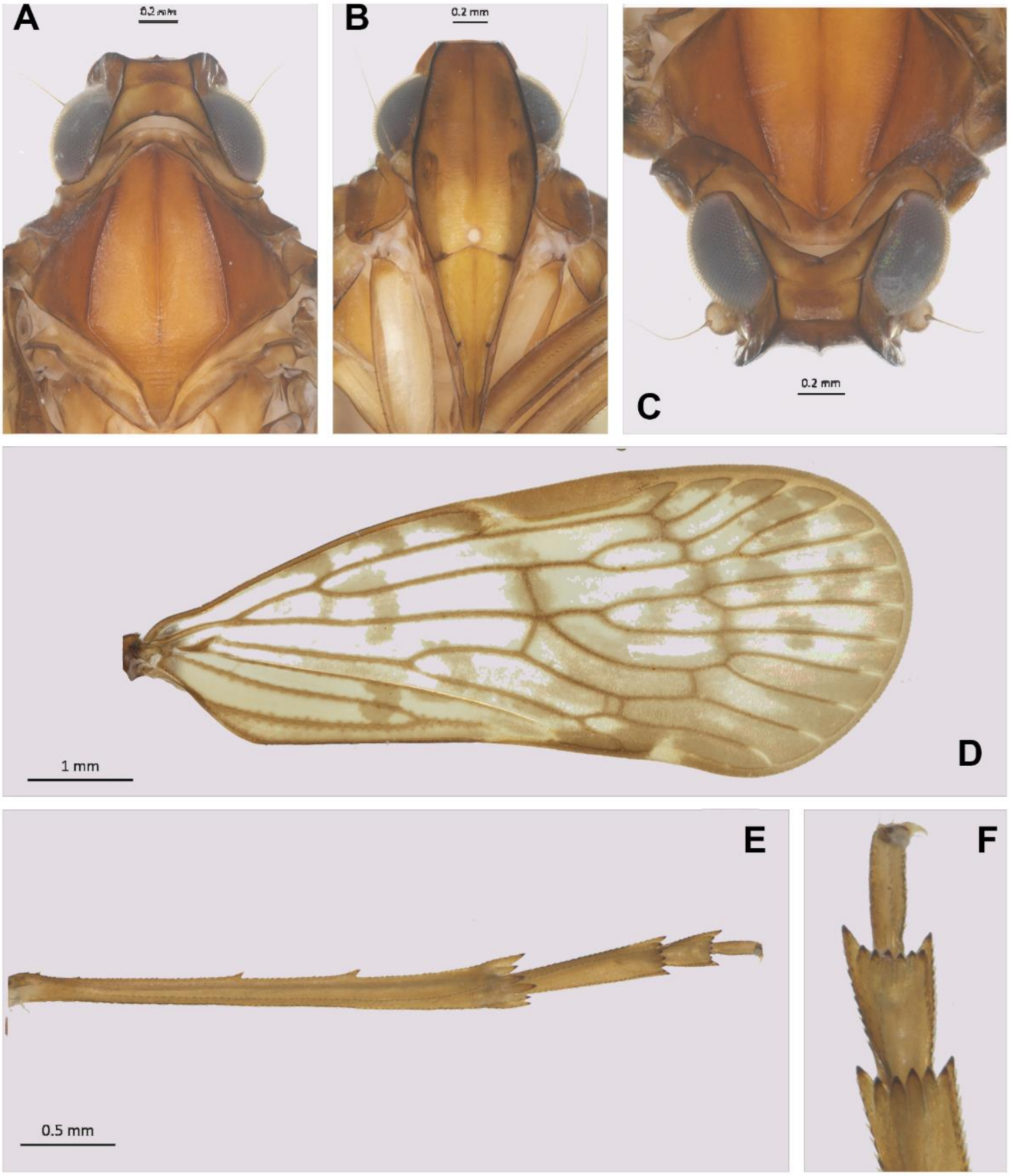

FIGURE 34. *Pintalia (C.) painensis* **sp. nov**: A-C head; D tegmina (forewings); E posterior leg; F tarsomeres.

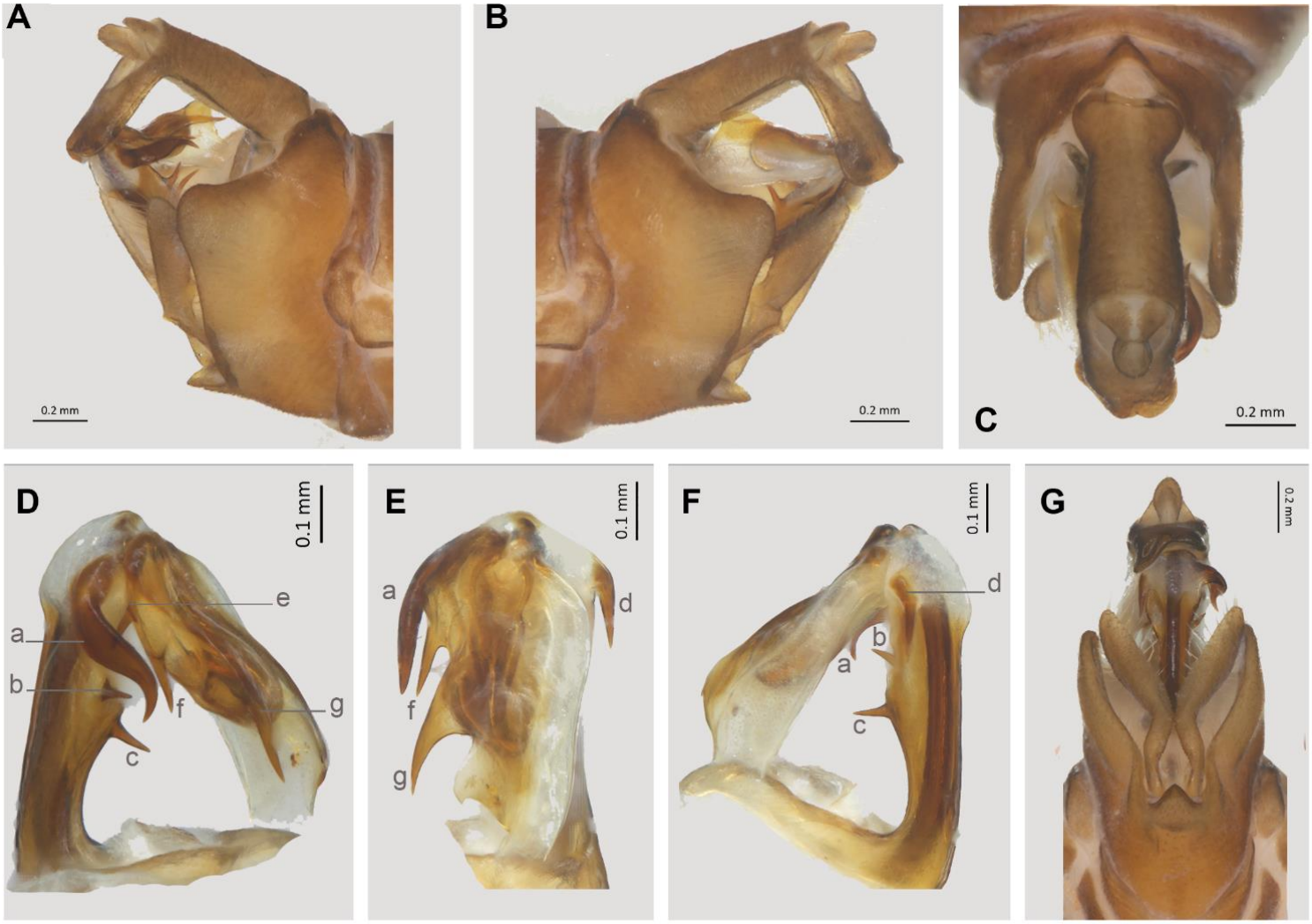

FIGURE 35. *Pintalia (C.) painensis* **sp. nov**, male genitalia: A genital capsule right lateral; B genital capsule left lateral; C genital capsule dorsally; D aedeagus right lateral; E aedeagus frontal; F aedeagus left lateral; G genital capsule ventrally.

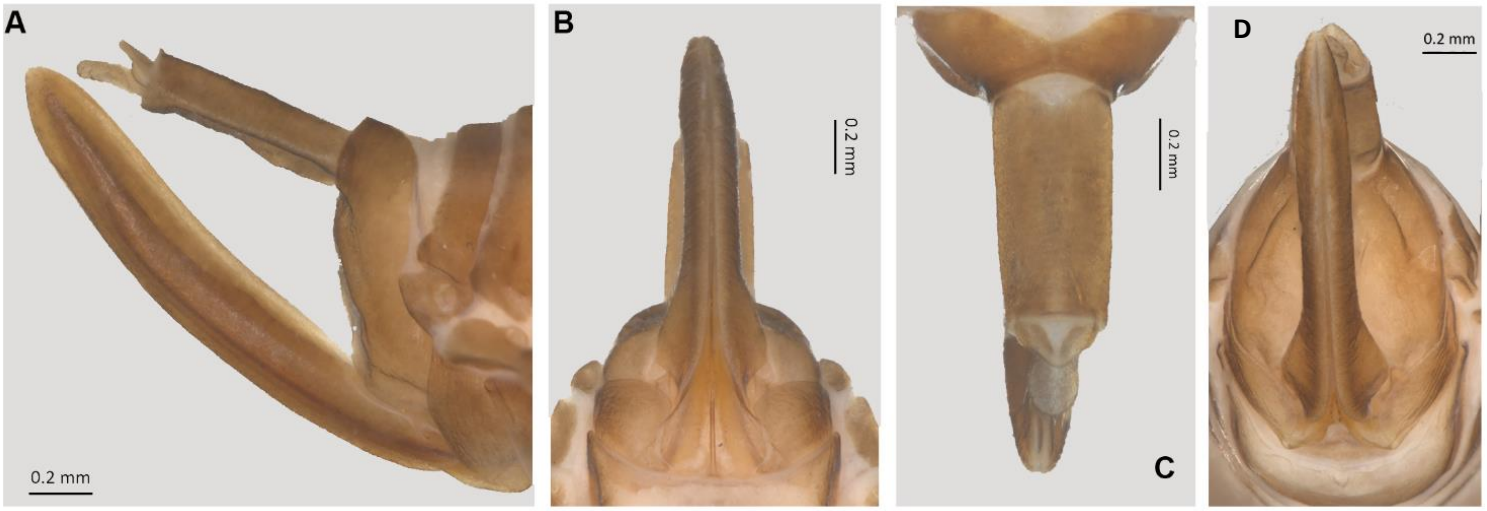

FIGURE 36. *Pintalia (C.) painensis* **sp. nov**, female genitalia: A right lateral; B ventral view; C dorsal view; D caudal view.

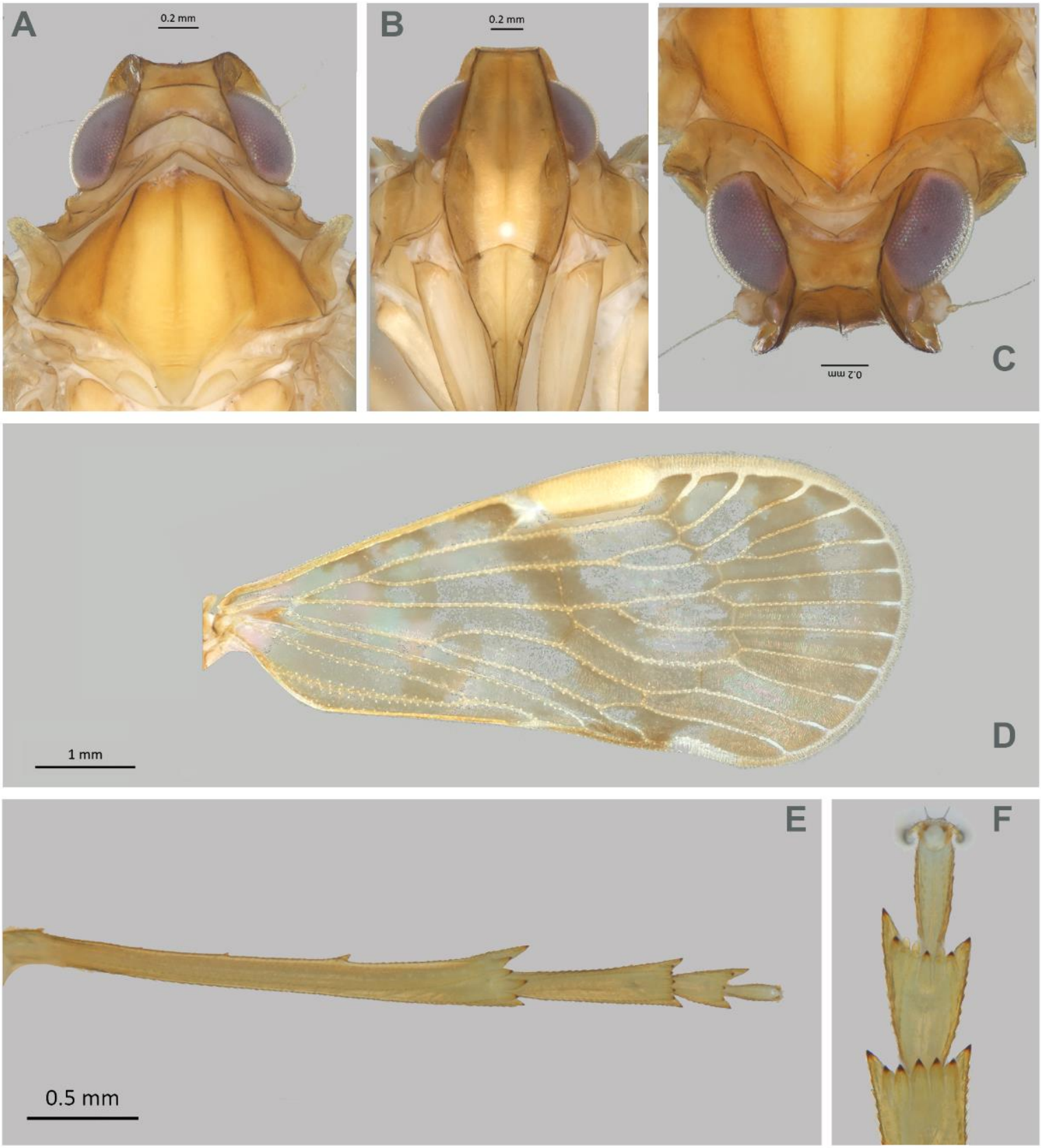

FIGURE 37. *Pintalia (C.) dorensis* **sp. nov**: A-C head; D tegmina (forewings); E posterior leg; F tarsomeres.

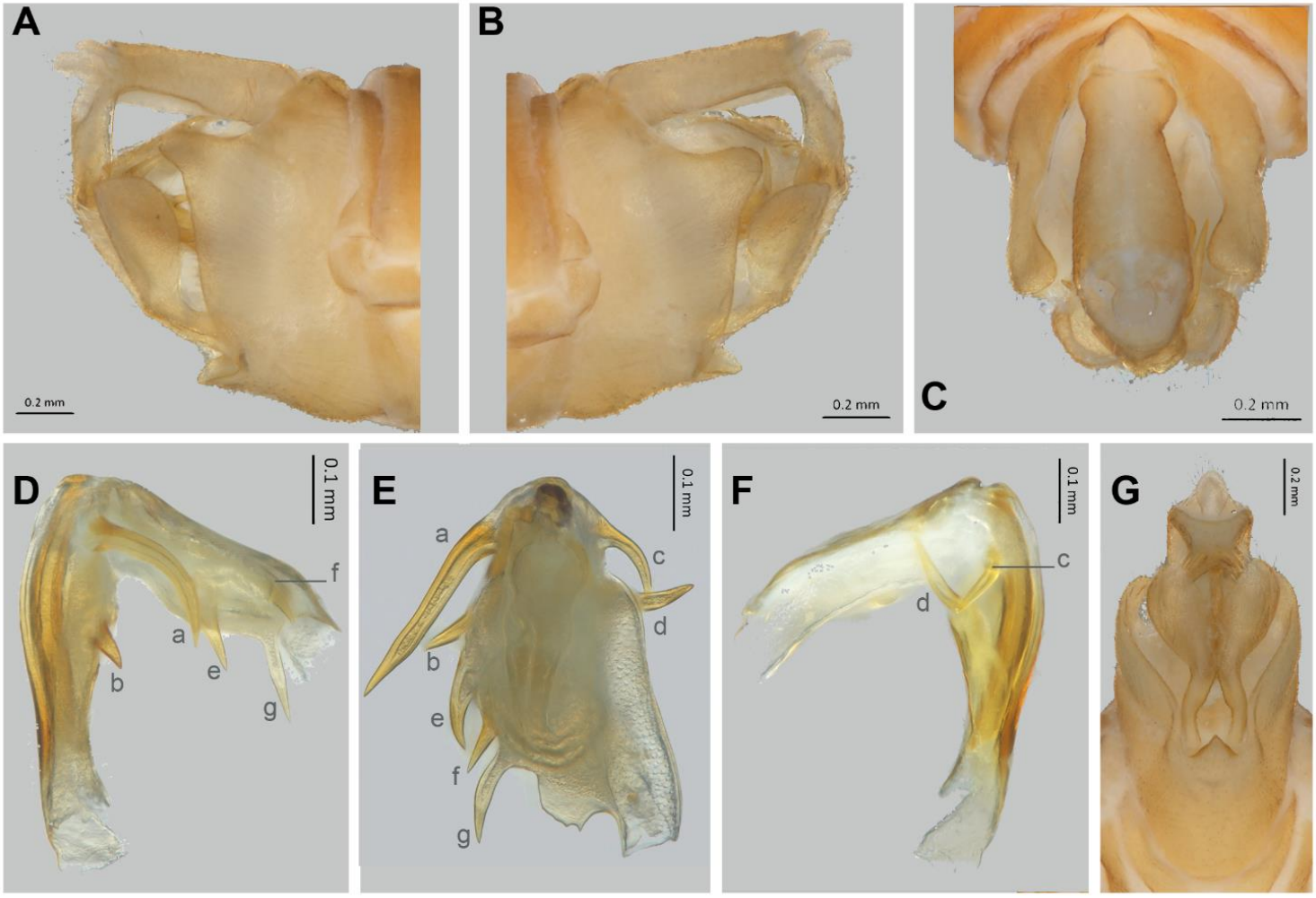

FIGURE 38. *Pintalia (C.) dorensis* **sp. nov**, male genitalia: A genital capsule right lateral; B genital capsule left lateral; C genital capsule dorsally; D aedeagus right lateral; E aedeagus frontally; F aedeagus left lateral; G genital capsule ventrally.

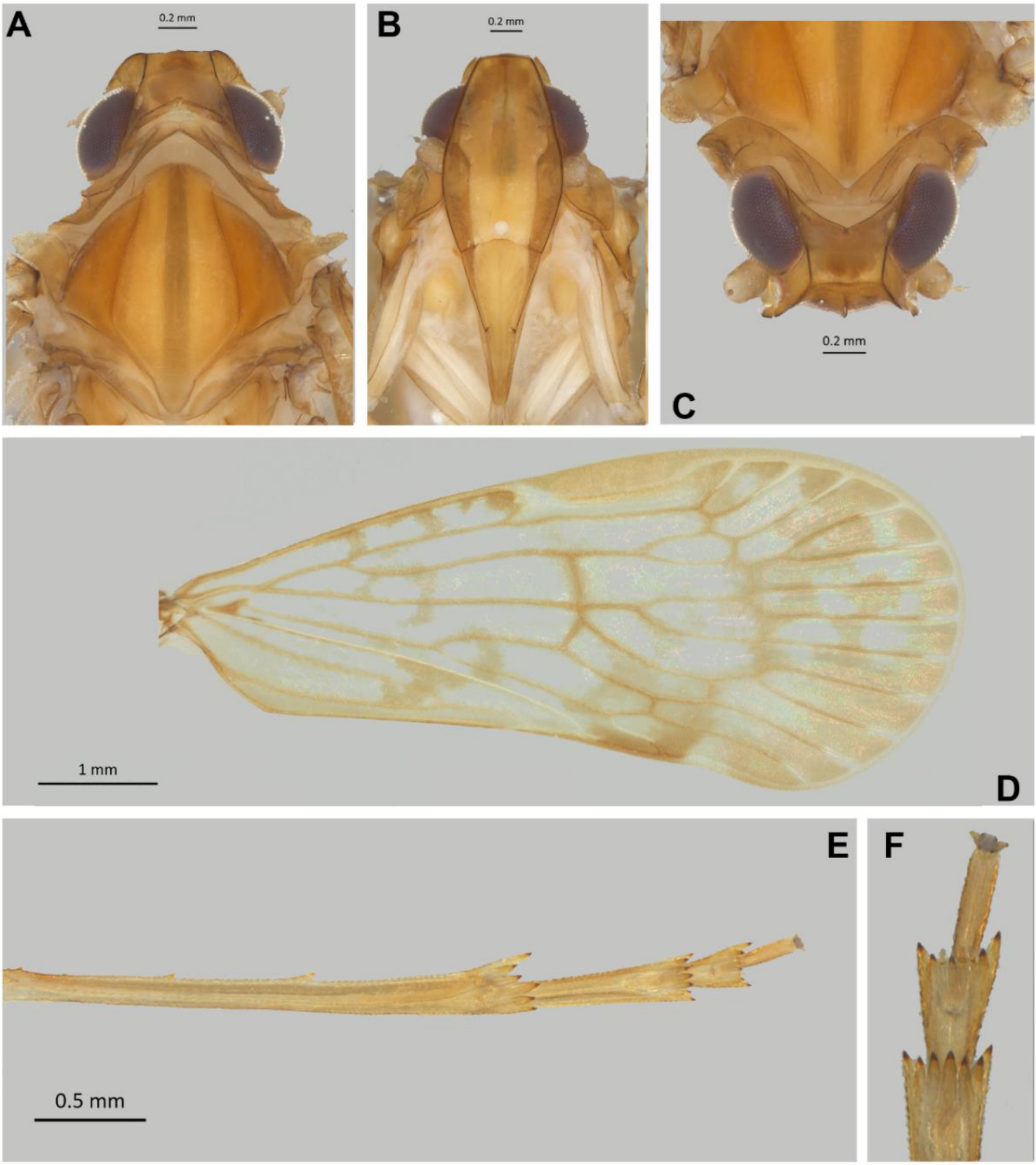

FIGURE 39. *Pintalia (C.) lundi* **sp. nov**: A-C head; D tegmina (forewings); E posterior leg; F tarsomeres.

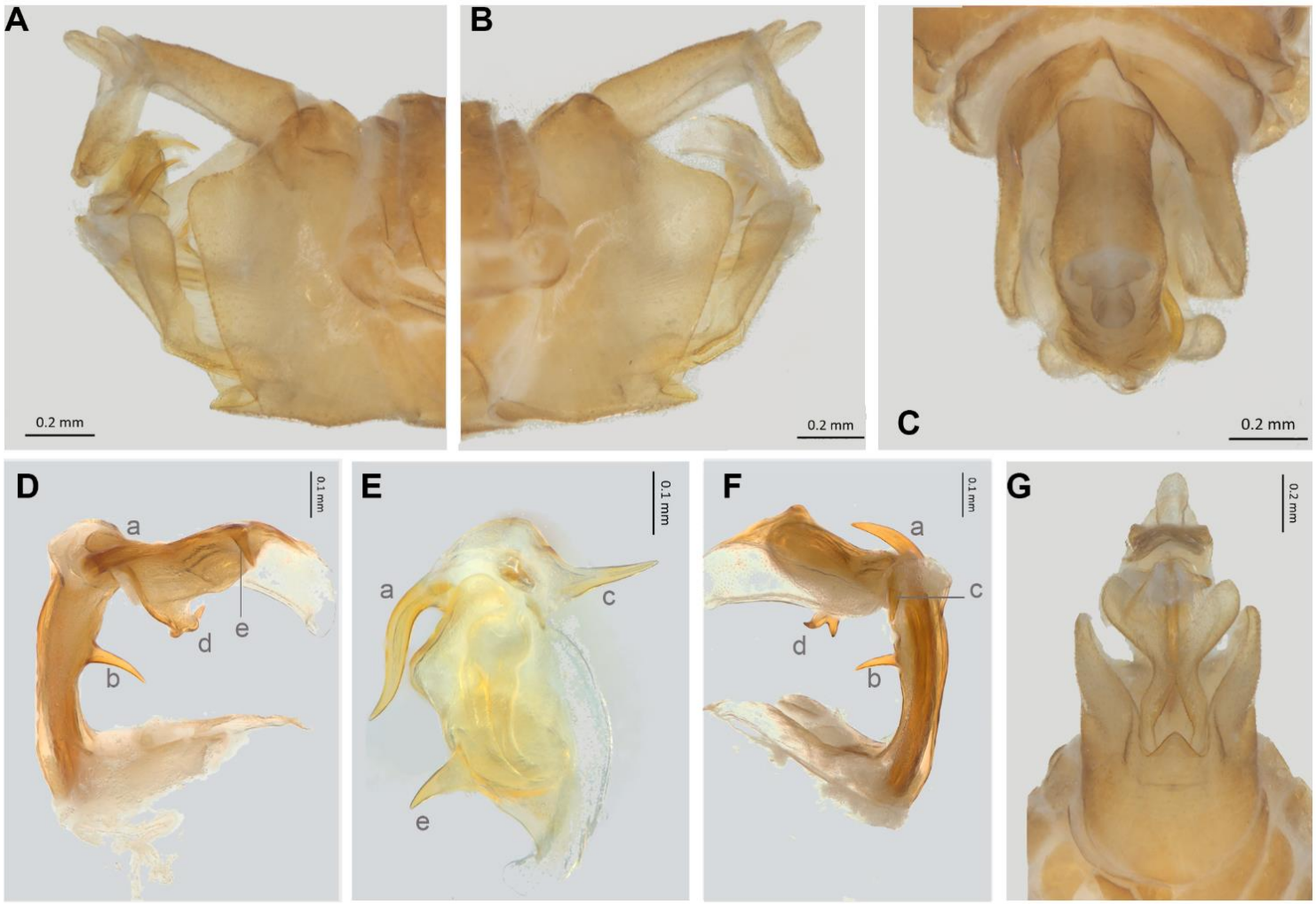

FIGURE 40. *Pintalia (C.) lundi* **sp. nov**, male genitalia: A genital capsule right lateral; B genital capsule left lateral; C genital capsule dorsally; D aedeagus right lateral; E aedeagus frontal; F aedeagus left lateral; G genital capsule ventrally.

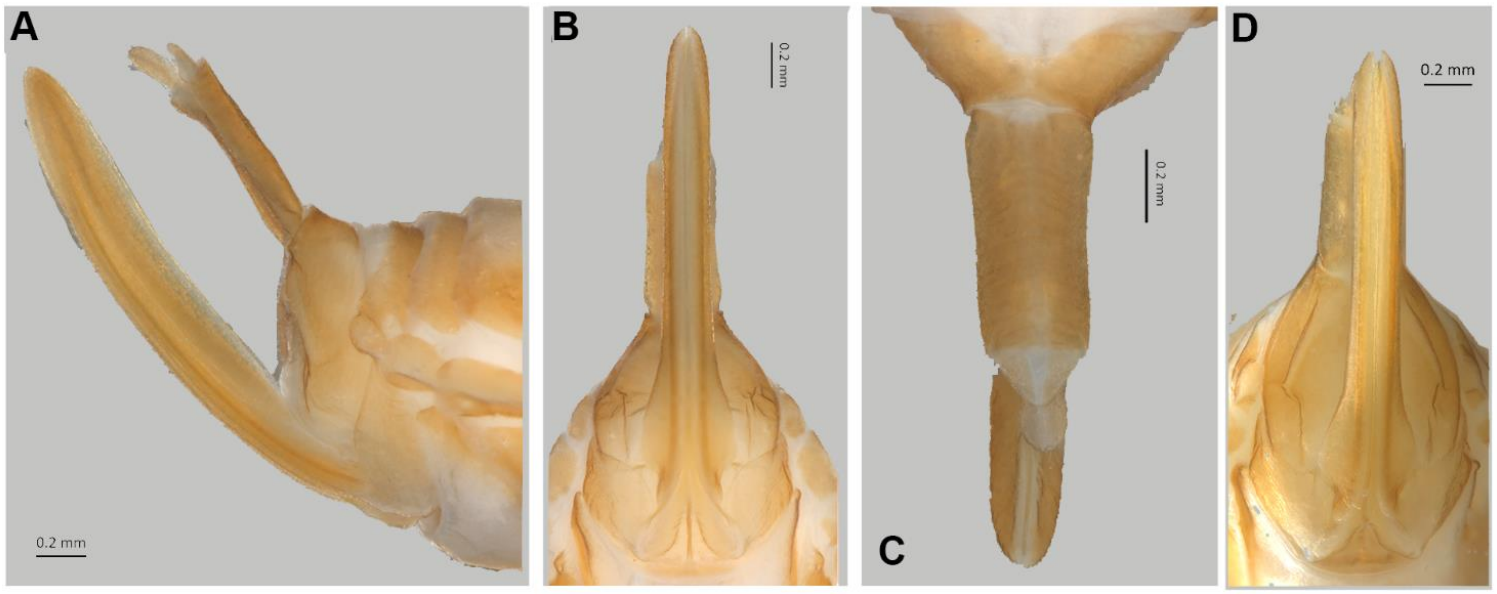

FIGURE 41. *Pintalia (C.) lundi* **sp. nov**, female genitalia: A right lateral; B ventral view; C dorsal view; D caudal view.

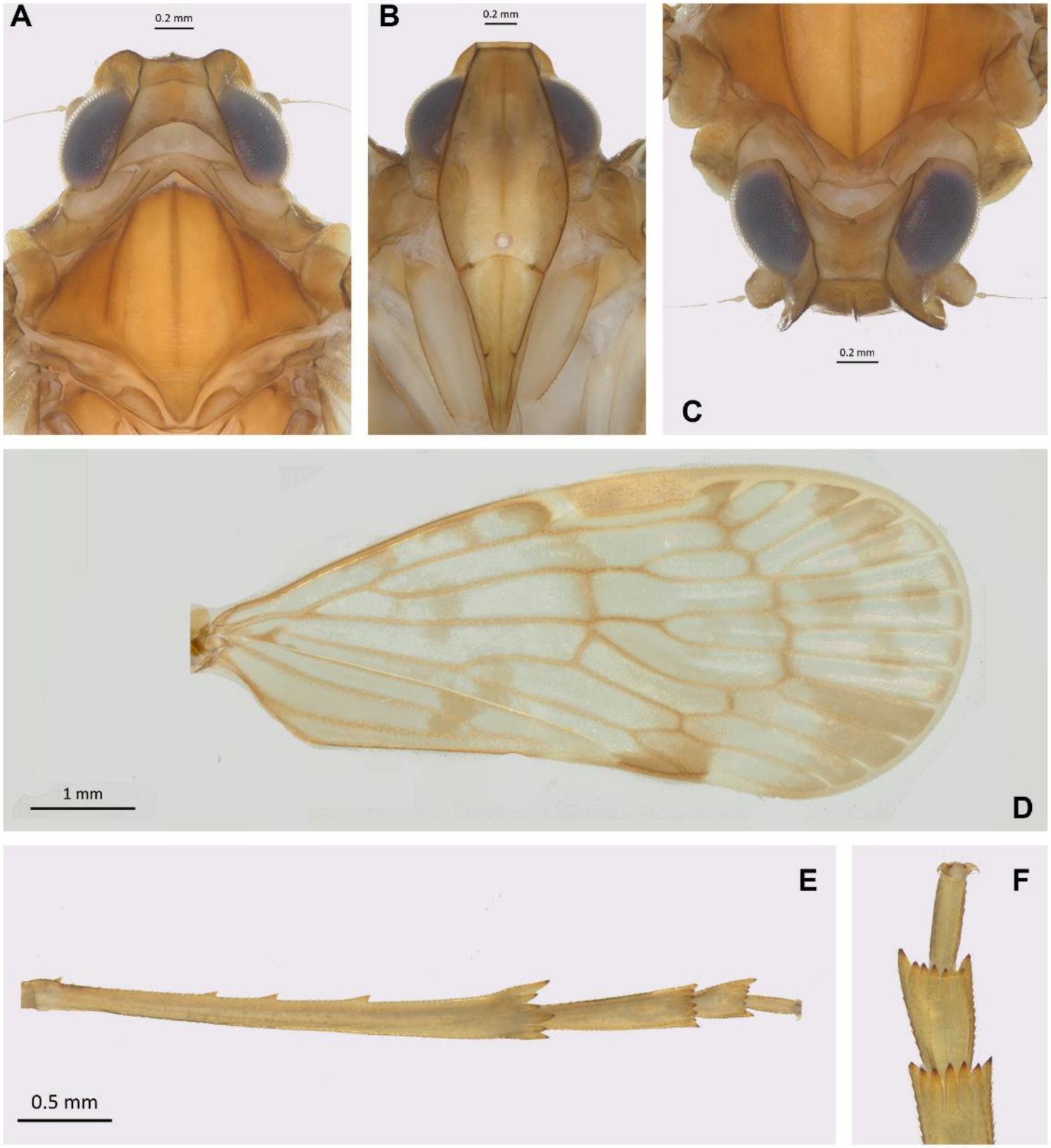

FIGURE 42. *Pintalia (C.) montalvaniensis* **sp. nov**: A-C head; D tegmina (forewings); E posterior leg; F tarsomeres.

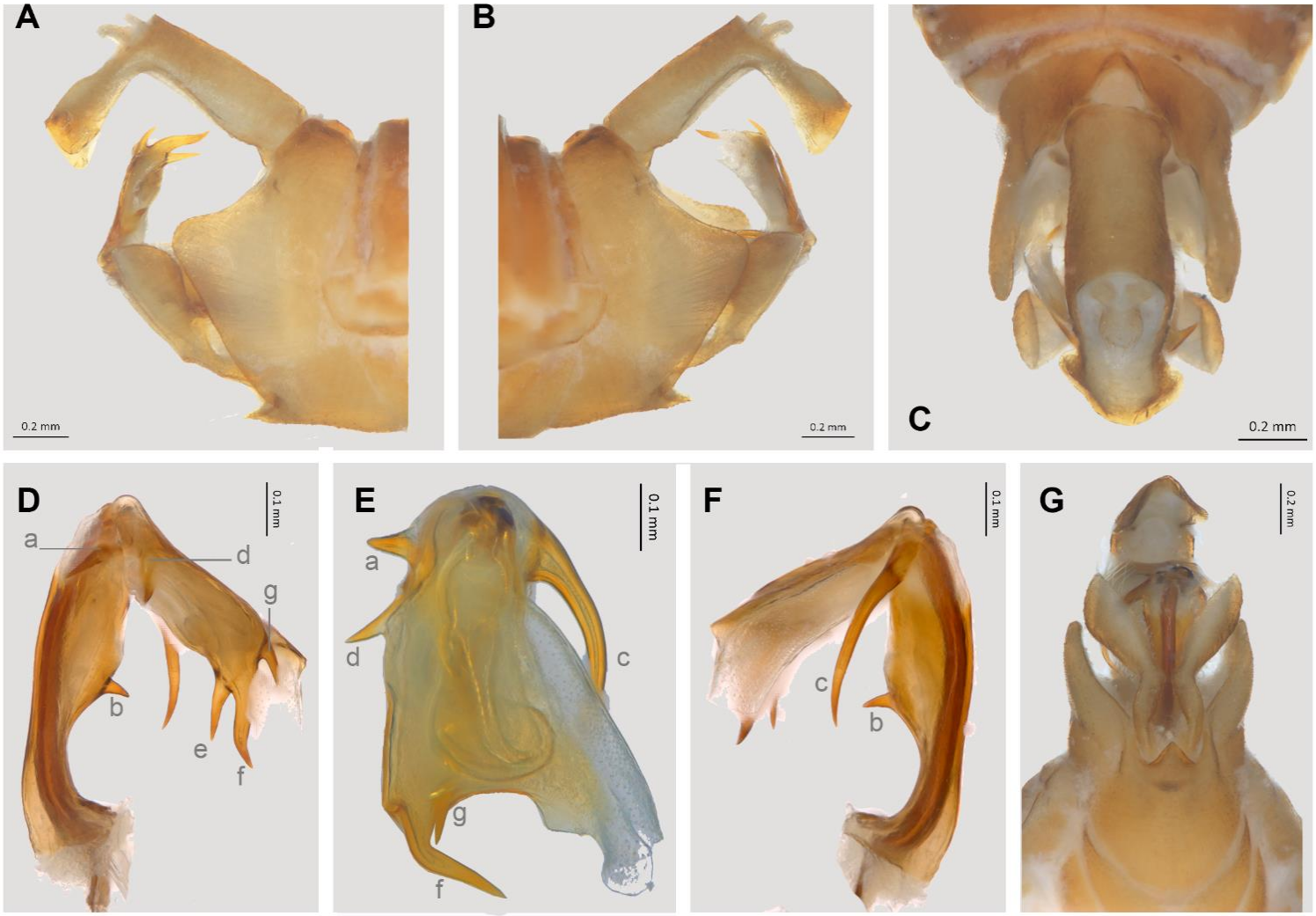

FIGURE 43. *Pintalia (C.) montalvanensis* **sp. nov**, male genitalia: A genital capsule right lateral; B genital capsule left lateral; C genital capsule dorsally; D aedeagus right lateral; E aedeagus frontal; F aedeagus left lateral; G genital capsule ventrally.

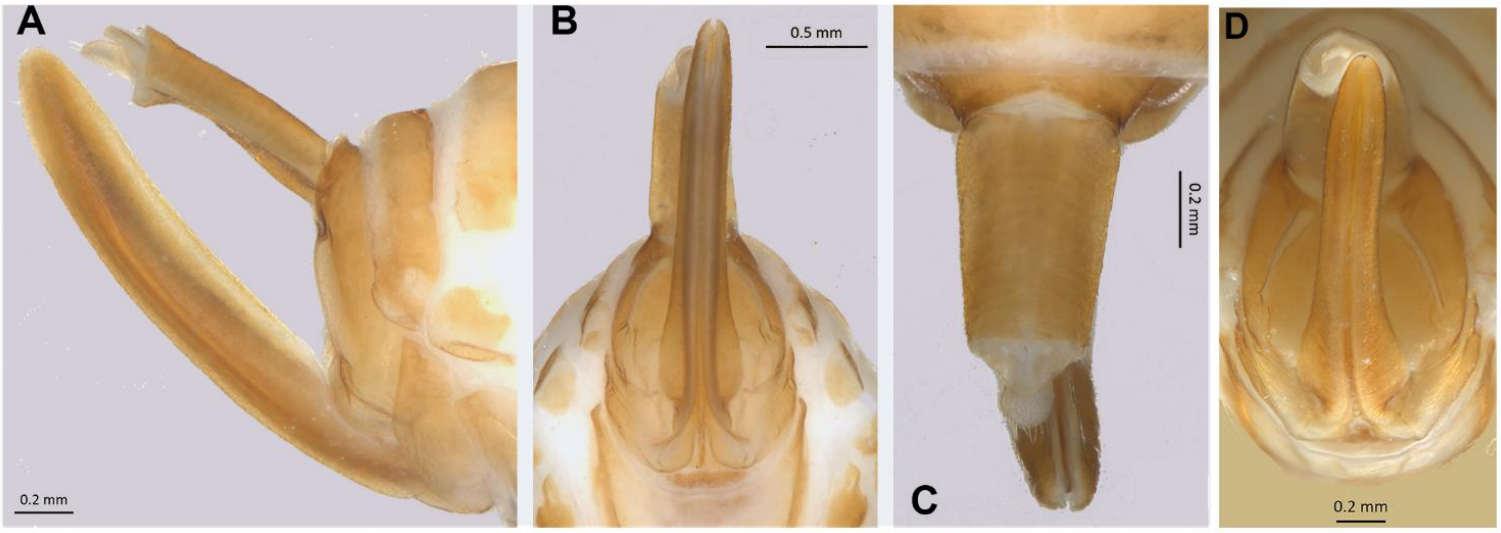

FIGURE 44. *Pintalia (C.) montalvanensis* **sp. nov**, female genitalia: A right lateral; B ventral view; C dorsal view; D caudal view.

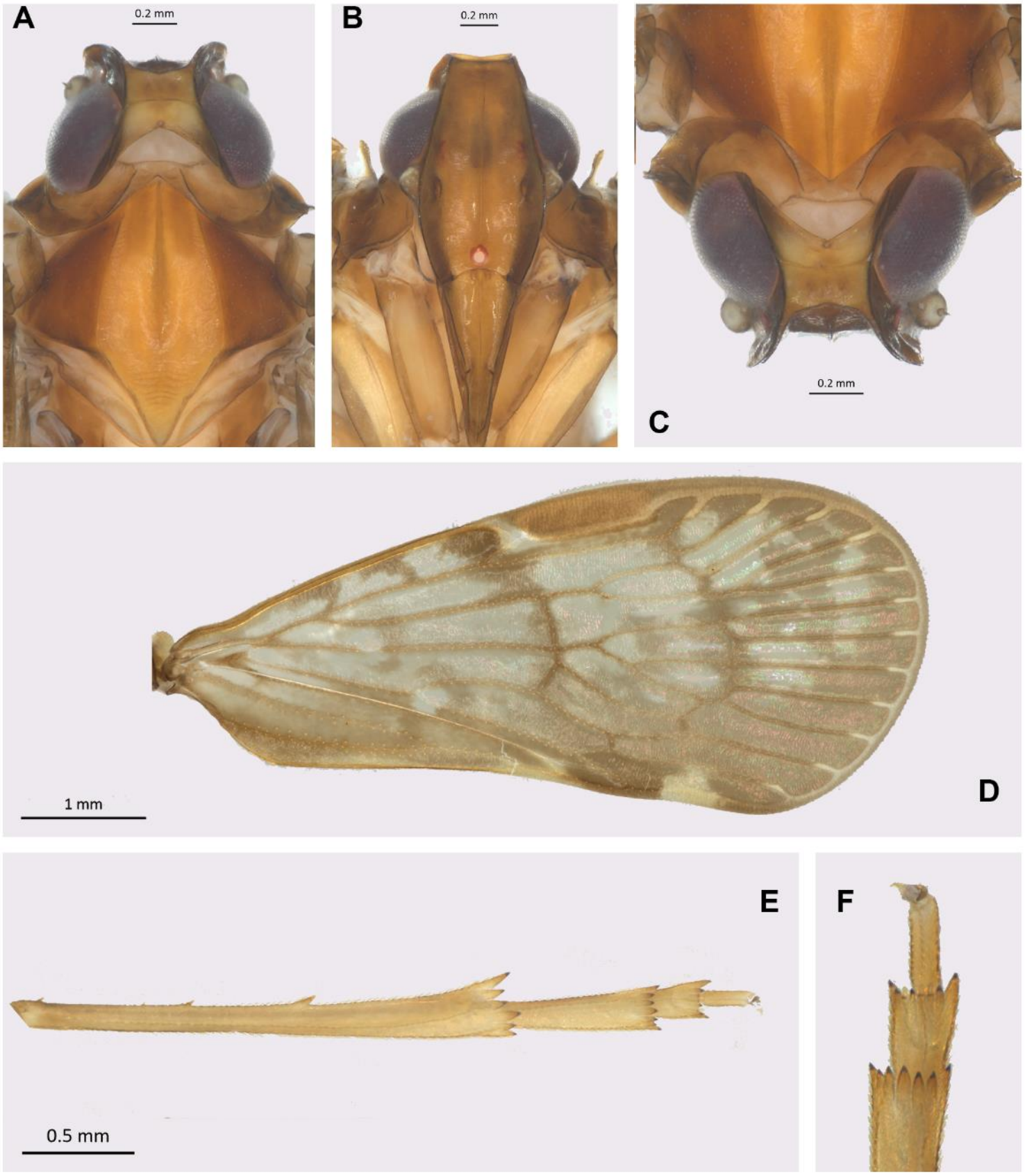

FIGURE 45. *Pintalia (C.) muiri* **sp. nov**: A-C head; D tegmina (forewings); E posterior leg; F tarsomeres.

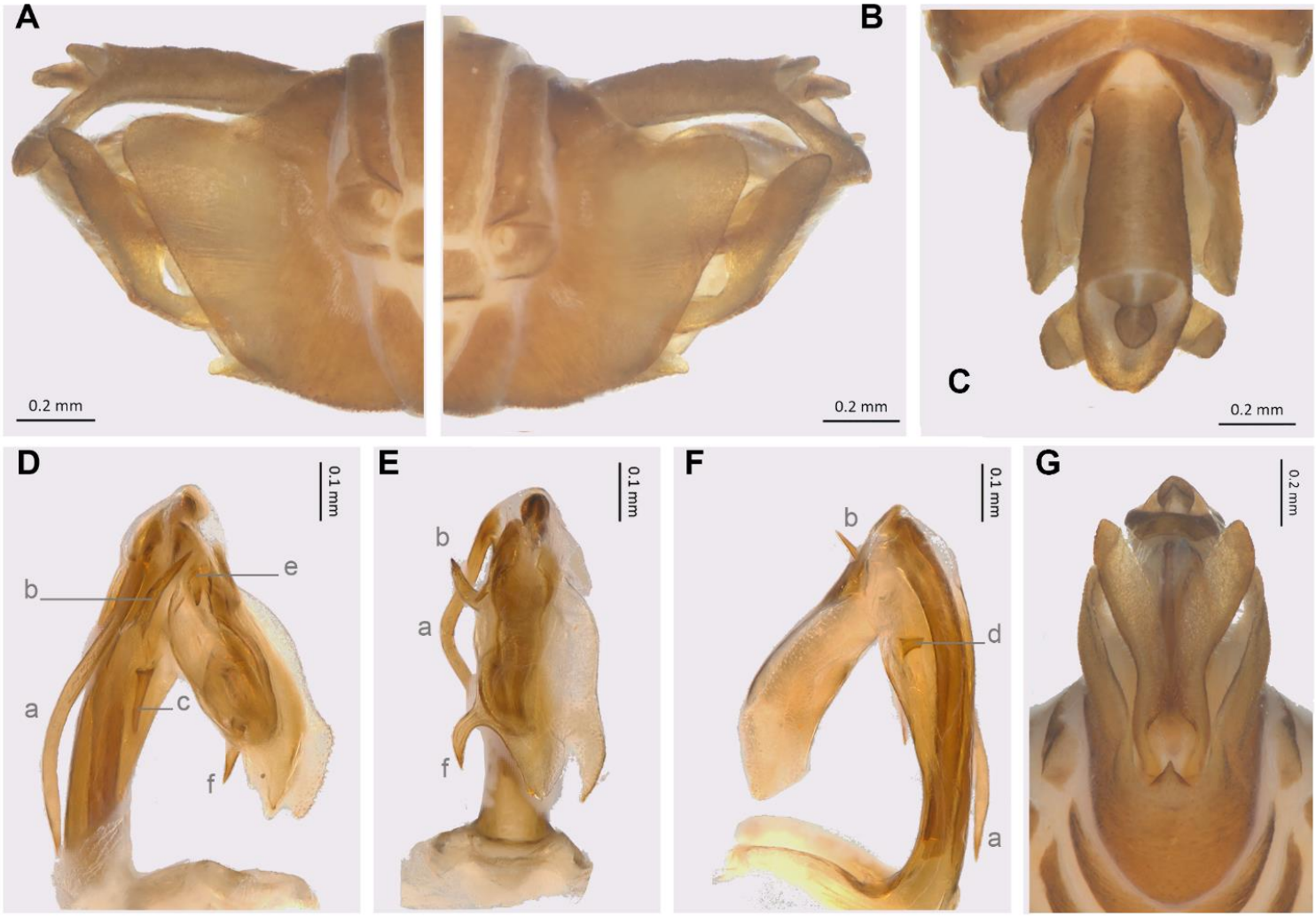

FIGURE 46. *Pintalia (C.) muiri* **sp. nov**, male genitalia: A genital capsule right lateral; B genital capsule left lateral; C genital capsule dorsally; D aedeagus right lateral; E aedeagus frontal; F aedeagus left lateral; G genital capsule ventrally.

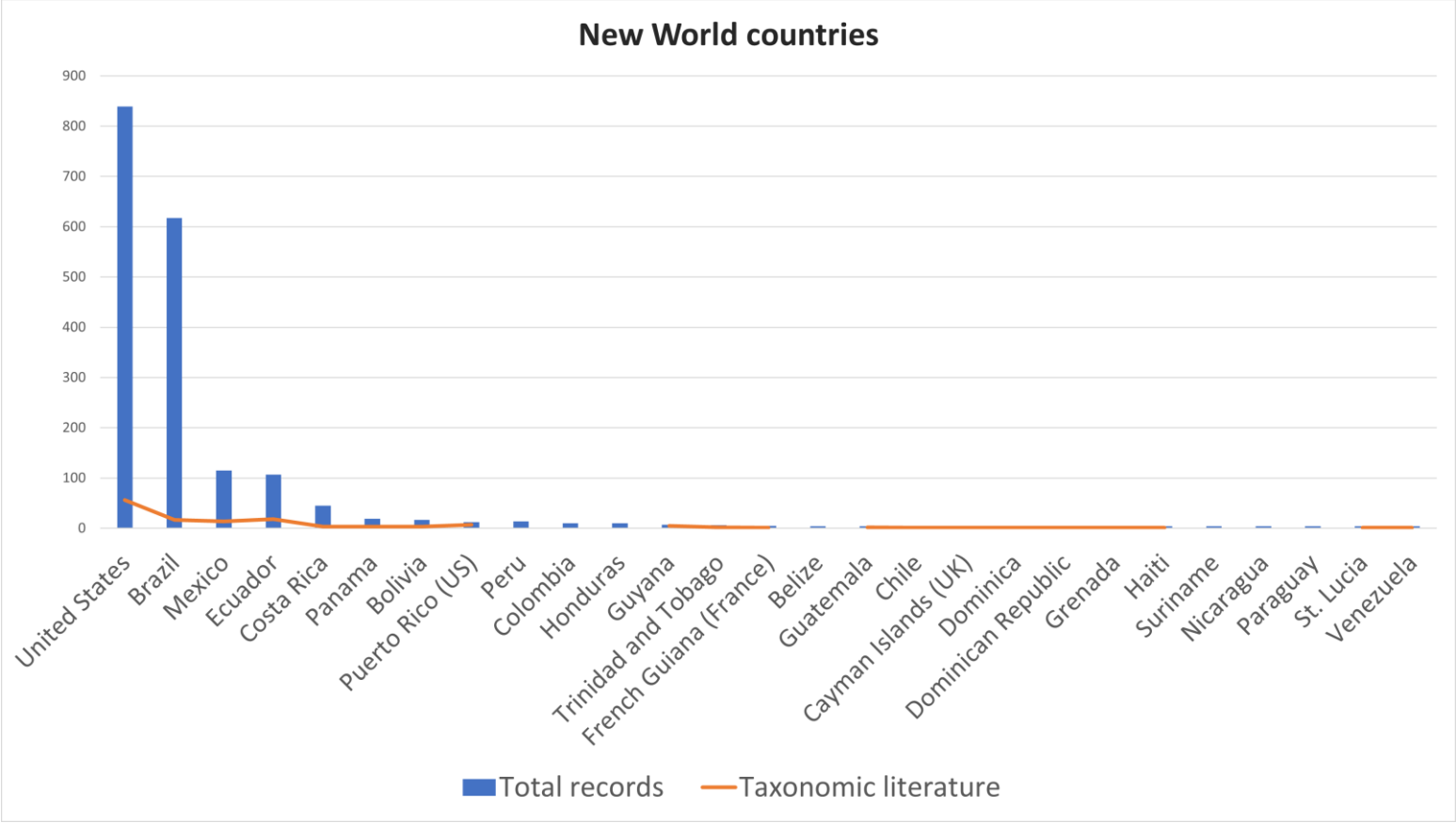

FIGURE 47: *Pintalia* Stål, 1862, records by political division, all records (blue bars) and Taxonomic literature records (orange lines).

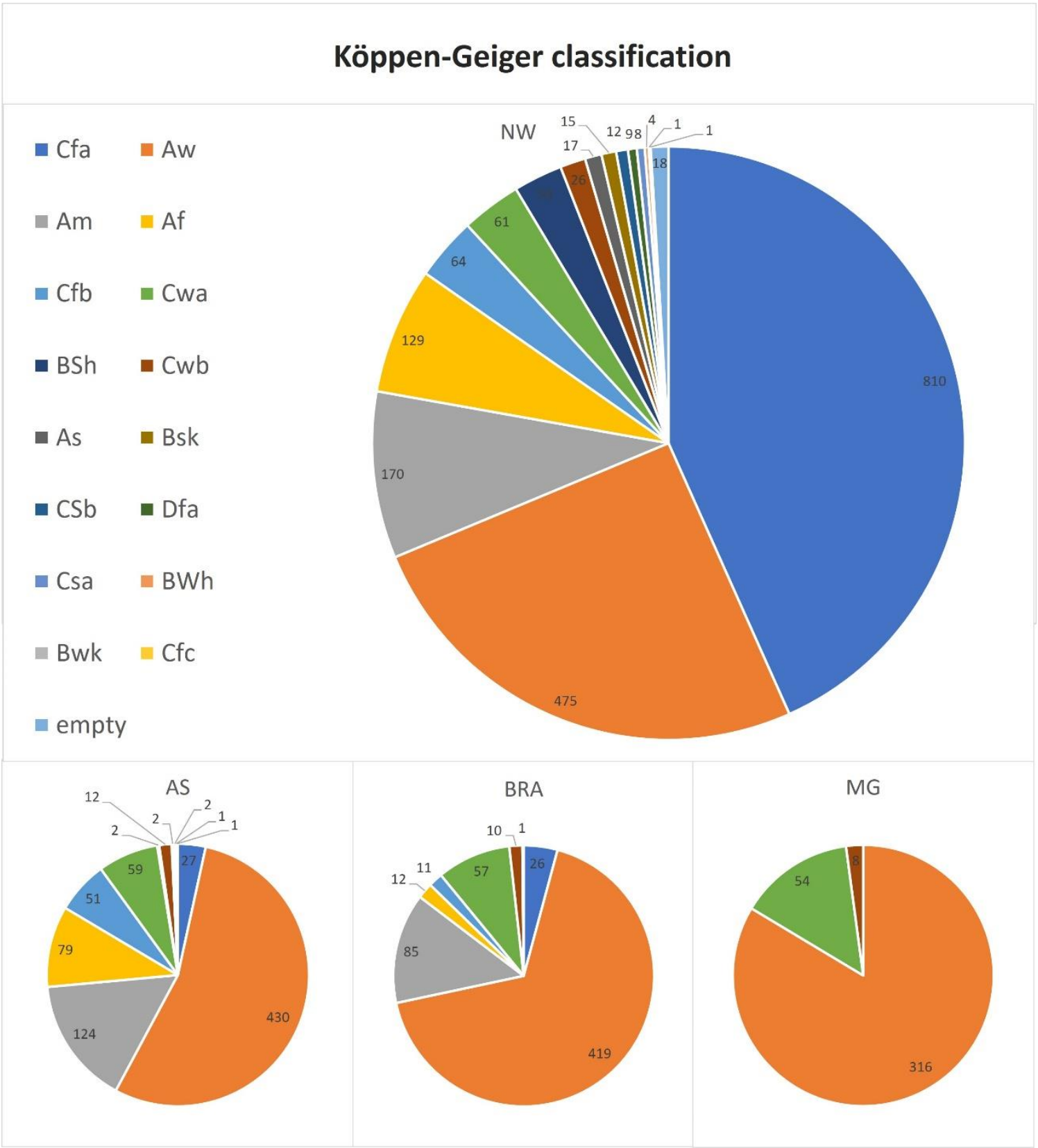

FIGURE 48: Distribution of *Pintalia* Stål, 1862, according to Köppen-Geiger classification (1900, 1918, 1927, 1936) (PEEL et al., 2007*)*, throughout New World (NW), South America (AS), Brazil (BRA) and Minas Gerais state (MG). *Af* = Equatorial climate; *Am* = monsoon climate; *Aw* = Savanna climate (dry in reverse); *As* = Savanna climate (dry in summer); *BWh* = Hot arid climate; *BSh* = Warm semi-arid climate; *BSk* = Cold semi-arid climate; *BWk* = Cold arid climate; *Cfa* = humid subtropical climate; *Cfb* = Temperate oceanic climate; *Cfc* = Subpolar oceanic climate; *Cwa* = Humid subtropical climate; *Cwb* = Subtropical altitude climate; *Csa* = Mediterranean hot summer climate; *Csb* = Mediterranean cool summer climate.

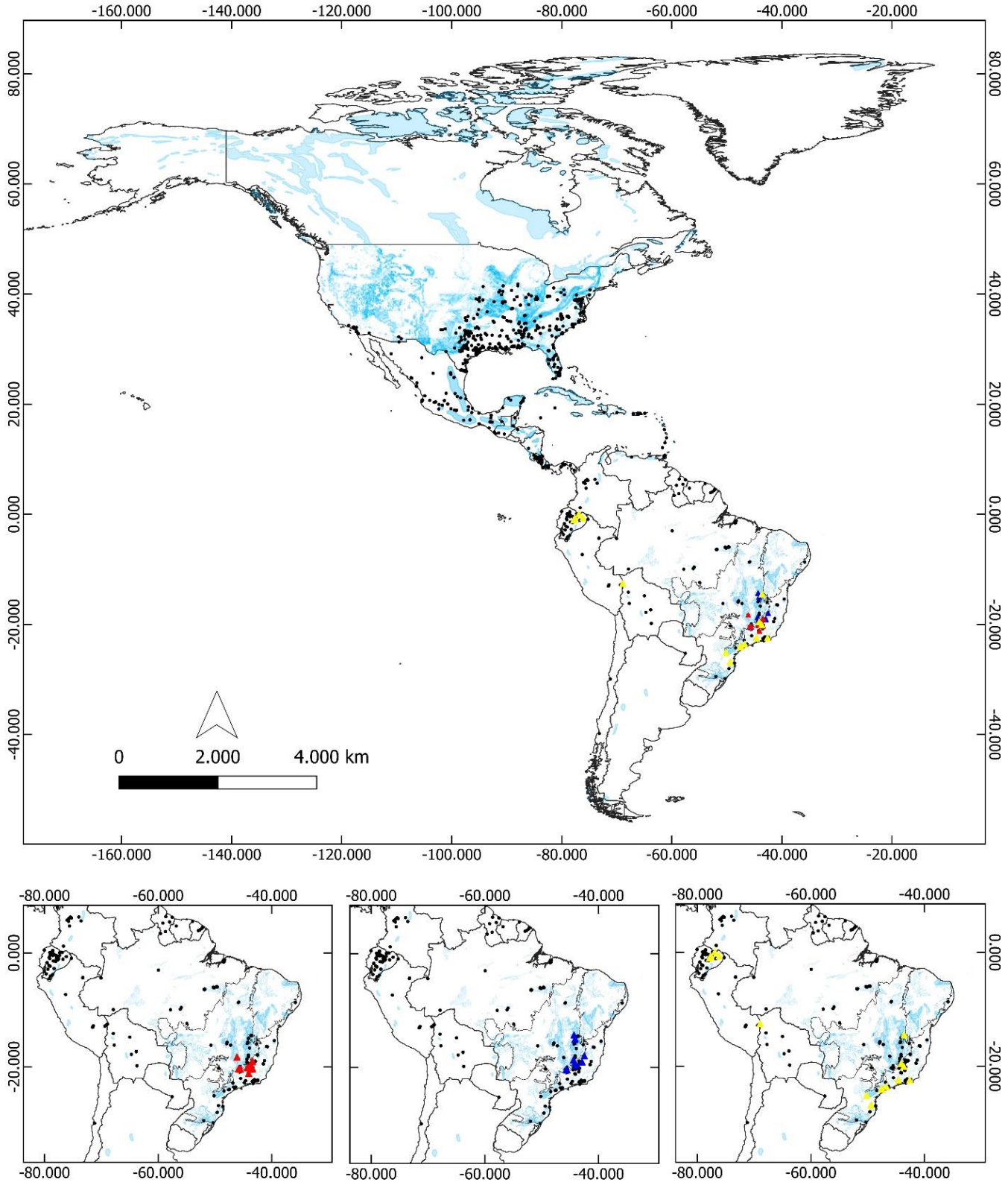

FIGURE 49. Occurrence of *Pintalia* Stål, 1862 in New World. Yellow triangle *P. (Ecuadorensis)* **subgen;** red triangle *P. (Pictipennis)* **subgen. n**; blue triangle *P. (Caudata)* **subgen. n**; the black dots are all records of *Pintalia* Stål, 1862 for South America; The South American shapefile was obtained from Efrain Maps (https://www.efrainmaps.es/english-version/free-downloads/americas/); The biomes of Brazil were obtained from ForestGis (https://forest-gis.com/download-gis-base-de-dados/); The shapefile with karst areas and the occurrence of caves in Brazil were obtained from CECAV (https://www.icmbio.gov.br/cecav/projetos-e-atividades/provincias-espeleologicas.html); and shapefills with North American karst areas were obtained from the U.S. Geological Survey Open-file Report 2014-1156 (https://pubs.usgs.gov/of/2014/1156/)

CAPÍTULO III

Ferricixius davidi

Rodrigo Lopes Ferreira

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Adaptive Shifts in Neotropical planthoppers: new troglobitic species and the first surface species of *Ferricixius* Hoch and Ferreira, 2012 (Hemiptera: Fulgoromorpha: Cixiidae) from Brazilian caves

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Abstract

Here we describe three cixiid species new to science which we assign to the hitherto monotypic genus *Ferricixius* Hoch & Ferreira, 2012 from Brazil. Two of the new species are – like the type species *F. davidii* Hoch and Ferreira, 2012 – obligately cavernicolous and display varying degrees of troglomorphy, such as the reduction of compound eyes, wings and bodily pigmentation, while one species displays well developed compound eyes and wings, and – although so far found inside caves - is ecologically classified as either epigean, or subtroglophile. We provide a modified diagnosis for the genus and an identification key to the species of *Ferricixius*, as well as information on the distribution, ecology, and habitat of the three new species described herein. Evolutionary implications are discussed, and adaptive shifts from epigean to subterranean habitat are presumed to be the most likely scenario underlying the evolution of cave-dwelling *Ferricixius*.

Key words: cave, planthopper, taxonomy, adaptive shifts, Brazil, iron quadrangle.

Introduction

During the last decade, advances in biospeleological research in Brazil led to the discovery of the first ever reported species of cave-restricted planthoppers in the country, belonging to the families Cixiidae and Kinnaridae. Cixiidae represents the family with the highest number of described species within Fulgoroidea, and currently has 16 genera with troglobitic species distributed in many parts of the world (Bourgoin 2022).

The genus *Ferricixius* Hoch and Ferreira, 2012, was erected to accommodate a single troglobitic species, *Ferricixius davidi* Hoch and Ferreira, 2012 that represented the first cave-restricted planthopper in the family Cixiidae described for Brazil, and only the

2nd record of a cave-dwelling cixiid from South America, the first being *Notolathrus sensitivus* Remes Lenicov, 1992 (Remes Lenicov 1992).

Furthermore, *Ferricixius davidii* represented the fifth troglobitic Fulgoroidea described for the Neotropical region (Hoch and Ferreira, 2012). More recently, two new genera have been erected for two obligately cavernicolous, and highly troglomorphic species of the planthopper family Kinnaridae from caves in Brazil: *Kinnapotiguara troglobia* (Hoch and Ferreira, 2013) and *Iuiuia caeca* Hoch and Ferreira, 2016. These data indicate that many more cave-dwelling species of Fulgoroidea are yet to be discovered in Brazilian caves.

It is interesting to note that – despite intensive searches carried out in several caves - the troglobitic *Ferricixius davidi* Hoch and Ferreira, 2012, is still only known from its type-locality, the MP-008 Cave, in Itabirito municipality, southeastern Brazil. Hoch and Ferreira (2012: 205f) stated that ".... for *Ferricixius davidi* there is no closely re- lated epigean relative which has been recognized in the surface fauna. Consequently, *Ferricixius davidi* must currently be regarded as a relict species. Whether initial adaptation to the subterranean environment took place in allopatry – by extinction of closely related epigean populations, as is postulated by the climatic relict hypothesis: e.g., Vandel 1964, Barr 1968 – or occured in parapatry by an adaptive shift of troglophilic populations to the cave environment in order to exploit novel food resources (as suggested by Howarth 1981) cannot be decided on the basis of the information currently available".

Subsequent screening of the Cixiidae of the ISLA collection, however, revealed the existence of a species which displayed a configuration of the male genitalia very similar to those of *F. davidi*, yet had well-developed compound eyes and wings, and was vividly pigmented. Subsequently, two additional cixiid species were discovered in caves in the Iron Quadrangle in Brazil, again sharing the same male genital characteristics, but displaying varying degrees of troglomorphy.

Here we describe these three species as new to science and assign them to the genus *Ferricixius* Hoch and Ferreira, 2012. Our contribution raises the number of obligately cavernicolous (troglobitic) Fulgoromorpha species to five (three in the Cixiidae, and two in the Kinnaridae) on Brazil.

The discovery of an apparently epigean *Ferricixius* species occurring parapatrically with 3 cavernicolous congeners sheds new light on the question whether initial adaptation to underground environments was by allopatry, as postulated by the CRH (recently reviewed by Hampe and Jump 2011) or by (one or more) adaptive shift(s).

Here we describe three new species of *Ferricixius* Hoch and Ferreira, 2012, being two troglobitic, and one non-troglomorphic.

Material and methods

Study area

Specimens of the three new *Ferricixius* species were found in caves from seven municipalities from Minas Gerais and São Paulo states, southeastern Brazil. The specimens were found in limestone, quartzite and iron ore caves. Details on the habitat of each new species (as well as for *Ferricixius davidi*) will be presented below (see the sections Habitat and threats).

Collection, preservation, permanent storage, and depository

Specimens were collected manually (by visual search or direct intuitive search DIS, as described by Wynne et al. 2019) as in the caves using brushes moistened with ethanol and immediately transferred to vials containing 70% ethanol. After dissecting the male genitalia, the specimens were stored in individual vials with 70% ethanol, the bodies were stored in 2.0 ml vials, and the male genitalia were stored in 0.5 ml vials. Holotypes and paratypes were stored in individual 50ml vials for each species. Type material and additional material examined, are deposited in the Coleção de Invertebrados Subterrâneos de Lavras (ISLA), in the Centro de Estudos em Biologia Subterrânea (CEBS) from the Universidade Federal de Lavras (UFLA).

Male genitalia preparation and examination

When available, paratypes were chosen to prepare male genital parts for dissection and examination. Genital capsules were removed from the specimens with the aid of entomological pins and transferred to ethanol gel, with a layer of 70% liquid ethanol added above to remove reflections during photographs. When necessary, pancreatin solution (Alvarez-Padilha et al., 2007) was used. |In such cases, the male genital parts were submerged in pancreatin for 12 hours (in room temperature) to remove soft tissues from the genital constituents.

Morphological examination techniques and visualization

We followed the color description with the standard names of sRGB Centroids for the ISCC-NBS Color System, Centrore (2016). Measurements and examinations of the external morphology were performed with the holotypes and paratypes immersed in ethanol, without further manipulation. A Zeiss Axio Zoom V16 stereomicroscope and Zen 2.3 software were used to examine the morphological characters of the specimens, capture images and perform measurements (presented in millimeters in the descriptions).

In addition, the Inkscape software (https://inkscape.org/) was used to process the images and make the drawings.

Terminology

The morphological terms applied here follow Löcker et al. (2006), and the names of some structures of the male genitalia were adapted (anal tube = anal segment; pygofer = genital segment); The terms for structures of the head follow Löcker (2014); and the terms used for wing cells and tegmina venation follow Bourgoin et al., (2015), and an adapted image is provided here (Figure 2).

Measurements

The measures used in this study were: Body length (measured dorsally, from the middle of the apical transverse carina to the caudal border of the anal segment), length of vertex (summing the length of the basal and apical compartments): medially, from the apical transverse carina to the caudal border), width of vertex (measured at the level of the caudal border medially), width of apical vertex compartment (maximum width, here, near from apical transverse carina), length of the apical vertex compartment (maximum length,i.e. measured medially from the subapical carina to the apical transverse carina), length of frons (measured medially, from the frontoclypeal suture to the apical transverse carina), width of frons (i.e., maximum width in frontal view, here at the same level or just below the antennal scape), width of anterior or - apical - region of the frons (i.e., slightly below level of the apical transverse carina in frontal view), length of forewings, or tegmina (measured from tegulae to distal margin of tegmen), length of hind tibia (measured medially, from the base of the hind tíbia).

Abbreviations

ISLA: Invertebrados subterrâneos de Lavras, Lavras, Brazil

CEBS: Centro de estudos em Biologia Subterrânea

UFLA: Universidade Federal de Lavras

NW: New World

AS South America

BRA: Brazil

ASH: Adaptive Shift hypothesis

CRH: Climatic Relict hypothesis

Results

Ferricixius Hoch & Ferreira, 2012

Type-species. *Ferricixius davidi*, 2012., Brazil, MP8 cave (UTM 619795W, 7764761S, 23K), Minas Gerais State, Itabirito municipality.

Diagnosis emended. The genus *Ferricixius* Hoch and Ferreira, 2012 contains obligatory and facultative cave species which – due to the presence or absence of troglomorphies- differ strongly in their habitus. The general configuration of the male genitalia, however, is consistent among all 4 species, and indicates that these species are members of the same evolutionary lineage. The male copulatory organ, the aedeagus, displays large, compress process arising from a wide base at ca. midlength of shaft which is present in all *Ferricixius* species, however, varies in shape among them. Although a phylogenetic analysis of the Cixiidae at large including *Ferricixius* is lacking, we consider this character as homologous in the species here accommodated in *Ferricixius*, and - to our knowledge unique among Cixiidae- to be a synapomorphy of *Ferricixius* species.

Species from this genus exhibit the male genitalia with a bilaterally symmetrical genital segment, laterally trapezoidal with a straight posterior margin, without lateral processes; the ventromedian process is triangular, usually elongated, and usually thinner apically. The anal segment is bilaterally symmetrical, hood-shaped, ventrally concave with straight lateral margins, in dorsal view usually as wide at the base as distally, caudal margin usually evenly rounded. Genital styles moderately short and spoon-shaped, with many bristles; compressed or "creased" ventral/distal portion; in lateral view, wide on the distal region and narrow near to the base; curved ventrodistal margin; apically straight or almost straight; in ventral view elongated with a diamond-shaped basal opening with apical margins serrated. Aedeagal shaft laterally compressed, ventrally exhibit a large and elongated, compress process, that is usually weakly concave for right lateral; usually irregular and serrated distally; shaft with three spines apically; in right lateral view with two usually long spines that share the same origin (bifid), being that the smallest spine usually reaches at least half the longest length of the largest spine; in left lateral view, usually exhibit a moderately long and curved spine apically, which usually do not exceed the middle of the shaft, sometimes this spines occurs more ventrally. Flagellum on the left lateral, approximately the same size as the shaft; membranous portion of the flagellum narrow, bilobed almost tubular; near the base exhibit a process dorsolaterally; the process dorsolateral usually is 3/4 weakly concave, and apically is flattened dorsoventrally with rounded and irregularly dentate lateral margins, rarely is hook-like short apically. Other characters can also be useful for generic diagnosis, such as 4-5 lateral spines and 4-6 apical teeth on the hind tibia, usually two carinae and compartments of the vertex that is

narrower at the level of the subapical carina, fused post- and anteclypeus, and in lateral view mesonotum flattened. Females are like males but moderately larger. The female genitalia exhibit the segment-X tubular, moderately short; curved dorsally and straight ventrally; epiproct very short; paraproct moderately larger, 3-4 times smaller than the segment-X. The segment IX is laterally rounded; Ovipositor in sabre-shaped (curved upwards), not surpassing the segment X.

Key to the species of the genus *Ferricixius* Hoch and Ferreira, 2012

1. Compound eyes and tegmen well developed (Fig. 1A, 3A-D). Flagellum of antennae without arista. Hind legs with 1st and 2nd tarsomere with 8 apical teeth (Fig. 3E-F); ventral process curved distally with two teeth bigger than the others apically (Fig. 4D-F); epigean species. ……*Ferricixius urieli* **sp. nov** (Figures: 1A; 3A-F; 4A-G; 5D; 12A).

- Habitus strongly troglomorphic (Fig. 1B-D). Compound eyes and tegmina reduced or missing (Fig. 6A-D, 9A-D). Flagellum of antennae with arista (Fig. 13A-B). 1st and 2nd tarsomere with 4-6 apical teeth (Fig. 6E-F, 9E-F, 12E) ...…….....(2).

2(1). Second tarsomere of posterior leg with 2 apical teeth. Flagellum of aedeagus with dorsolateral process “hook-shaped”, apically sharpened. Without any “spine-like” process laterally on flagellum of aedeagus……..……..*Ferricixius davidi* Hoch and Ferreira, 2012 (Fig. 1D, 12A-E, 13A-D, 14A-C; 15C).

- Second tarsomere of posterior leg with 4 apical teeth. Flagellum of aedeagus with a “spine-like” process left laterally (Fig. 7E, 10E) ……..... (3)

3(2). Aedeagal shaft with ventral process very narrow distally, and only 3 apical teeth; dorsally very sinuous (Fig. 10D, F). Subapical spine on the left lateral of shaft well curved, reaching or almost reaching the middle of the shaft (Fig. 10F) ……..……*Ferricixius goliathi* **sp. nov** (Fig. 1C, 9A-F, 10A-G; 11E-F; 12C).

- Aedeagal shaft with ventral process very wide distally, serrated with approx. 14 apical teeth; dorsally almost straight (Fig. 7D, F). Subapical spine on the left lateral of shaft is slightly curved, occurs more ventrally, and is almost 2x smaller than the average shaft length (Fig. 7F) ……..……*Ferricixius michaeli* **sp. nov** (Fig. 1B, 6A-F, 7A-G; 8D; 12B).

Taxonomy

***Ferricixius urieli* sp. nov.**
(Figures: 1A; 2A; 3A-F; 4A-G; 5D; 12A; 17A, E)

Type material. Holotype: Male, Brazil, Minas Gerais; Catas Altas municipality, CPC-13 Cave, (UTM 670405W, 7772216S, 23K), 24.viii.2016, (Col. Alves, J.P), (ISLA 41337). Holotype condition: Dissected, stored in individual vials in ethanol 70%.

Additional material. Brazil, Minas Gerais. 1♂, 2♀, same data as holotype except for Ouro Preto municipality, Porcos cave, other information not found/date or collector unknown (ISLA 100987); 1♂, same data as holotype except for Lima Duarte municipality, Casas Cave, (UTM 615466W, 7599900S, 23K), 27.ii.2022, (Col. Pacheco G, et al.) (ISLA 100988); 1♀ same data as male holotype except for Ibitipoca municipality, Casas Cave, (UTM 615466W, 7599900S, 23K), 27.ii.2022, (Col. Pacheco G, et al.) (ISLA 100989); 1♀, same data as male holotype except for Nova Lima municipality, RM-03 cave, (UTM 603947W, 7783375S, 23K), 17.vi.2021, (Col. Pacheco, G. et al.), (ISLA 100990); Brazil, São Paulo. 1♀, Iporanga municipality, Bomba Cave (UTM 736984W, 7277175S, 23K), 23.vii.2013, (Cebs et al.), (ISLA 100991).

Description.

Coloration (specimen preserved in 70% ethanol): As in figures 1A, 3A-C, principally Brilliant orange yellow (67) contrasting with some areas to head, mesonotum and abdomen with Brownish black (65), Deep yellowish brown (75), and Brownish black (65), hyaline tegmina with veins in Dark yellowish brown (78) as figure 1A and 3D.

Body length. Male. 4.636 - 5.812 mm (n = 3) Female. 5.549-5.762 mm (n=2).

Head (Figures 3A-C). Vertex (Figures 3A, C): Approx. 1.4 times longer (0.443) than wide (0.297); apical compartment narrow and elongated medially, approx. 1.6 times wider (0.261) than medially long (0.159); the apical transverse carina and subapical carina moderately elevated and elongated medially; angle formed by the caudal border triangular irregular, narrowed apically; without basal emargination. Frons (Figure 3 B): Approx. 1.2 times longer (0.736) than wide (0.607), approx. 1.9 times wider at the height of the antennae than at the anterior region (0.309). Compound eyes and ocelli (Figure 3A-C; 12 A): Well developed; Frontoclypeal suture (Figure 3B), as on the diagnosis of the genus. Post and anteclypeus (Figure 3B), as on the diagnosis of the genus.

Thorax (Figures 3A-C). Pronotum (Figure 3A, C): Submedian carinae well developed, in frontdorsal view slightly concave laterally and well evanescent distally; hind margin obtusely angled, almost concave laterally. Mesonotum (Figure 3A): Tricarinate, lateral carinae well developed and almost straight; median carina well developed, but evanescent distally. Tegmina (forewings) (Figures 3D): Length (6.166

mm); C3a and C2a cell with approximately the same size, sometimes C3a slightly larger, other cells and veins as provided here in the genus diagnosis. Posterior legs (Figures 3E-F): Exhibit 4-5 lateral spines on hind tibia; hind tibia (2.246 mm) with 6 apical teeth medially separated (3+3); 1st tarsomere with 8 apical teeth with approx. the same size; 2nd tarsomere with 8 apical teeth, and three thin setae.

Male genitalia (Figures 4A-G). Genital segment (Figures 4A-C, G): Ventromedian process triangular elongated, tapering after 2/3 to the apex. Anal segment (Figures 4A-C): in dorsal view approx. 2.0 times as long (0.873) as wide (0.434). Genital styles (Figures 4A-C, G): As on the diagnosis of the genus. Aedeagus (Figures 4D-F): Shaft laterally flattened with one large process starting near the base; weakly concave laterally and curved on the proximal margin, almost straight on the distal margin, and serrated/irregularly dentate on the ventral margin (more distally). Aedeagal shaft with two subapical spinose processes, one of which is bifid; the spinose bifid process occurs on the right lateral, the largest spine extends beyond the base of the ventral process when at rest and twice the size of the smaller spine; bifurcation begins moderately distant from the base this process; second spinose process occurs dorsally, moderately short and curved; sometimes shaft with a small process laterally near the middle when in fontal/dorsal view. Flagellum moderately tubular; process dorsolaterally apically rounded as provide on the diagnosis to the genus; in *F. urieli* **sp.nov** moderately short, approx. 1/3 the size of the flagellum.

Differential diagnosis. *F. urieli* **sp.nov** distinguishes of other species of the genus *Ferricixius* Hoch e Ferreira, 2012 mainly because of its epigeomorphic morphology, exhibiting well developed eyes, tegminae, wings and body size, vs tegminae and wings moderately reduced in *F. michaeli* **sp.nov**, and very reduced in *F. goliathi* **sp.nov** e *F. davidi*, furthermore, the eyes and ocelli are absent in *F. michaeli* **sp.nov**, *F. goliathi* **sp.nov** e *F. davidi* Hoch e Ferreira, 2012.

Etymology. The epithet *urieli* refers to the Archangel Uriel, which considered to be the angel of wisdom, who shines the light of God's truth to those who seek information, solutions, or even require wisdom. He is commonly portrayed carrying a book or a scroll which symbolize wisdom. The name "Uriel" is derived from the Hebrew אוּרִיאֵל and means "God is my light." It is also translated as "Fire of God." This name was given due to the fact that *F. urieli* is the only known epigean species of *Ferricixius*, thus, living in the light.

Remarks. The individuals grouped in other material examined were collected at different dates and locations and show small morphological variations that will be

detailed described here. The specimen collected in Ouro Preto-MG (ISLA 100987) has a body length close to the size of the male holotype (5.786mm), and few other variations; Tegmina with C3a cell slightly larger than C2a; anal segment with paraproct slightly smaller than the holotype; ventral process of the shaft serrated distally, but with an almost straight margin and many teeth; body color Strong orange yellow (68) contrasting with some areas with light orange yellow (70), deep yellowish brown (75) and dark yellowish brown (78), hyaline tegmina with dark yellowish brown veins (78). The specimen collected in Lima Duarte-MG (ISLA 100988) has a shorter body length among the individuals collected (4.636mm), and also exhibits few variations in comparison to the holotype: tegmina with C3a cell slightly larger than C2a, as in the specimen from Ouro Preto-MG; anal segment with paraproct slightly smaller than the holotype; ventral process of the shaft distally serrated, with a moderately concave margin and few teeth, two slightly larger ones together apically; body color as in the collected specimen from Ouro Preto-MG but slightly more Deep yellowish brown (75) and Dark yellowish brown (78), in the darker regions. The female associated with the specimen from Lima Duarte-MG exhibits a distinct color pattern when compared to the females from other locations: it is strongly darker, mostly Brownish black (65) contrasting in some areas with Strong yellowish brown (74), in addition it exhibit two very pigmented spots on the medial/distal region btween veins A1 and A3 of the Hind Wings.

Ecology. Most specimens of *F. urieli* were sampled by consultancy companies which unfortunately did not provide any specific information on the samplings or on their habitat. One of the authors however, collected the specimens from Casas cave (Lima Duarte municipality-MG). This cave is inserted in quartzite rocks and presents around 600 meters of horizontal projection. Even though the species present epigeomorphic morphology, thus, are expected to occur in external habitats or, when in caves, close to the entrances (Figure 5A), both the male and female were found in a deep cave chamber, in an aphotic area (Figure 5B-C). This chamber consists of a collapsed chamber, trespassed by a small autogenic stream. The male was found resting on a rock (Figure 5D), while the female was attracted by the headlamps. Some roots mats from the epigean vegetation were observed in some areas. However, immatures of *F. urieli* sp. nov. were not observed. It is interesting noting that although nymphs were not observed near the accessible root mats (for the collectors), there are roots also occurring in many inaccessible areas on the cave walls and ceiling. This cave is located within the limits of a State protected area (Parque Estadual do Ibitipoca), and entering this cave is only allowed for research. Other caves on the area were sampled but specimens were not

found. It is noteworthy that specimens of *F. urieli* were also found in caves from other lithologies, as limestone and iron ore, located quite distant from each other (in straight line, the most distant caves where the species occur are around 700 km far from each other), thus indicating it presents a wide distribution. This species likely occurs in external habitats, but considering its frequent association to caves, it might constitute a troglophilic species.

***Ferricixius michaeli* sp. nov.**
(Figures: 1B; 2B; 6A-F; 7A-G; 8D; 12 B; 17A, D)

Type material. Holotype: Male. Brazil, Minas Gerais. Prudente de Moraes municipality, ICMAT-53 Cave, (UTM 592388W, 7842404S, 23K), 13.ix.2018, (Col. Ativo ambiental et al.) (ISLA 100980); Female same data as male holotype (ISLA 100981). Holotype condition: They are not dissected, stored in individual vials in ethanol 70%. *Paratypes*: 1 nymph same data as male holotype except for (ISLA 100982).

Description.

Coloration (specimen preserved in 70% ethanol): As in figures 1B, 6A-C, 7A-G, principally Yellowish white (92) contrasting with some areas to thorax and male genitalia with Pale yellow (89) and Light yellow (86), hyaline tegmina with veins in Yellowish white (92) an on the figures 6D.

Body length. Male. 4.246 mm (n = 1); Female. 4.784 mm (n = 1).

Head (Figures 6 A-C). Vertex (Figures 6 A, C): Approx. 1.1 times wider (0.385) than long (0.345); apical compartment large and irregular, approx. 1.5 times wider (0.313) than medially long (0.203); apical transverse carina well developed, moderately elevated, and well elongated medially; subapical carina weakly elongated medially; angle formed by the caudal border weakly curved, almost straight; without basal emargination. Frons (Figure 6B): Almost as long (0.469) as wide (0.475), approx. 1.3 times wider at the height of the antennae than at the anterior region (0.351). Compound eyes and ocelli (6A-C; 12B): Well vestigial. Frontoclypeal suture (Figure 6B), as on the diagnosis of the genus provide here, and well evanescent. Post and anteclypeus (Figure 6B), as on the diagnosis of the genus provide here.

Thorax (Figures 6A-C). Pronotum (Figure 6A, C): submedian carinae moderately developed, in frontdorsal view slightly concave laterally and moderately evanescent distally; hind margin obtusely angled. Mesonotum (Figure 6A): tricarinate, carinae well evanescent. Tegmina (forewings) (Figures 6D): length (3.076 mm); ScP absent or evanescent; RA+RP1 fused; MP2+MP3+4 fused; petiole anterior to MP1+2 fork, short

or absent; C1’ cell present and reduced, displaced from the distal margin; C3 and C3’ cells absent; 8 apical cells and 7 subapical cells (including C1'). Posterior legs (Figures 6E-F): Exhibit 4 lateral spines on hind tibia; hind tibia (1.561 mm) with 6 apical teeth medially separated (3+3); 1st tarsomere with 6 apical teeth with approx. the same size; 2nd tarsomere with 4 apical teeth, the two middle ones are closer, without thin setae.

Male genitalia (Figures 7A-G). Genital segment (Figures 7A-C, G): Ventromedian process triangular elongated, gradually tapering to the apex. Anal segment (Figures 7A-C): In dorsal view approx. 1.8 times as long (0.684) as wide (0.381). Genital styles (Figures 7A-C, G): As on the diagnosis of the genus provide here. Aedeagus (Figures 7D-F): Laterally flattened with one large process starting near the base; weakly concave laterally and curved on the proximal margin, almost straight on the distal margin, and serrated/irregularly dentate on the ventral margin (more distally). Aedeagal shaft with two subapical spinose processes, one of which is bifid; the spinose bifid process occurs on the right lateral, the largest spine extends beyond the base of the ventral process when at rest and twice the size of the smaller spine; the bifurcation begins moderately distant from the base of the process; second spinose process moderately short and weakly curved, occurs more ventrally. Flagellum moderately tubular with "spine-like" process laterally near the apex; process dorsolaterally apically rounded as provide here on the diagnosis to the genus; in *F. michaeli* **sp.nov** moderately large and has approx. 2/3 the size of the flagellum.

Differential diagnosis. *F. michaeli* **sp.nov** distinguished from other species of the genus *Ferricixius* Hoch e Ferreira, 2012 mainly by its troglomorphic morphology with a slightly reduced tegmina (still reaching of genital segment), vs epigeomorphic morphology in *F. urieli* **sp.nov** and, troglomorphic morphology with a very reduced tegmina in *F. goliathi* **sp.nov** and *F. davidi* Hoch e Ferreira, 2012.

Etymology. The epithet *michaeli* refers to the Archangel Michael, who is present in several religions, as Christian, Jewish and Islamic. Archangel Michael is considered a defender of the church and of all Christian people, being considered the messenger of God. In Hebrew, Michael means “one who is similar to God”, interpreted as “Who is like God”.

Ecology. Specimens of *F. michaeli* sp. nov. were collected in ICMAT-0053 cave, a limestone cave located in the municipality of Matozinhos, Minas Gerais state, southeastern Brazil (Fig 8A-C). The cave presents 345.7 meters of horizontal projection and a single entrance. The two specimens were collected in a small aphotic chamber in the deeper area of the cave. The female was found under a small block of dry clay while

the male was observed on the cave roof, just above the spot where the female was collected. The site was apparently dry, with no evidence of recent water activity or the presence of roots. The chamber was quite oligotrophic, whith no visible organic resources (as bat guano or vegetable debris) and only few invertebrate specimens were observed in the area (Pholcidae spiders and Phalangopsidae crickets). Two other visits were carried out in the cave, the first in September 2017 and the second in March 2019, but both failed in finding additional specimens. This may indicate the species occurs in cryptic habitats or presents an extremely low population desnity, unlike other troglobitic species of the genus (*F. davidi* and *F. goliathi* sp.nov.), which are always observed during visits to the caves where they occur.

The type locality of *F. michaeli* sp. nov. is inserted in a region strongly affected by agricultural and mining activities. Pastures and quarries surround the outcrop in which the cave is located (Fig. 8A). These activities can directly affect the water quality and availability as well as the surrounding vegetation, which are essential for phytophagous hemipterans. Another concern is the dust generated by the limestone mining, which was observed to accumulate in the surrounding vegetation and in parts of the cave, especially near the entrance. Mining activities occurs in the region for at least four decades. As the species is strongly dependent on vegetation and moisture, changes arising from such activities can put the species at risk. Thus, actions aiming at recovering the environment surrounding the outcrop are strongly recommended.

***Ferricixius goliathi* sp. nov.**
(Figures: 1C; 2C 9A-F; 10A-G; 11E-F;12C; 17A, C)

Type material. Holotype: Male. Brazil, Minas Gerais. Nova Lima municipality, ABOB_0043 Cave, (UTM 618184W, 77608807S, 23K), 14.ii.2020, (Col. Zampaulo) (ISLA 100983); Female same data as male holotype except for 19.vii.2021, (Col. Simões, M. H) (ISLA 100984). Holotype condition: They are not dissected, stored in individual vials in ethanol 70%. *Paratypes*: 1♂ same data as male holotype except for (ISLA 100985). 1♂ and 1 nymph same data as male holotype except for (ISLA 100986).

Description.

Coloration (specimen preserved in 70% ethanol): As in figures 1C, 9A-C, 10A-G, principally Yellowish white (92) contrasting with some areas to thorax and male genitalia with Pale yellow (89) and Light yellow (86), hyaline tegmina with veins in Yellowish white (92) an on the figures 9D.

Body length. Male. 3.976-4.156 mm (n = 3); Female. 4.312 (n = 1).

Head (Figures 9A-C). Vertex (Figures 9A, C): Approx. 1.2 times wider (0.329) than long (0.261); apical compartment large and irregular, approx. 1.7 times wider (0.288) than medially long (0.162); apical transverse carina moderately evanescent; subapical carina weakly elongated medially; angle formed by the caudal border moderately curved; without basal emargination. Frons (Figure 9B): Approx. 1.2 times longer (0.465) than wide (0.385), approx. 1.3 times wider at the height of the antennae than at the anterior region (0.293). Compound eyes and ocelli (9A-C; 12C): Well vestigial. Frontoclypeal suture (Figure 9B), as on the diagnosis of the genus, and well evanescent. Post and anteclypeus (Figure 9B), as on the diagnosis of the genus.

Thorax (Figures 9A-C). Pronotum (Figure 9A, C): Submedian carinae moderately developed, in frontdorsal view almost straight laterally and well evanescent distally; hind margin curved. Mesonotum (Figure 9A): Tricarinate, very evanescent carinae. Tegmina (forewings) (Figures 9D): Length (1.235 mm); very reduced; fork ScP+RA evanescent; MP present and distally forked; CuA and CuP present, CuA without fork. Posterior legs (Figures 9E-F): Exhibit 4 lateral spines on hind tibia; hind tibia (1.235 mm) with 4 apical teeth medially separated (2+2); 1st tarsomere with 4 apical teeth with approx. the same size; 2nd tarsomere with 4 apical teeth, without thin setae.

Male genitalia (Figures 10A-G). Genital segment (Figures 10A-C, G): ventromedian process triangular elongated, very smaller apically with rounded apex. Anal segment (Figures 10A-C): In dorsal view approx. 2.0 times as long (0.699) as wide (0.334), slightly narrow medially and concave distally. Genital styles (Figures 10A-C, G): as on the diagnosis of the genus provide here. Aedeagus (Figures 10D-F): Shaft laterally flattened with a large process starting near to the base, which becomes abruptly smaller distally, weakly curved laterally on the proximal margin, very sinuous on the distal margin, and with three teeth on the ventral margin (more distally). Aedeagal shaft with two subapical spinose processes, one of which is bifid; spinose bifid process occurs on the right lateral, largest spine extends beyond the base of the shaft when at rest and less twice the size of the smaller spine; bifurcation begins near the base the process; second spinose process moderately large and curved, occurs in left lateral. Flagellum moderately tubular with "spine-like" process laterally on the apex; process dorsolaterally apically rounded as provide here on the diagnosis to the genus; in *F. goliathi* **sp.nov** moderately short and has approx. 1/3 the size of the flagellum.

Differential diagnosis. *F. goliathi* **sp.nov** distinguishes of other species of the genus *Ferricixius* Hoch e Ferreira, 2012 mainly by the morphology of the ventral process on the shaft aedeagal which becomes abruptly smaller distally (tubular) vs wide and

flattened in *F. michaeli* **sp.nov** e *F. davidi* Hoch e Ferreira, 2012, or slightly curved as in F. urieli sp.nov. Furthermore, *F. goliathi* **sp.nov** exhibit on the ventral process of the shaft only three teeth on the ventral margin (more distally) vs. serrated with many teeth in *F. urieli* **sp.nov**, *F. michaeli* **sp.nov** and *F. davidi* Hoch e Ferreira, 2012.

Etymology. The epithet *goliathi* refers to Goliath (/gəˈlaɪəθ/ gə-LY-əth)[a] who is a character from the biblical Book of Samuel, described as a Philistine giant defeated by the young David in single combat. In the original description of *Ferricixius davidi*, the epithet *davidi* was given referring to David, king-to-be of who managed to defeat Goliath, a physically far superior Philistine warrior. The epithet was chosen as a metaphor of a tiny insect fighting the giant mining sector. Now, the epithet *goliathi* intend to homage the mining company (the former "giant"), whose biologists found and registered for the first time this new species. The "giant" of the mining sector, instead of destroying the new species, helped to preserve it.

Ecology. Specimens of *F. goliathi* **sp. nov**. were only found in the ABOB-0043 cave, which is inserted in the contact between the canga (ferrugineous breccia) and iron itabirites from the Cauê Formation (Fig. 11A; E-F). This formation is located in the Serra da Moeda Geomorphological Unit, which, in turn, belongs to the Speleological Unit of the Iron Quadrangle (Valentim & Olivito, 2011). This cave is located at 1,143 meters of altitude in a small and isolated remnant of rupestrian field located between different mining structures (dam, pit, ore beneficiation plant and roads). The cave has 35.11 meters of horizontal projection, 121.3m^2 of area, 96.35m^3 of volume and 4.96m of unevenness, being considered, therefore, a large cave when compared to other caves associated with the iron formation in the region, which has approximately 2,000 registered caves with an average size of about 20 meters n (CECAV, 2021). This cavity has only one entrance with a horizontal lenticular format and the ceiling height does not exceed 1.5 m at the highest point, with a width of approximately 10 m (Fig. 11B).

The ABOB_0043 cave is a typically oligotrophic environment, with small amounts of litter deposited only in its entrance zone, sparse roots in the initial conduits (entrance and dysphotic zone) and, eventually, remains (carcasses) of vertebrates (rodents) and amphibian feces in the aphotic conduits (Fig.11B). There are no exposed roots in the aphotic conduits. The cave is composed of a predominantly flat conduit in its initial portion, which becomes ascending in its middle to final portion. Therefore, the contribution of organic matter (litter) to the cave interior is very low.

As observed for the vast majority of caves inserted in the iron formation, the ABOB-043 cave is located at the middle slope and very superficially in relation to the

external landscape. This cave presents a high climatic stability, with high humidity rates during the rainy season and several microhabitats (blocks and canaliculi) that can serve as shelter for several species, of which at least eight are troglobites, indicating its biospeleological relevance.

All specimens of *F. goliathi* sp. nov. were observed in aphotic zones, mainly in the intermediate chambers and at the deeper portions of the cave (points 1 to 4 on the map – Figure 11D). Specimens were mainly observed on the cave ceiling. Regarding their abundance, 15 specimens were observed in the rainy season while 13 specimens were found in the dry season, including a few immature individuals.

Complementary description

***Ferricixius davidi* Hoch e Ferreira, 2012**

(Figures: 1D; 12 D; 13A-D; 14A-D; 15A-C;16A-C; 17A-B)

Type material. Holotype: Male, Brazil, Minas Gerais. Itabirito municipality, MP-008 cave, 20.x.2011, (Col. Oliveira, M.P.), ES/ ISLA 1768.

Material examined. 2♀ and 1♂, same data as holotype except for (ISLA 100992).

Coloration (preserved specimen): Pale yellow (89) contrasting with some areas which are light yellow (86), hyaline tegmina with regions dark yellowish white (92) (conspicuous dark spot).

Body length. Female (examined): 2.868 - 3.207 mm (n =2).

Head (Figures 13 A-B). Vertex (Figure 13A): Apical compartment wider than medially long; caudal border of the vertex irregular; subapical carina elongated medially; apical transverse carina also elongated medially and evanescent laterally. Frons: In lateral view (Figure 13B); lateral carinae totally curved of the base of the vertex to the frontoclypeal suture. Compound eyes and ocellu (Fig. 13B; 13b1; 13D): Compound eyes absent, lateral ocelli vestigial (distinct). Antennae (Fig. 13a1; 13A-C): Short scape, globular pedicel with evident sensory plates; pedicel with flagellum and arista; arista base dashed with two threads apically.

Thorax (Figures 13 A-E). Pronotum (Figure 13 A-B). Mesonotum (Fig. 13A-B). Tegmina (forewings) (Figure 13C): Length (0.867), very reduced; vein ScP+R, MP present, CuA, CuP, and Pcu present, a crossed vein occurs distally between SCP+R and CuP. Vibrational organ (singing) (Fig. 13D). Posterior legs (Fig. 13E): Hind tibia with 4 lateral spines and 6 apical teeth; first tarsomere with 4 apical teeth and second tarsomere with 2 apical teeth.

Female genitalia (Fig. 15C-E). Segment X short; curved dorsally and flattened ventrally. The segment IX as on the diagnosis of the genus. Ovipositor long and in arc-shaped curved up-wards not surpassing the segment X; Gonocoxa VIII exhibits inferior medial region with thin elongated lines side by side.

Discussion

Two alternative hypotheses are considered to explain the evolution of obligatorily cave-dwelling terrestrial species, the climate relics hypothesis (CRH) (Barr 1968) and the adaptive shifts hypothesis (ASH) (Howarth, 2019). Both hypotheses consider the pre-adaptations of troglophilic species to complete the entire life cycle inside the caves (Sket, 2008). In CRH, extreme weather changes such as glacial retreat during the Pleistocene would have extinguished epigean populations and chased away troglophiles populations within cavities, initiating speciation of those populations capable of growing and reproducing in the subterranean environment (Culver, 1982; Rivera et al., 2002). In ASH, the search for a new food resource is pointed out as the incipient factor for the isolation and consequent speciation of troglophile populations in caves (Howarth, 1981; Hoch 2013).

Adaptive shifts (ASH) can be verified whenever for an obligate cave species, populations with corresponding intermediate and/or epigean troglomorphisms can be found around the cave (Hoch & Howarth 1999; Howarth, 2019). We did not find populations of *F. urieli* **sp.nov** around the type cavities of *F. michaeli* **sp.nov**, *F. goliathi* **sp.nov** and *Ferricixius davidi* Hoch and Ferreira, 2012. However, a single female *of F. urieli* **sp.nov** (ISLA 100990), was collected on te the RM-03 cave, in the municipality of Nova Lima-MG, moderately close (20 km) to the type locality de *F. goliathi* **sp.nov**, ABOB_43 cave. *F. urieli* **sp.nov**, it is moderately large and has well-developed wings, possibly these characters give it a good locomotion capacity, which is reflected in its wide distribution (Fig. 17E). Furthermore, most of the records obtained for *F. urieli* **sp.nov**, are for the Iron quadrangle, in municipalities close to the type location of *Ferricixius davidi* Hoch and Ferreira, 2012, *F. goliathi* **sp.nov** and *F. michaeli* **sp.nov**.

F. michaeli **sp.nov.** exhibits characters with intermediate troglomorphisms, such as slightly reduced body size and wings, although it has vestigial and apparently non-functional eyes and ocelli. *F. michaeli* **sp.nov.** can be distinguished from other species of the genus *Ferricixius* Hoch and Ferreira, 2012, by the venation and size of the tegmina and also by the ventral serrated process of the aedeagus, which is wide and almost straight distally. Furthermore, among the troglobitic species of *Ferricixius* Hoch and Ferreira,

2012, *F. michaeli* **sp.nov** is the only species that presents type locality for a carbonate lithology cave. Caves of carbonate lithology are characterized by being often formed by long and wide channels, due to the high rate of dissolution of the rock by water. Selection in a habitat characterized by large spaces may have allowed *F. michaeli* **sp.nov** to maintain the slightly reduced size of the body and wings, given the absence of selective pressure from smaller individuals capable of transiting in small spaces, such as those formed in iron rocks.

Ferricixius davidi Hoch and Ferreira, 2012, and *F. goliathi* **sp.nov.** occur only in the type locality in caves of the Iron quadrangle. Caves in iron lithology are characterized by being often small and connected by numerous canaliculi inserted into the matrix rock. These environments often select smaller individuals, capable of moving between spaces in the rock to feed and/or reproduce. *Ferricixius davidi* Hoch and Ferreira, 2012, and *F. goliathi* **sp.nov**. are the smallest species among their congeners and exhibit strong troglomorphisms, such as body size, fore and hind wings very reduced, and smaller number of teeth on the first and second tarsomere of the hind leg. However, *Ferricixius davidi* Hoch and Ferreira, 2012, and *F. goliathi* **sp.nov.** can be differentiated mainly by aedeagus, the ventral process in the shaft aedeagal is narrow and with 3 distal teeth in *F. goliathi* **sp.nov** and is wide and with many teeth in *Ferricixius davidi* Hoch and Ferreira, 2012. The dorsolateral process of the flagellum is hook-shaped in *Ferricixius davidi* Hoch and Ferreira, 2012, and apically circular and dorsoventrally flattened in *F. goliathi* **sp.nov** as on the other species of the genus. Furthermore, *F. goliathi* **sp.nov** exhibits a spine-like process apically in the flagellum that is absent in *Ferricixius davidi* Hoch and Ferreira, 2012.

The discovery of new troglobitic species of the genus *Ferricixius* Hoch and Ferreira, 2012, highlights the importance of biospeleological studies in areas of interest for mining on Brazil. The new obligatory cave species described here are unique and endemic and must be protected along with their entire habitat. However, recent threats put the new species described here and many others that live in caves at risk. Decree 10.935/2022, recently published by the Federal Government of Brazil (Ferreira et al., 2022) is a threat to single cavities and all the fauna associated with them. The Decree 10.935/2022 approved by President Jair Messias Bolsonaro without consulting experts in the field, allows mining and road construction projects to irreversibly impact natural underground cavities across the country, even caves recognized as of maximum biological, archaeological and geological relevance, and that have several singular attributes. Therefore decree 10.935/2022 must be repealed urgently.

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References

Álvarez-Padilla, F., & Hormiga, G. (2007) A protocol for digesting internal soft tissues and mounting spiders for scanning electron microscopy. *The Journal of Arachnology*, *35*(3), 538-542.

Barr, T. C. (1968). Cave ecology and the evolution of troglobites. In *Evolutionary biology* (pp. 35-102). Springer, Boston, MA.

Bourgoin T. (2022) FLOW (Fulgoromorpha Lists on The Web): a world knowledge base dedicated to Fulgoromorpha. Version 8, updated [date]. https://hemiptera-databases.org/flow/

Culver, D. C. (1982) Cave Life: Evolution and Ecology Harvard University Press. *Cambridge, Massachusetts*.

Ferreira, R. L., Bernard, E., da Cruz Júnior, F. W., Piló, L. B., Calux, A., Souza-Silva, M., ... & Frick, W. F. (2022) Brazilian cave heritage under siege. *Science*, *375*(6586), 1238-1239.

Hampe, A., & Jump, A. S. (2011) Climate relicts: past, present, future. *Annual Review of Ecology, Evolution, and Systematics*, *42*, 313-333.

Hoch, H. (2013) Trirhacus helenae sp. n., a new cave-dwelling planthopper from Croatia (Hemiptera: Fulgoromorpha: Cixiidae). *Deutsche Entomologische Zeitschrift*, *60*(2), 155-161.

Hoch, H., & Ferreira, R. (2016) Iuiuia caeca gen. n., sp. n., a new troglobitic planthopper in the family Kinnaridae (Hemiptera, Fulgoromorpha) from Brazil. *Deutsche Entomologische Zeitschrift*, *63*, 171.

Hoch, H., & Ferreira, R. L. (2012) Ferricixius davidi gen. n., sp. n.–the first cavernicolous planthopper from Brazil (Hemiptera, Fulgoromorpha, Cixiidae). *Deutsche Entomologische Zeitschrift*, *59*(2), 201-206.

Hoch, H., & Ferreira, R. L. (2013). Potiguara troglobia gen. n., sp. n.–first record of a troglobitic Kinnaridae from Brazil (Hemiptera: Fulgoromorpha). *Deutsche Entomologische Zeitschrift*, *60*(1), 33-40.

Hoch, H., & Howarth, F. G. (1999) Multiple cave invasions by species of the planthopper genus Oliarus in Hawaii (Homoptera: Fulgoroidea: Cixiidae). *Zoological Journal of the Linnean Society*, *127*(4), 453-475.

Howarth, F. G. (1981) Non-relictual terrestrial troglobites in the tropical Hawaiian caves. In *Proceedings of the 8th International Congress of Speleology, Huntsville, AL (USA)* (Vol. 1, No. 98, p. 1).

Howarth, F. G. (2019) Adaptive shifts. In: **Encyclopedia of caves**. *Academic Press*. p. 47-55.

Rivera, M. A. J., Howarth, F. G., Taiti, S., & Roderick, G. K. (2002) Evolution in Hawaiian cave-adapted isopods (Oniscidea: Philosciidae): vicariant speciation or adaptive shifts?. *Molecular Phylogenetics and Evolution*, *25*(1), 1-9.

List of figures

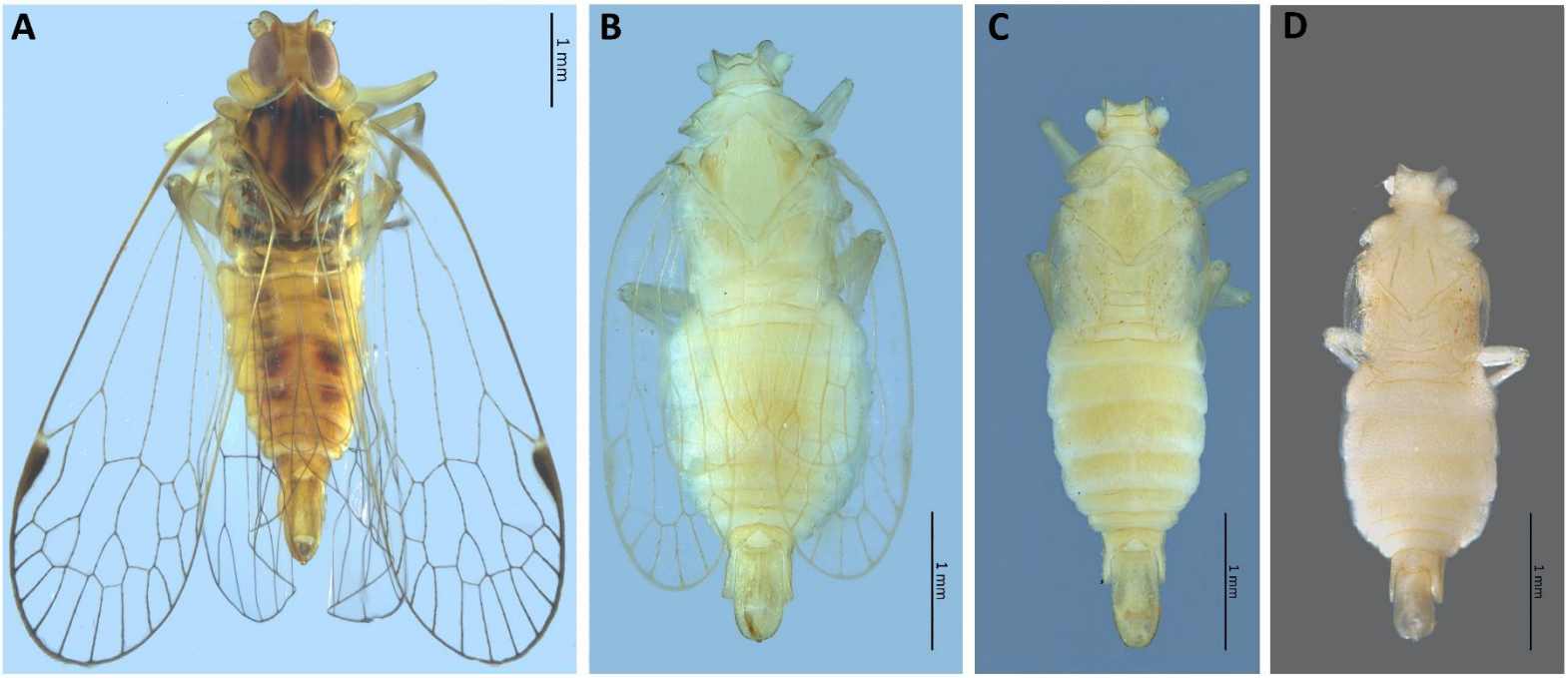

FIGURE 1. Habitus in dorsal view: *Ferricixius urieli* **sp.nov**. (A); *Ferricixius michaeli* **sp.nov**. (B); *Ferricixius goliathi* **sp.nov**. (C); F*erricixius davidi* Hoch and Ferreira, 2012 (D).

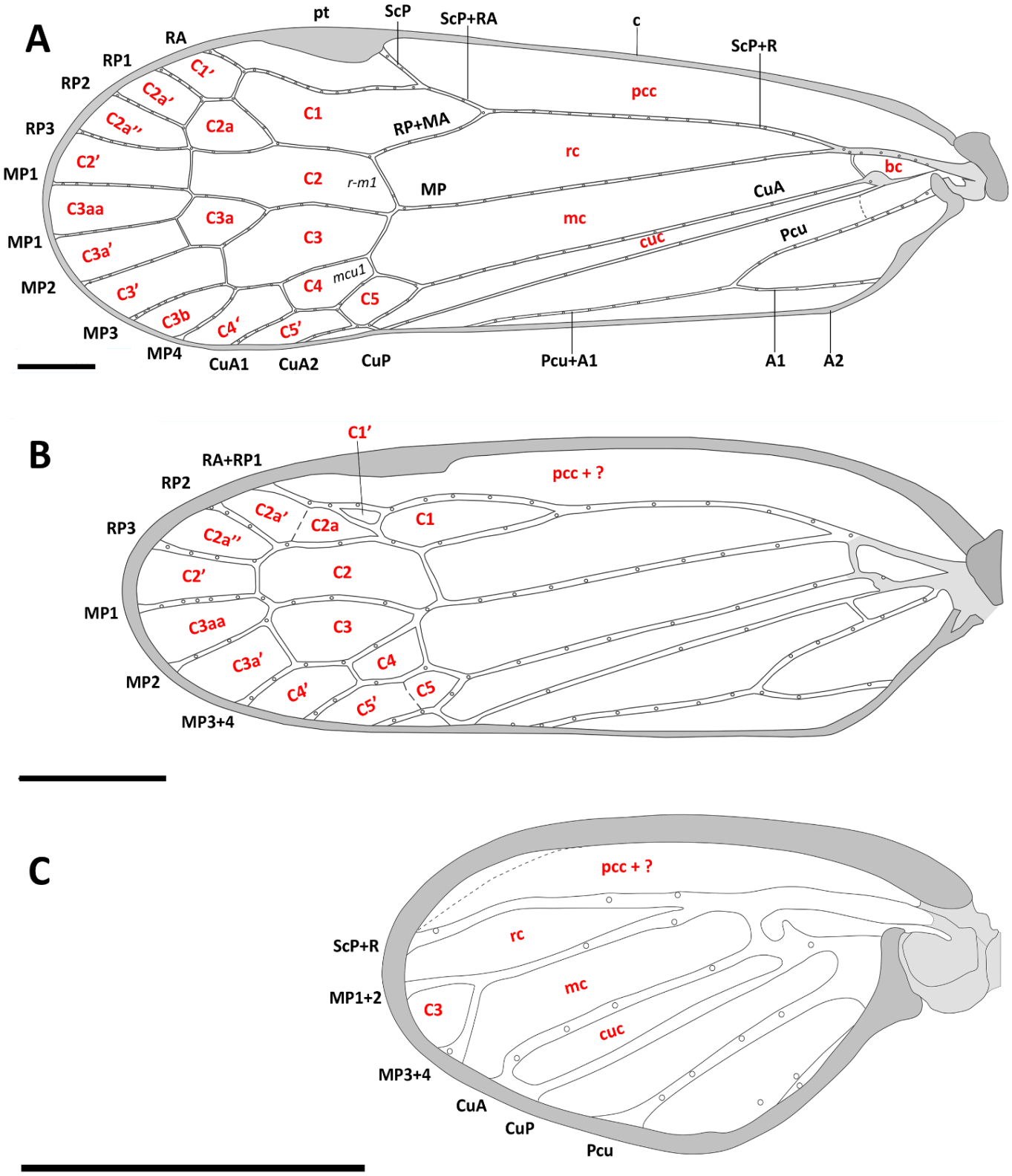

FIGURE 2. Tegmina: Ferricixius urieli **sp.nov**. (A); Ferricixius michaeli **sp.nov**. (B); Ferricixius goliathi **sp.nov**. (C).

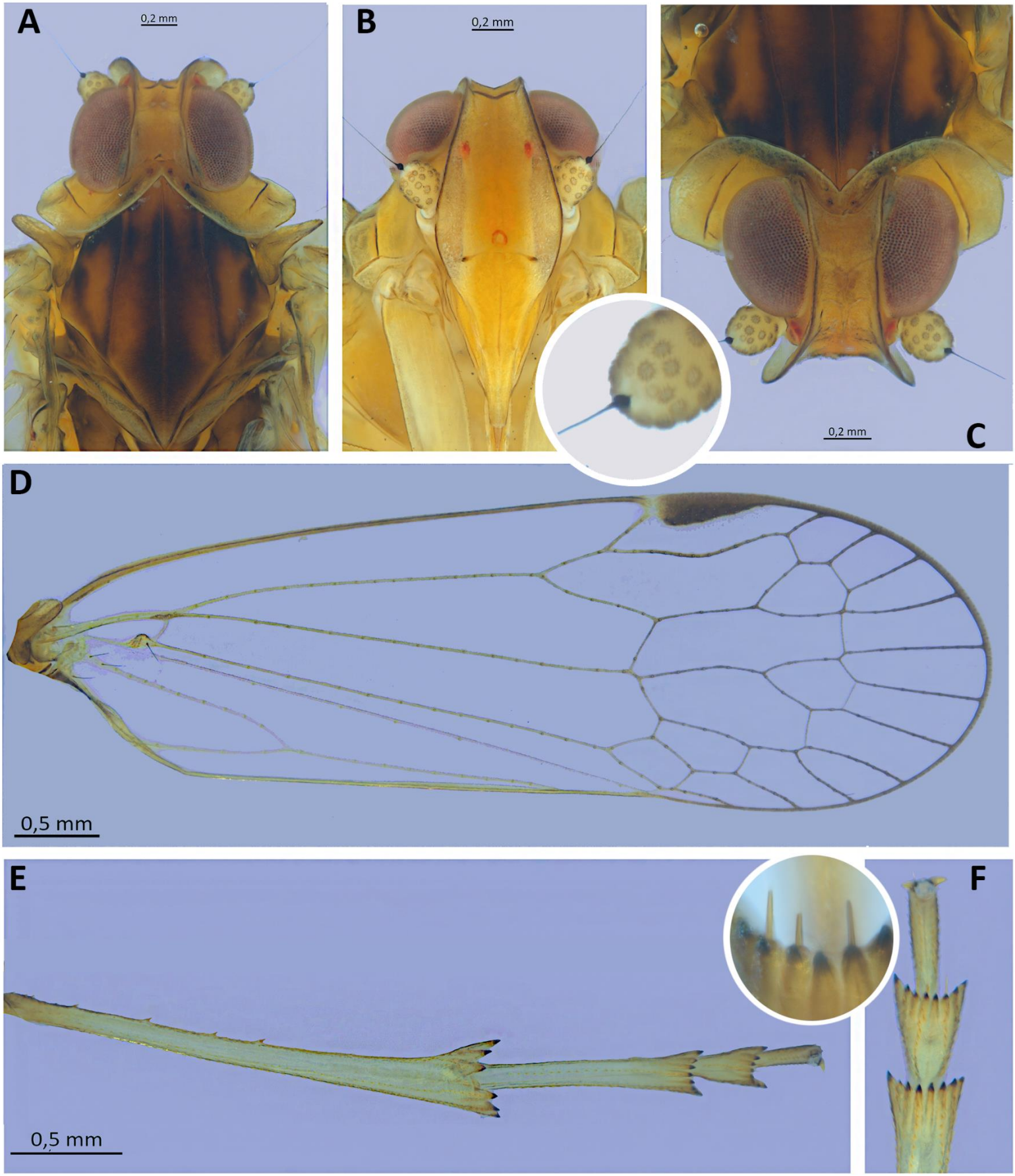

FIGURE 3. *Ferricixius urieli* **sp. nov**: A-C head, C1 pedicel with flagellum; D tegmina (forewings); E posterior leg; F tarsomeres.

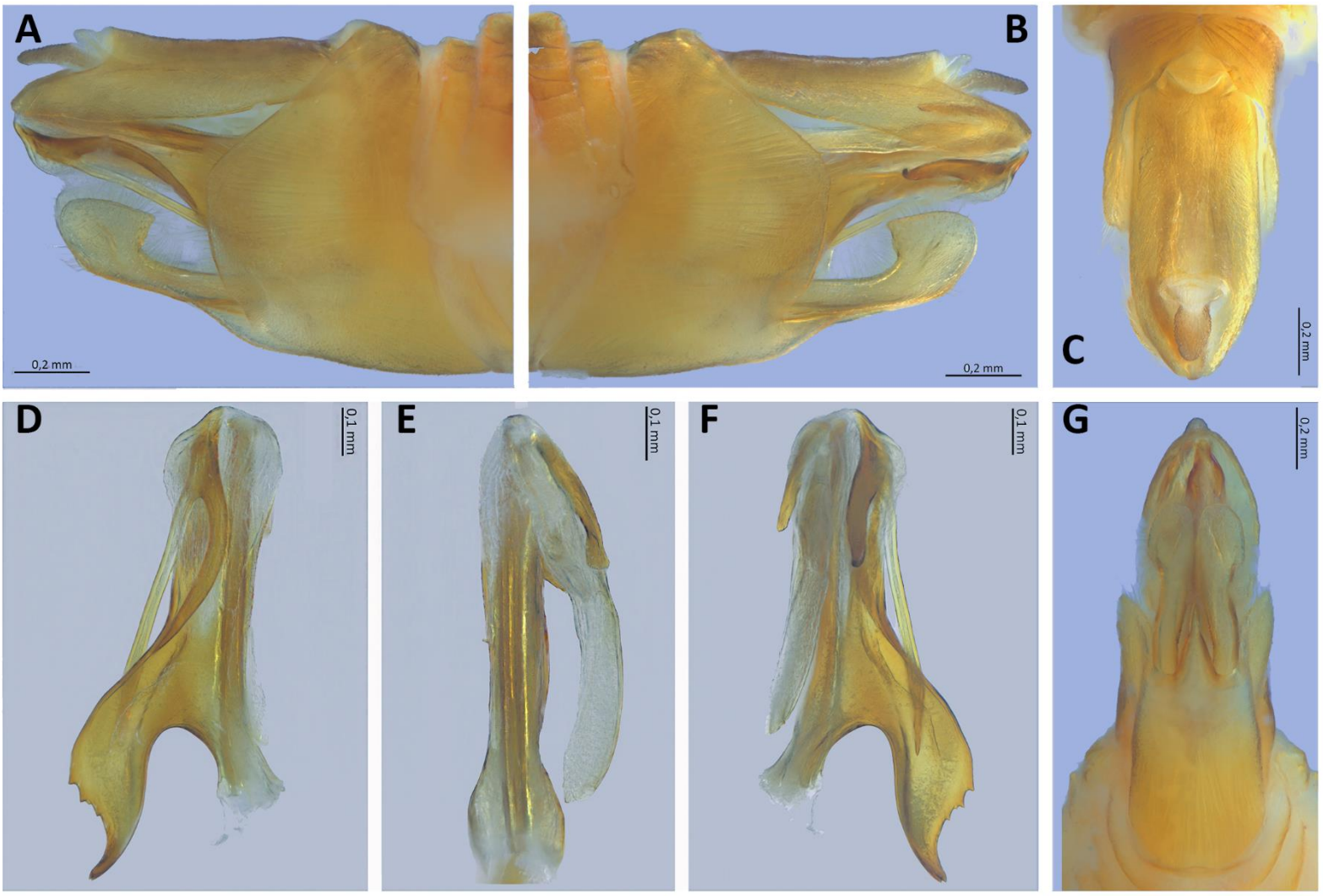

FIGURE 4. *Ferricixius urieli* **sp. nov,** male genitália: A genital capsule right lateral; B genital capsule left lateral; C genital capsule dorsally; D aedeagus right lateral; E aedeagus frontally; F aedeagus left lateral; G genital capsule ventrally.

FIGURE 5. Habitat *Ferricixius urieli* **sp. nov**: Casas cave, Limas Duarte municipality- MG (A-C); habitus *Ferricixius urieli* sp. nov (D).

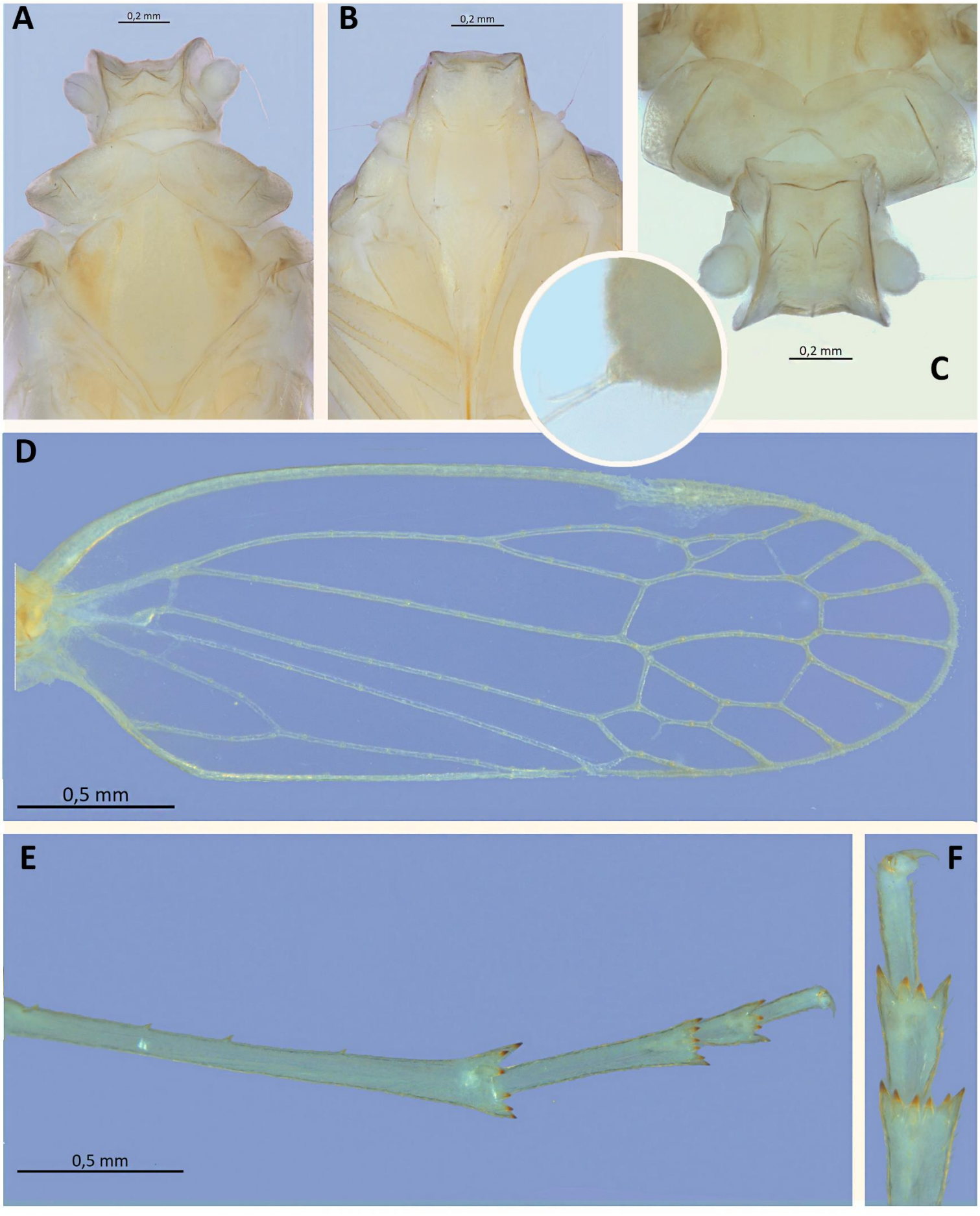

FIGURE 6. *Ferricixius michaeli* **sp. nov**: A-C head, C1 pedicel with flagellum and arista; D tegmina (forewings); E posterior leg; F tarsomeres.

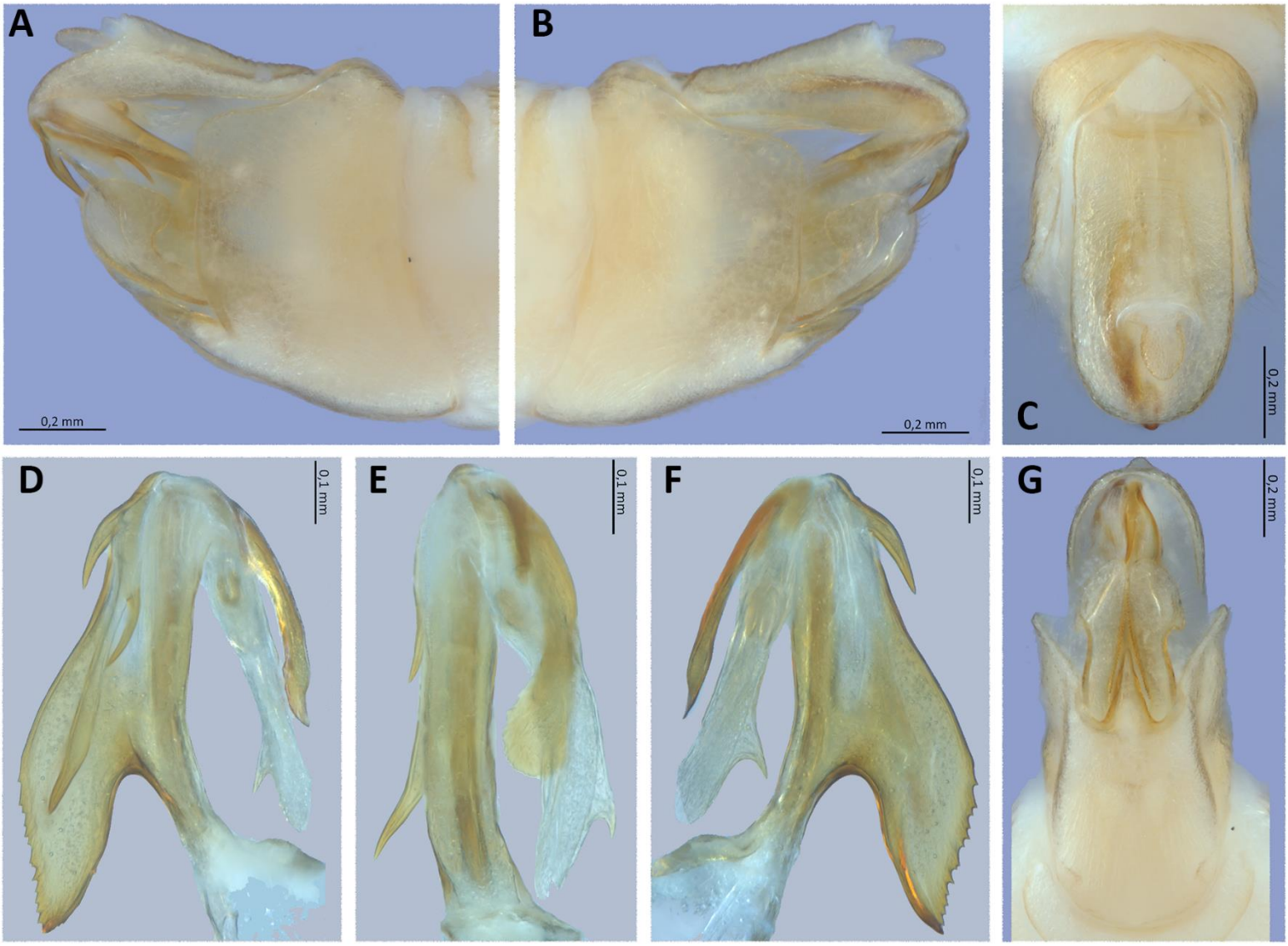

FIGURE 7. *Ferricixius michaeli* **sp. nov,** male genitália: A genital capsule right lateral; B genital capsule left lateral; C genital capsule dorsally; D aedeagus right lateral; E aedeagus frontally; F aedeagus left lateral; G genital capsule ventrally.

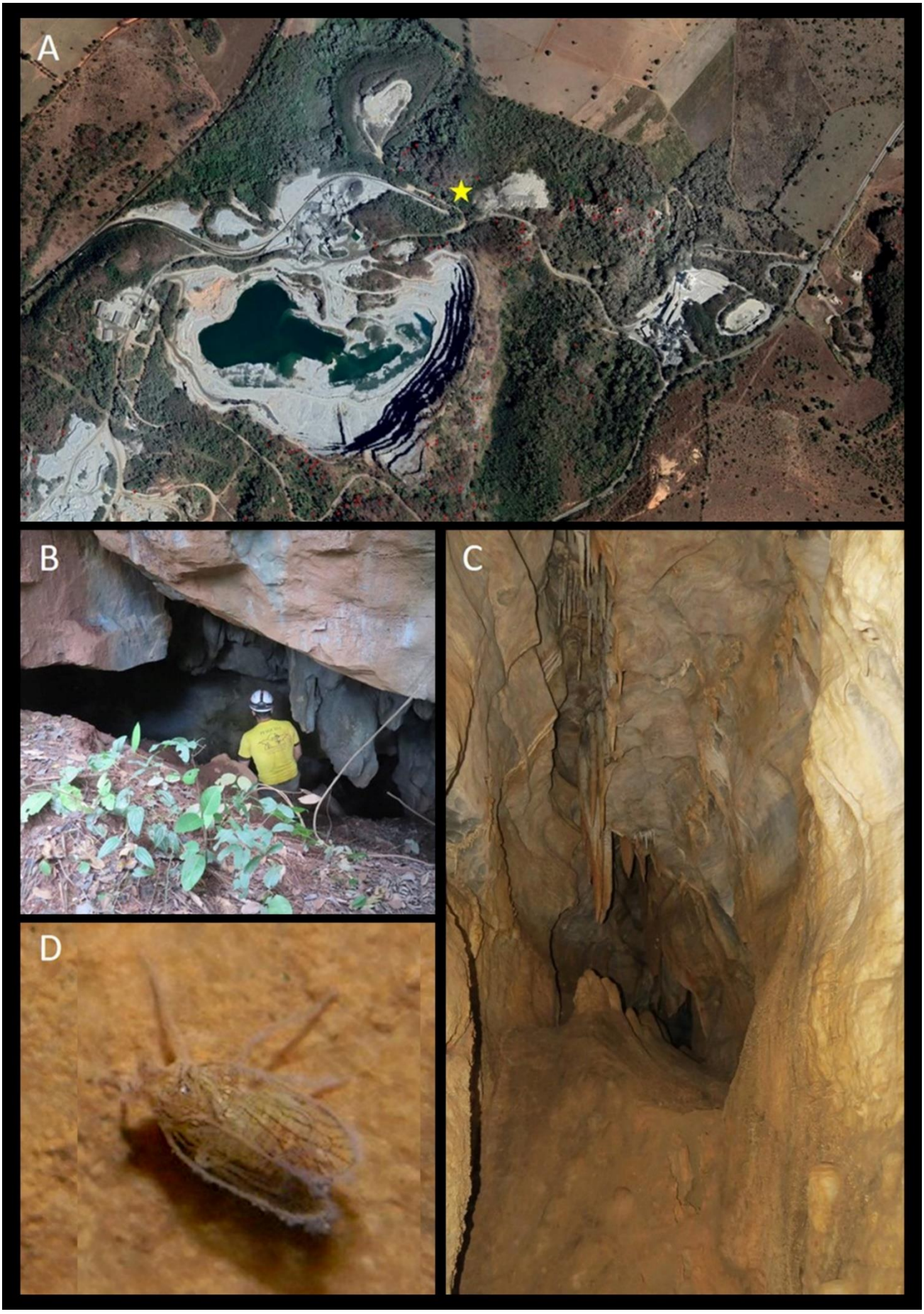

FIGURE 8. Habitat *Ferricixius michaeli* sp. nov: ICMAT-53 cave, Prudente de Moraes municipality- MG (A-C); habitus *Ferricixius michaeli* sp. nov (D).

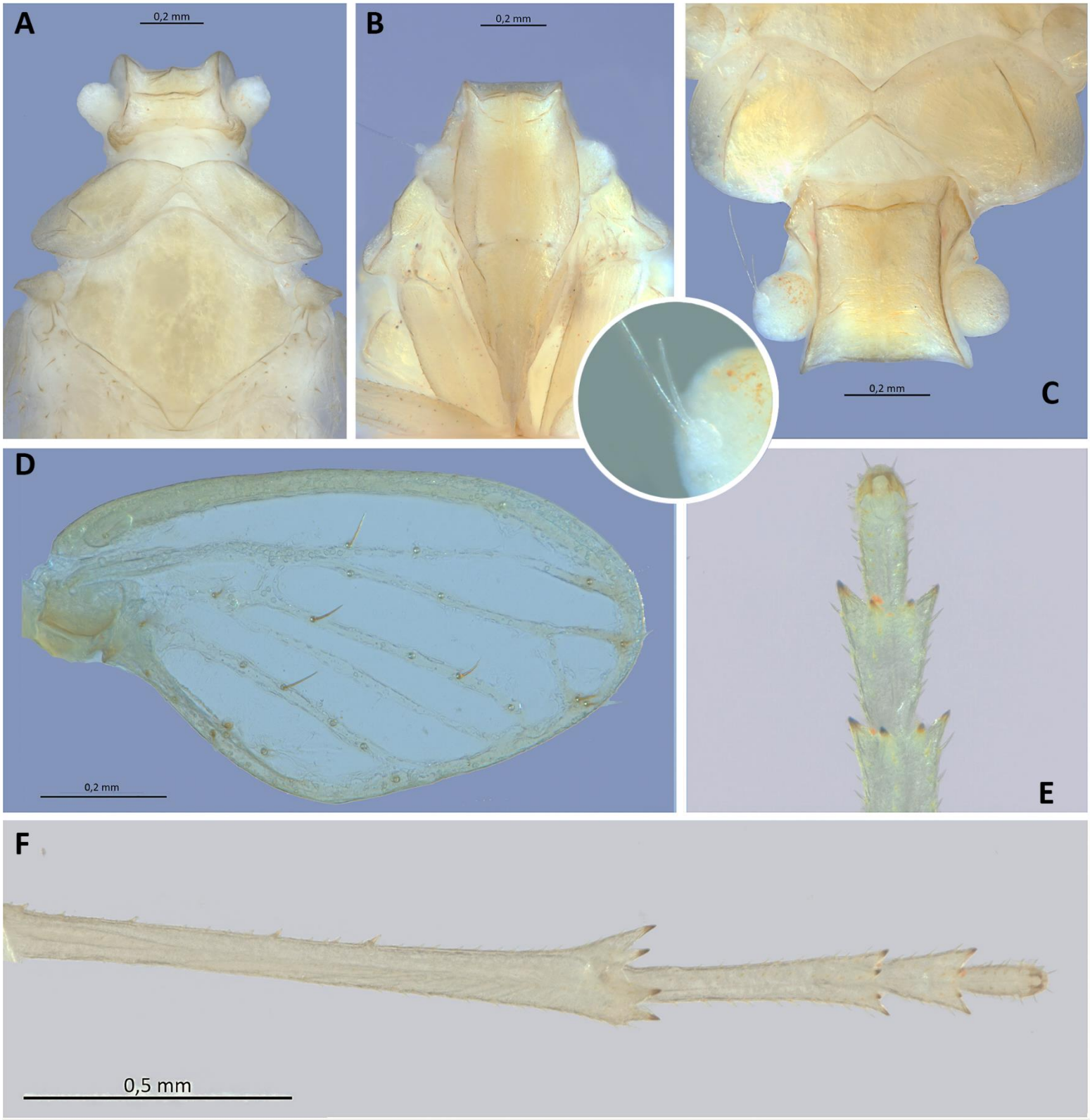

FIGURE 9. *Ferricixius goliathi* **sp. nov**: A-C head, C1 pedicel with flagellum and arista; D tegmina (forewings); E posterior leg; F tarsomeres.

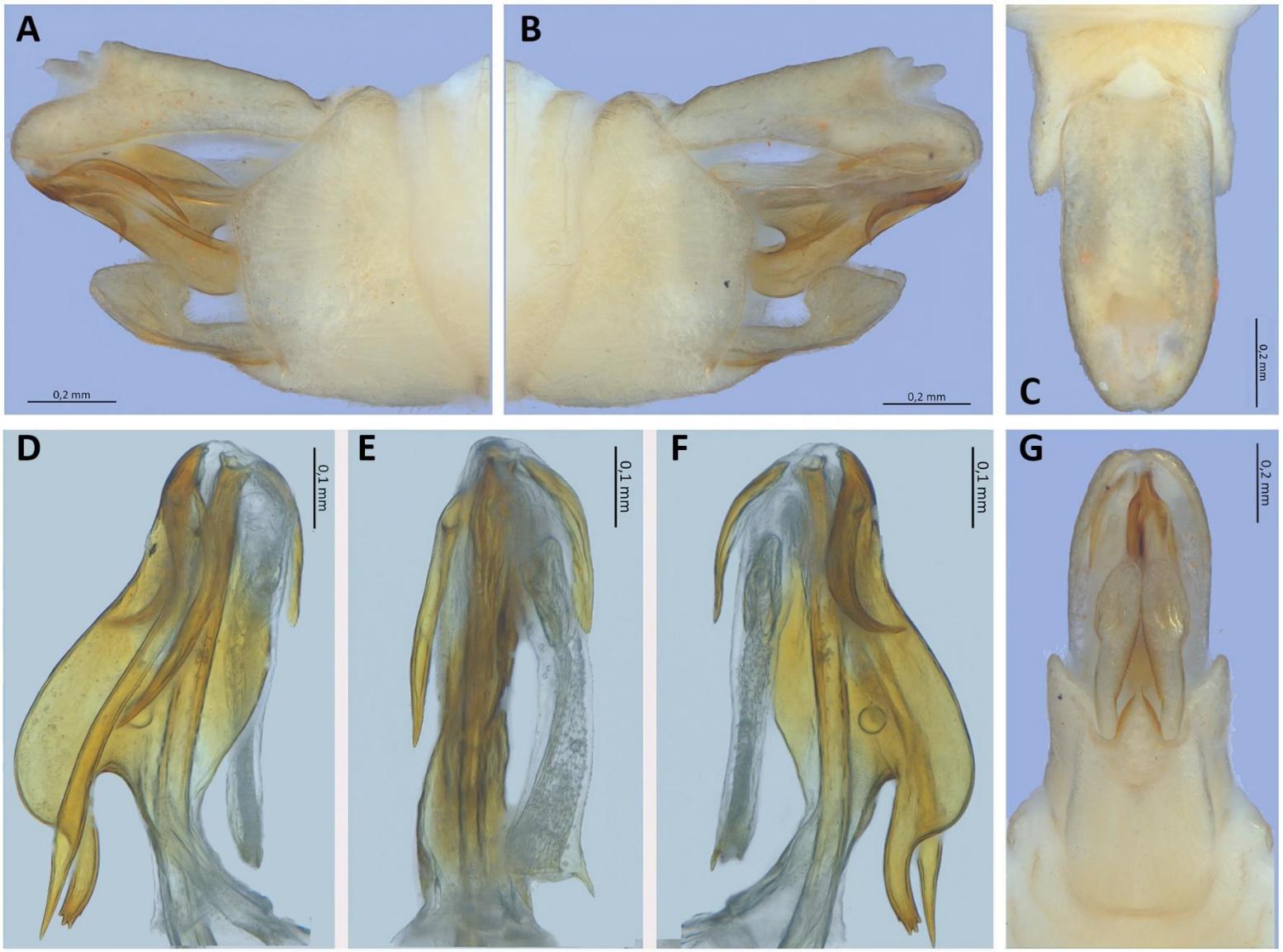

FIGURE 10. *Ferricixius goliathi* **sp. nov,** male genitália: A genital capsule right lateral; B genital capsule left lateral; C genital capsule dorsally; D aedeagus right lateral; E aedeagus frontally; F aedeagus left lateral; G genital capsule ventrally.

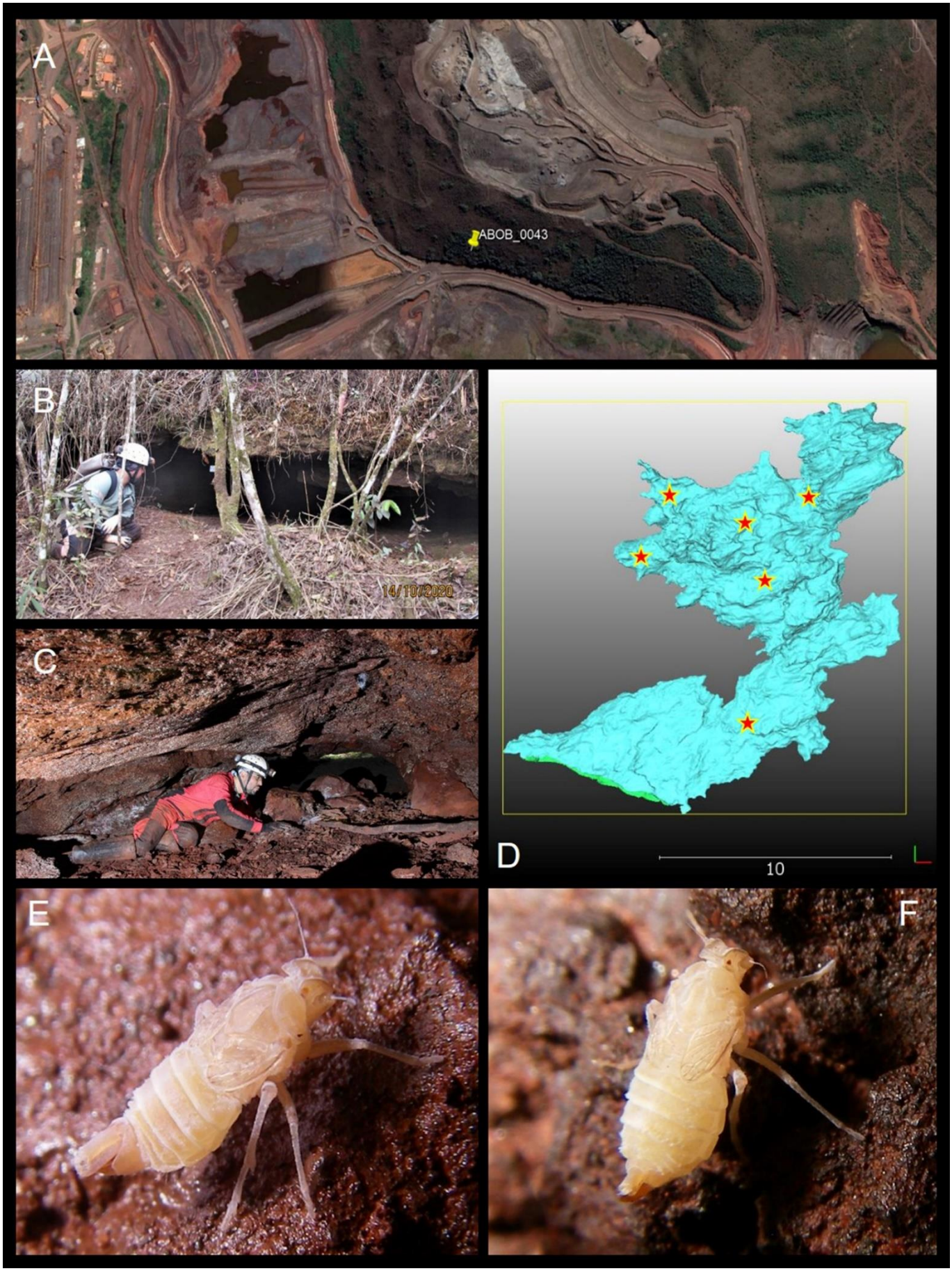

FIGURE 11. Habitat *Ferricixius goliathi* **sp. nov**.: ABOB_43 cave, Nova Lima municipality- MG (A-C); Map of ABOB_43 (D); habitus *Ferricixius goliathi* sp. nov. male (E), female (F).

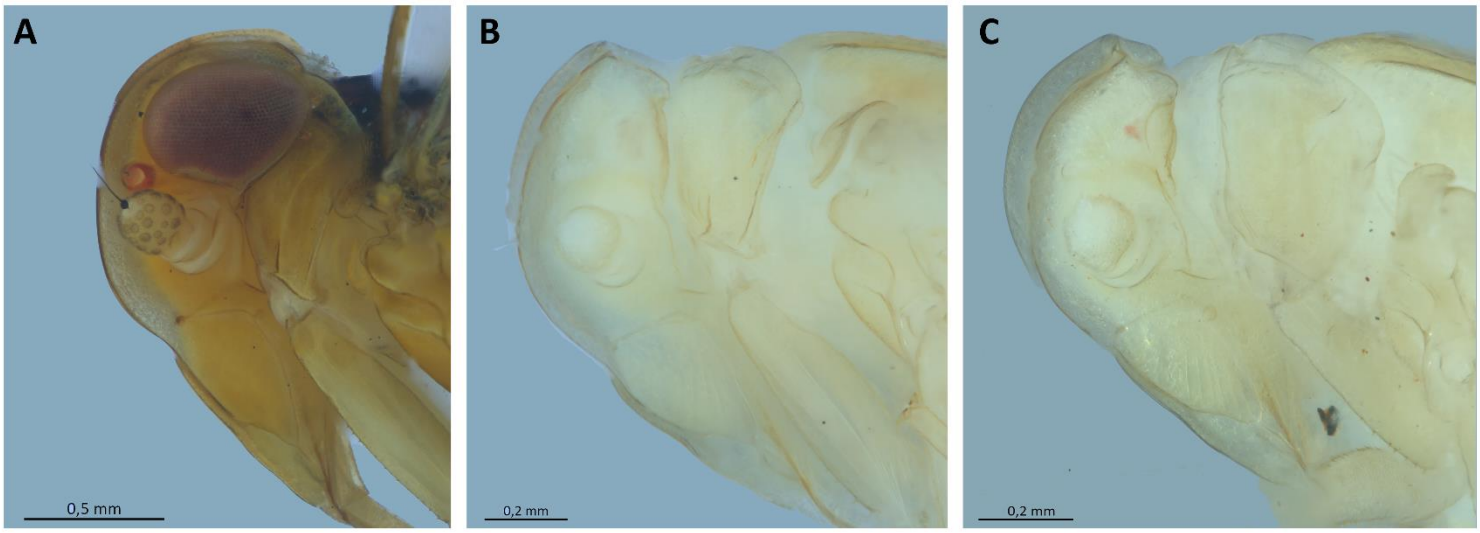

FIGURE 12. Head in lateral view: *Ferricixius urieli* **sp.nov**. (A); *Ferricixius michaeli* **sp.nov**. (B); *Ferricixius goliathi* **sp.nov**. (C).

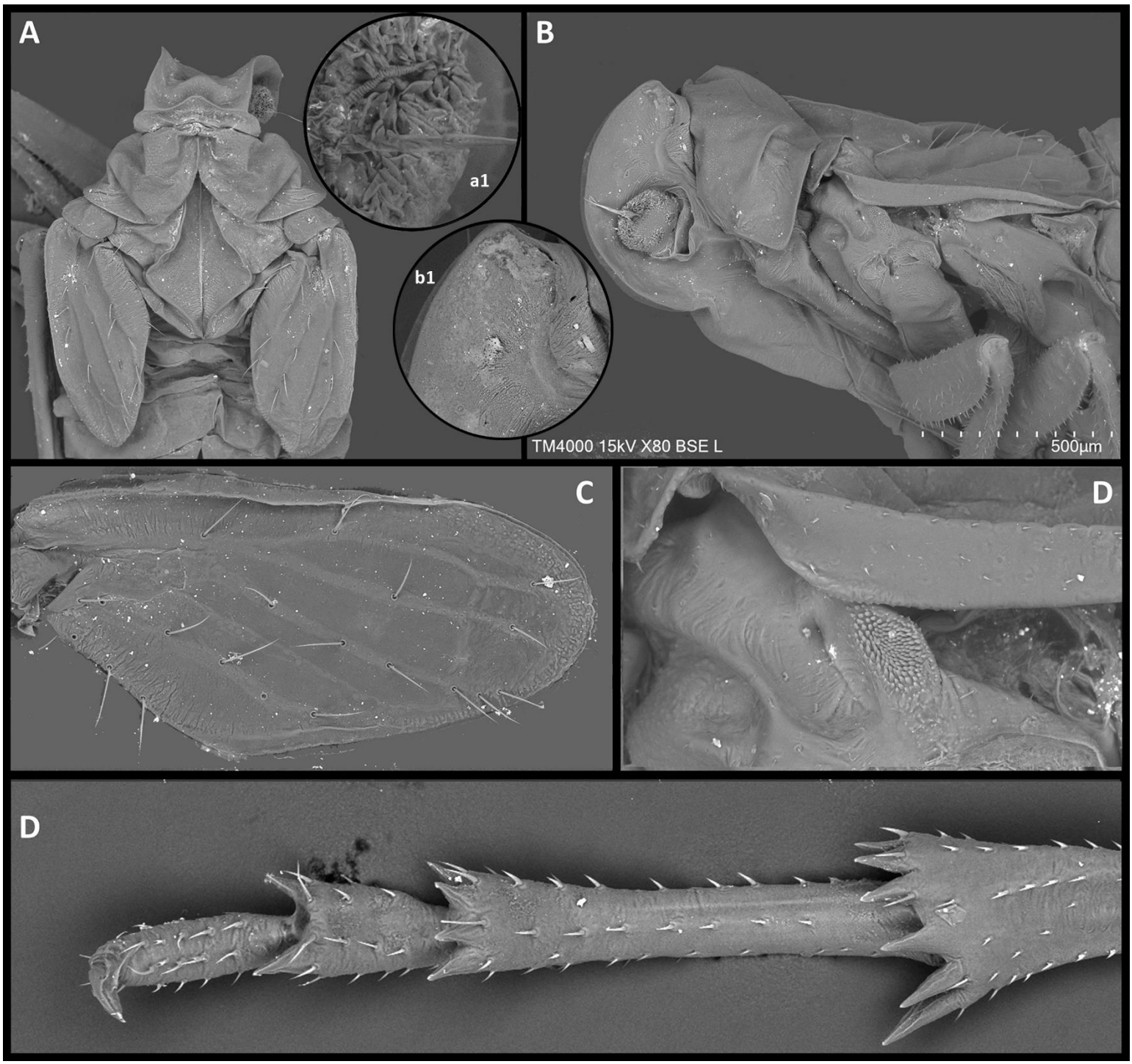

FIGURE 13. *Ferricixius davidi* Hoch and Ferreira, 2012, Female: Head and thorax in dorsal view (A), pedicel with flagellum and awn (a1); Head and thorax in lateral view (B), ocular region (b1); tegmina in ventral view (C); acoustic organ (D); hind leg, with apical teeth of the posterior tibia and tarsomeres (E).

FIGURE 14. *Ferricixius davidi* Hoch and Ferreira, 2012, Female: Antenna in lateral view, with scape, pedicel, flagellum and arista (A); flagellum and arista (B); sensory plates (C); vestigial ocellus (D).

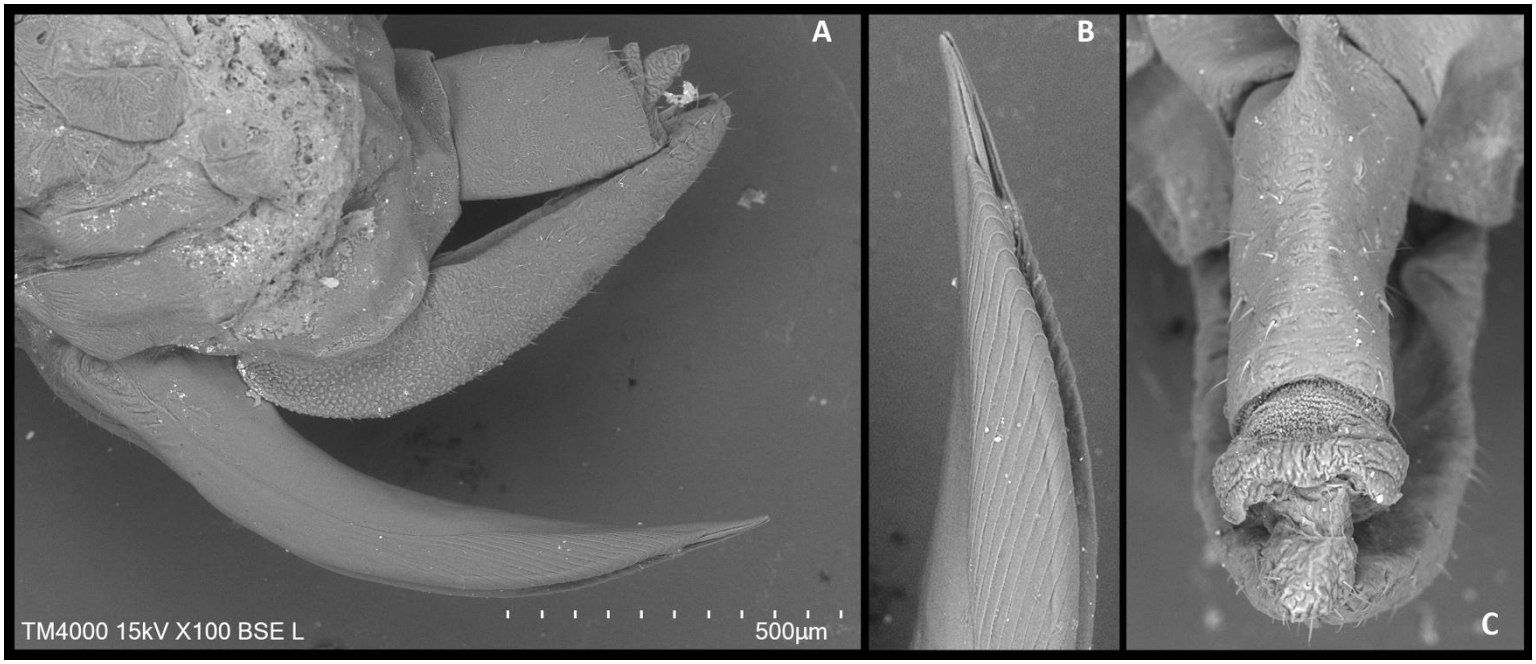

FIGURE 15. *Ferricixius davidi* Hoch and Ferreira, 2012, Female genitalia: Female genitalia in lateral view (A); gonocoxa VIII apically (B); segment-X, epiproct and paraproct in dorsocaudal view (C).

FIGURE 16. Habitat *Ferricixius davidi* Hoch e Ferreira, 2012: MP-008 cave, Itabirito municipality- MG (A); Collection record by the active search method in MP-008 (B); habitus lateral *Ferricixius davidi* Hoch e Ferreira, 2012

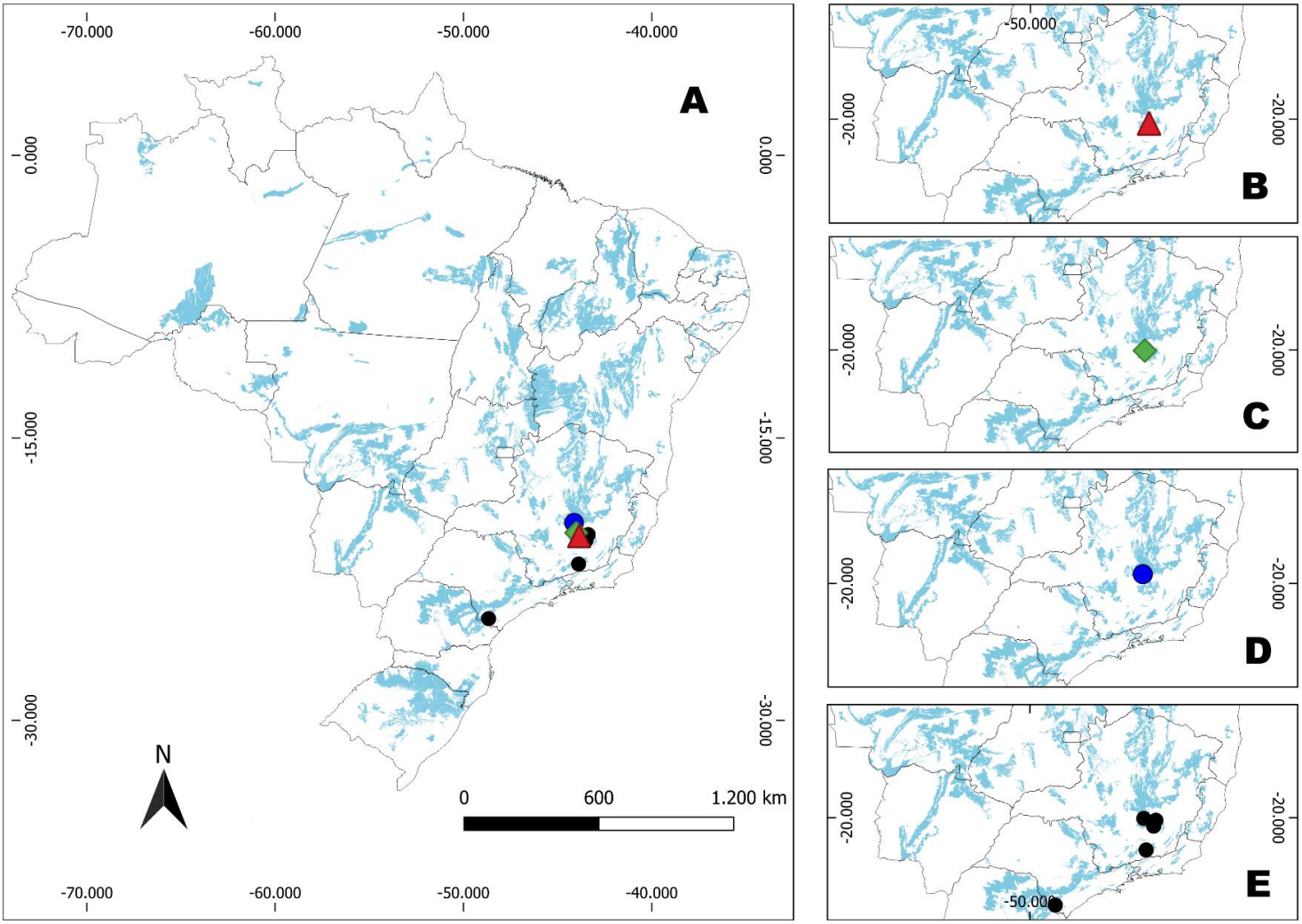

FIGURE 9. Distribution of the genus *Ferricixius* Hoch and Ferreira, 2012 in Brazil. Red triangle: *F. davidi* Hoch e Ferreira, 2012. Green diamond, *F. goliath* **sp. nov**. Blue circle, *F. michaeli* **sp. nov**. Black circle, *F. urieli* **sp. nov**. The limits of Brazil were obtained from ForestGis (https://forest-gis.com/download-gis-base-de-dados/); The shapefile with karst areas and the occurrence of caves in Brazil were obtained from CECAV (https://www.icmbio.gov.br/cecav/projetos-e-atividades/provincias-espeleologicas.html).