

UNIVERSIDADE FEDERAL DE VIÇOSA

Baetidae (Insecta: Ephemeroptera) de Minas Gerais, Brasil

Igor Ferreira Amaral
Magister Scientiae

**VIÇOSA - MINAS GERAIS
2025**

IGOR FERREIRA AMARAL

Baetidae (Insecta: Ephemeroptera) de Minas Gerais, Brasil

Dissertação apresentada à Universidade Federal de Viçosa, como parte das exigências do Programa de Pós-Graduação em Entomologia, para obtenção do título de *Magister Scientiae*.

Orientador: Frederico Falcao Salles

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**Ficha catalográfica elaborada pela Biblioteca Central da Universidade
Federal de Viçosa - Campus Viçosa**

T

A485b Amaral, Igor Ferreira, 1999-
2025 Baetidae (Insecta: Ephemeroptera) de Minas Gerais, Brasil /
Igor Ferreira Amaral. – Viçosa, MG, 2025.
1 dissertação eletrônica (151 f.): il. (algumas color.).

Orientador: Frederico Falcão Salles.
Dissertação (mestrado) - Universidade Federal de Viçosa,
Departamento de Entomologia, 2025.
Inclui bibliografia.
DOI: <https://doi.org/10.47328/ufvbbt.2025.646>
Modo de acesso: World Wide Web.

1. Efemérida - Minas Gerais. 2. Baetidae - Classificação -
Minas Gerais. I. Salles, Frederico Falcão, 1975-. II. Universidade
Federal de Viçosa. Departamento de Entomologia. Programa de
Pós-Graduação em Entomologia. III. Título.

CDD 22. ed. 595.734098151

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APROVADA: 28 de julho de 2025.

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A todos os meus familiares, especialmente ao meu avô, Seu Omar.
E ao meu orientador de graduação, Marcão (Carneirinho), que me incentivou
dizendo: "Quem arrisca, não petisca!".

AGRADECIMENTOS

A realização desta dissertação não é apenas uma conquista pessoal, mas também coletiva — especialmente da minha família, que me ofereceu apoio incondicional ao longo de toda essa caminhada. Mesmo sem compreender exatamente o que faço, nunca deixaram de acreditar no meu sonho e no meu potencial. A eles, meu amor e gratidão.

Na mesma linha, este trabalho também é, de certa forma, uma realização para meu querido orientador da graduação, Marcão (ou Carneirinho), que acreditou em mim desde o início e viu em mim um potencial para a taxonomia. Deixo aqui a minha gratidão.

Agradeço profundamente ao meu orientador de mestrado, Frederico Salles. Faltam linhas para expressar a gratidão que tenho. Obrigado por estar sempre presente, acompanhando cada identificação, corrigindo cada linha, cada palavra dos meus textos. Mais do que ensinamentos acadêmicos, levei comigo aprendizados de vida. Obrigado pela paciência, principalmente com os temas futebol e música.

Gostaria de agradecer aos meus amigos do Museu de Entomologia da UFV, que sempre dizem o que pensam e me fazem refletir e ponderar sobre muitas coisas. Crescemos juntos, e foi justamente por serem tão bons que me impulsionaram a buscar ser melhor também.

Agradeço especialmente a Erika Cifuentes-Vargas e a Lâmara dos Santos, por terem aceitado trabalhar comigo. Ninguém melhor do que eu sabe como pode ser desafiador conviver comigo — afinal, eu mesmo me aturo 24 horas por dia! Obrigado pela parceria, pela paciência e pelo comprometimento.

Agradeço de coração ao Rodrigo Gastaldo, Ana Dária, Mellis Rippel, Fátima Jabeen e Lucas Almeida por dedicarem tempo à leitura dos meus textos, por me ajudarem a lidar com minhas inseguranças e por estarem sempre prontos para me incentivar quando eu duvidava de mim mesmo.

Ao Felipe Sarmiento (Ney) pelas boas apostas que perdi.

Ao Pedro Bonfá e à Isabel Cortes, pela paciência e por me ensinarem, com generosidade, inúmeras técnicas e procedimentos sem os quais este trabalho não teria sido possível.

Agradeço a todas as pessoas que, de alguma forma, cruzaram meu caminho e me ofereceram apoio quando precisei: Francielle Soares, Verônica Fialho, Juliana Alvim, Gabriele França, Samuel Lima, Laís Viana, Douglas Ferreira, Marina Moreira, Pedro Rodrigues, Mateus Matos, Dayvson Costa Antoniel e Amanda Sobreira.

Este trabalho foi realizado com o apoio das seguintes agências de pesquisa brasileiras: Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – Brasil (CAPES) – Código de Financiamento 001, Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG) e Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq).

“Longe se vai
Sonhando demais
Mas onde se chega assim
Vou descobrir o que me faz sentir
Eu, caçador de mim”

(Milton Nascimento)

RESUMO

AMARAL, Igor Ferreira, M.Sc., Universidade Federal de Viçosa, julho de 2025. **Baetidae (Insecta: Ephemeroptera) de Minas Gerais, Brasil.** Orientador: Frederico Falcao Salles.

A família Baetidae, estabelecida por Leach em 1815, é uma das mais diversas dentro de Ephemeroptera, com cerca de 1.100 espécies em 113 gêneros. Sua distribuição é quase global, com altos níveis de endemismo em regiões tropicais, especialmente na América do Sul. No Brasil, embora mais de 150 espécies já tenham sido registradas, grandes lacunas taxonômicas ainda persistem, sobretudo em estados grandes e complexos ecologicamente como Minas Gerais. Esta dissertação teve como objetivo ampliar o conhecimento sobre a fauna de Baetidae em Minas Gerais por meio de quatro estudos principais: (1) descrição e complementação de semaforontes de *Americabaetis titthion*; (2) descrição de uma nova espécie de *Cloeodes* para o estado; (3) descrição de três novas espécies de *Americabaetis*, sendo uma registrada para Minas Gerais, acompanhadas de chave taxonômica interativa; e (4) síntese integrativa da diversidade conhecida e potencial da família no estado, incluindo análise de distribuição espacial, cobertura amostral e identificação de lacunas geográficas e taxonômicas. Além de ampliar os registros para o estado, os estudos contribuíram significativamente para a taxonomia da família, foram encontrados diversos novos táxons, novos registros, apontadas as áreas prioritárias para pesquisas futuras e feito descrição de semaforontes e espécies novas. Apesar dos avanços, a maior parte das áreas do Cerrado no estado seguem subamostradas e o bioma da Caatinga permanece sem qualquer registro. Os resultados ressaltam o elevado potencial taxonômico do estado, a importância dos ecótonos como zonas de alta diversidade e a necessidade de ampliar os esforços de coleta para alcançar uma compreensão mais completa da fauna de Baetidae em Minas Gerais e na região Sudeste do Brasil.

Palavras-chave: efêmera; taxonomia; Região Neotropical; déficit taxonômico; Região Sudeste

ABSTRACT

AMARAL, Igor Ferreira, M.Sc., Universidade Federal de Viçosa, July, 2025. **Baetidae (Insecta: Ephemeroptera) From Minas Gerais, Brazil.** Adviser: Frederico Falcao Salles.

The family Baetidae, established by Leach in 1815, is one of the most diverse within Ephemeroptera, with about 1,100 species in 113 genera. Its distribution is nearly global, with high levels of endemism in tropical regions, especially in South America. In Brazil, although more than 150 species have already been recorded, major taxonomic gaps still persist, particularly in large and ecologically complex states such as Minas Gerais. This dissertation aimed to expand the knowledge of Baetidae fauna in Minas Gerais through four main studies: (1) description and supplementation of semaphoronts of *Americabaetis titthion*; (2) description of a new species of *Cloeodes* for the state; (3) description of three new species of *Americabaetis*, one of them recorded for Minas Gerais, accompanied by an interactive taxonomic key; and (4) integrative synthesis of the known and potential diversity of the family in the state, including spatial distribution analysis, sampling coverage, and identification of geographic and taxonomic gaps. In addition to expanding the records for the state, these studies significantly contributed to the taxonomy of the family, with the discovery of several new taxa, new records, the identification of priority areas for future research, and the description of semaphoronts and new species. Despite these advances, most Cerrado areas in the state remain under-sampled, and the Caatinga biome still lacks any records. The results highlight the high taxonomic potential of the state, the importance of ecotones as zones of high diversity, and the need to increase sampling efforts to achieve a more comprehensive understanding of the Baetidae fauna in Minas Gerais and in the Southeastern region of Brazil.

Keywords: mayfly; taxonomy; Neotropical Region; taxonomic shortfalls; Southeastern Region

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1. INTRODUÇÃO

1.1 Visão geral da família Baetidae

Estabelecida por Leach em 1815, Baetidae é uma das primeiras famílias reconhecidas dentro da ordem Ephemeroptera. Com cerca de 1.100 espécies distribuídas em 113 gêneros, é uma das famílias mais diversas da ordem, superada apenas por Leptophlebiidae em questão de número de gêneros (Sartori & Brittain, 2015; Cruz et al., 2021). Sua distribuição é ampla, ocorrendo em todos os continentes, com exceção da Antártica, Nova Zelândia e algumas ilhas oceânicas (Edmunds et al., 1976), e apresenta alto endemismo no Hemisfério Sul, especialmente nas regiões Afrotropical e Neotropical (Barber-James et al., 2008; Gattolliat & Nieto, 2009). As ninfas são amplamente distribuídas em ambientes aquáticos diversos e substratos variados, sendo encontradas em cachoeiras (*Mayobaetis* Waltz & McCafferty, 1985), corredeiras (*Baetodes* Needham & Murphy, 1924) ou em águas lentas, como lagos e poças temporárias (*Callibaetis* Eaton, 1881) (Nieto, 2010). Devido à sua abundância e diversidade, a presença de espécies de Baetidae pode contribuir significativamente para programas de monitoramento e avaliação da qualidade da água (Buss & Salles, 2007).

Baetidae pode ser distinguida das demais famílias da ordem por suas características típicas tanto na fase adulta quanto na fase de ninfa. Na sua forma adulta, apresentam os tarsos das pernas medianas e posteriores trisegmentados, veias IMA, MA2, IMP e MP2 da asa anterior desatadas da porção basal e, com exceção do gênero *Aturbina* Lugo-Ortiz & McCafferty, 1995, os machos apresentam os olhos compostos com uma porção turbinada (Lugo-Ortiz & McCafferty, 1999c; Dominguez et al., 2006). Já as ninfas apresentam os ramos laterais da sutura epicraniana localizados abaixo dos ocelos laterais e os ápices femorais com um lobo orientado ventralmente (Wang & McCafferty, 1996).

Os registros fósseis mais antigos de Baetidae datam do Cretáceo Inferior (120–135 Ma), com exemplar preservado em âmbar libanês (McCafferty, 1997). A maior parte dos fósseis conhecidos provém da Ásia, incluindo espécies do Cretáceo Médio, como *Vetufiformosa buckleyi* Poinar, 2011, e do Cretáceo Tardio, como *Palaeocloeon taimyricum* Kluge, 1997. Nas Américas, são conhecidos apenas dois registros: *Patracloeon carolinensis* Sroka & Gattolliat, 2025 do Cretáceo Tardio e *Cloeon tzeltal* Varela-Hernández, Riquelme & Montiel-Chávez, 2022, do Mioceno. Embora escassos, os registros fósseis indicam que o grupo já era

diversificado no Cretáceo e possivelmente se originou antes da principal fragmentação continental iniciada no Jurássico (Sroka & Gattoliat, 2025).

As relações filogenéticas de Baetidae, tanto em relação a outras famílias de Ephemeroptera quanto internamente, ainda permanecem em debate. A família já foi considerada grupo-irmão de Siphlaenigmatidae, formando os agrupamentos Baetoidea ou Tretamerotarsata, com base em caracteres morfológicos (McCafferty, 1991; Kluge, 2004). No entanto, análises moleculares não sustentaram essa hipótese e as semelhanças entre as duas famílias passaram a ser interpretadas como convergências evolutivas (Ogden & Whiting, 2005; Ogden et al., 2009). Nessas mesmas análises, Siphuriscidae é tida como grupo-irmão de Baetidae e Isonychiidae, sendo esse agrupamento grupo-irmão das demais famílias da ordem (Ogden et al., 2009). Estudos posteriores, entretanto, não recuperaram Isonychiidae junto a Baetidae, sendo somente Baetidae mantido como grupo-irmão das outras famílias da ordem (Ogden et al., 2019).

Internamente, já foram propostas algumas divisões em subfamílias, principalmente Cloeoninae e Baetinae, por Kazlauskas (1972), com base em caracteres das asas. Posteriormente, Riek (1973) propôs uma nova divisão que incluía Siphlaenigmatidae como subfamília de Baetidae e estabelecia Callibaetinae, contendo apenas o gênero *Callibaetis*. Essa proposta, entretanto, não foi sustentada por Landa & Soldán (1985), que analisaram tanto características de ninfas quanto de adultos. Mais tarde, Gillies (1991) propôs o reconhecimento de Baetinae, Cloeoninae e Callibaetinae. Utilizando dados moleculares para investigar as relações filogenéticas de espécies afrotropicais, Monaghan et al. (2005) e Gattoliat et al. (2008) recuperaram Baetinae como um grupo monofilético, embora Cloeoninae tenha apresentado baixo suporte em suas análises. Por outro lado, Nieto (2010), ao utilizar dados morfológicos de espécies da América do Sul, encontrou as três subfamílias como agrupamentos parafiléticos. Mais recentemente, Cruz et al. (2021), em uma análise global da família baseada em caracteres morfológicos, recuperou o monofiletismo de Baetinae, incluindo o gênero *Callibaetis*, mas não confirmou Cloeoninae como monofilética.

1.2 Região Sudeste e Minas Gerais

Os estudos sobre a família Baetidae no Brasil só ganharam impulso a partir dos trabalhos conduzidos por Salles e colaboradores no início dos anos 2000. Até este período,

embora algumas espécies já tivessem sido descritas, seus registros concentravam-se majoritariamente nas regiões Norte e Sul do país, com pouquíssimas ocorrências conhecidas para o Sudeste — como *Baetodes serratus* Needham & Murphy, 1924, e *Callibaetis (Callibaetis) guttatus* Navás, 1915. Muitos trabalhos envolvendo espécies descritas para o país na década de 90 foram realizados por Lugo-Ortiz e McCafferty, como a descrição de algumas espécies de *Americabaetis* Kluge, 1992 e descrição dos gêneros *Cryptonympha* Lugo-Ortiz & McCafferty, 1998, *Rivudiva* Lugo-Ortiz & McCafferty, 1998 e *Spiritiops* Lugo-Ortiz & McCafferty, 1998, entretanto, esses trabalhos não tratavam da fauna do país especificamente ou da diversidade e distribuição das espécies. O primeiro levantamento direcionado à Região Sudeste foi realizado por Lugo-Ortiz e colaboradores em 2002, para o Espírito Santo. Apesar das poucas espécies registradas, o trabalho já destacava as lacunas de conhecimento no país em relação ao desconhecimento da fauna não só de Baetidae, mas de Ephemeroptera no geral. Em sequência, Salles et al. (2003) realizam um segundo trabalho, com foco no Estado de São Paulo. No ano seguinte, Salles et al. (2004a) publicaram um inventário mais abrangente para toda a região, registrando o maior número de espécies no Estado do Rio de Janeiro (18), seguido por Minas Gerais (15), São Paulo (14) e Espírito Santo (5). Esse trabalho também apresentou uma chave para identificação das ninfas dos gêneros de Baetidae ocorrentes no Sudeste brasileiro.

Até 2004, eram registradas para o Brasil 166 espécies de Ephemeroptera, distribuídas em 63 gêneros. A família Baetidae já se destacava como uma das mais diversas, representando, juntamente com Leptophlebiidae, cerca de 50% das espécies brasileiras (Salles et al., 2004b). Naquele período, as regiões Sudeste e Norte apresentavam o maior número de registros. Desde então, houve um aumento expressivo nas publicações sobre a ordem, impulsionado por fatores como a formação de novos taxonomistas, a intensificação das colaborações científicas, os investimentos em ciência e tecnologia (especialmente entre 2000 e 2010) e o crescente interesse nos Ephemeroptera como bioindicadores da qualidade da água (Shimano et al., 2013; Domínguez & Dos Santos, 2014).

Atualmente, Baetidae conta com cerca de 152 espécies descritas para o Brasil, distribuídas em 24 gêneros, com ocorrência registrada em todas as regiões do país e estados, exceto na Paraíba (Boldrini et al., 2025; Salles et al., 2025a). Na Região Sudeste, Minas Gerais apresenta o maior número de espécies registradas (53), seguido por Espírito Santo (41), Rio de Janeiro (26) e São Paulo (11) (Salles et al., 2023; Salles et al., 2025a; Alvim et al., dado em publicação). Segundo Shimano et al. (2013), aproximadamente 50% das publicações

brasileiras sobre Ephemeroptera entre 1992 e 2011 referem-se à Região Sudeste, sendo a maioria relacionada à Baetidae.

Embora Minas Gerais seja atualmente o estado com o maior número de espécies registradas, ao se considerar sua extensão territorial e complexidade ecológica em comparação com o Espírito Santo, é evidente que ainda há uma grande lacuna de conhecimento sobre a fauna de Baetidae no estado. Enquanto o Espírito Santo ocupa cerca de 0,6% do território nacional e apresenta 476 registros da família, Minas Gerais abrange quase 7% do país e conta com apenas 332 registros (Salles et al., 2023; Salles et al., 2025a; Alvim et al., dado em publicação). Em termos ecológicos, o estado é extremamente diverso, abrigando três biomas: Cerrado (54,08% da porção noroeste), Mata Atlântica (40,36% da porção sudeste) e Caatinga (5,56% no norte) (BDIA, 2024). Além disso, Minas Gerais abriga cinco grandes bacias hidrográficas: São Francisco, Grande, Paranaíba, Doce e Jequitinhonha (IBGE, 2021).

A análise dos trabalhos taxonômicos e de levantamento da fauna de Baetidae em Minas Gerais revela que poucas áreas foram adequadamente amostradas. A Bacia do rio Doce é a região mais estudada, tendo abrigado os primeiros levantamentos realizados no estado (Francischetti, 2015; Alvim et al., dado em publicação), além de estudos posteriores com descrições taxonômicas (De Lima et al., 2022; Viana et al., 2024). Apesar da ocorrência de espécies descritas e registradas para Minas Gerais, como *Paracloeodes poranga* (Salles & Lugo-Ortiz, 2003), *Tupiara ibirapitanga* Salles, Lugo-Ortiz, Da-Silva & Francischetti, 2003, *Camelobaetidius lassance* Salles & Serrão, 2005, *Cloeodes ioachimi* Salles, Massariol & Angeli, 2015, *Callibaetis (Abaetetuba) cochlea* Cruz, Salles & Hamada, 2017 e *Callibaetis (Cunhaporanga) imperator* Cruz, Salles & Hamada, 2017, esses trabalhos não tiveram como objetivo investigar a diversidade da família no estado, sendo, portanto, insuficientes para caracterizar adequadamente sua fauna.

Diante da grande extensão territorial de Minas Gerais e da escassez de estudos taxonômicos direcionados à Baetidae na região, esta dissertação teve como objetivo principal reconhecer a biodiversidade da família e sua distribuição no estado, contribuindo para o conhecimento da fauna Neotropical, indicando áreas prioritárias e reduzindo as lacunas taxonômicas ainda existentes.

2. OBJETIVOS

2.1. Objetivo geral

Investigar e documentar a diversidade da família Baetidae (Ephemeroptera) no Estado de Minas Gerais.

2.2. Objetivos específicos

1. Fornecer descrições de semaforontes ainda não caracterizados de espécies já registradas em Minas Gerais, com ênfase na morfologia detalhada dos estágios adultos e dos ovos (Capítulo I);
2. Revisar material previamente identificado, com base em análises morfológicas comparativas, e propor a delimitação e descrição de espécies novas para a ciência (Capítulo II);
3. Expandir o conhecimento taxonômico de grupos pouco estudados, como o gênero *Americabaetis*, por meio de descrições de novas espécies e atualização de chaves interativas para identificação (Capítulo III);
4. Realizar uma síntese integrativa da diversidade conhecida e potencial da família no estado, incluindo análise de distribuição espacial, cobertura amostral e identificação de lacunas geográficas e taxonômica (Capítulo IV).

3. ESTRUTURA DA DISSERTAÇÃO

Esta dissertação está organizada em quatro seções, correspondentes a artigos científicos desenvolvidos ao longo do projeto, sendo dois já publicados, um aceito e outro em processo de submissão. Os dados apresentados foram obtidos por meio de coletas realizadas entre 2018 e 2025, material depositado no Museu de Entomologia da UFV, além de revisão da literatura. Cada capítulo segue o formato editorial das revistas *Zootaxa* ou *Neotropical Entomology*, conforme o periódico de destino.

Seção I – Comprehensive description of new and known stages of *Americabaetis titthion* Lugo-Ortiz & McCafferty (Ephemeroptera: Baetidae) (*Zootaxa*, publicado)

Descreve o estágio adulto macho de *Americabaetis titthion*, até então desconhecido, e complementa as descrições da ninfa e da fêmea imago. A espécie foi coletada novamente em Araponga (MG), permitindo sua caracterização completa. O estudo preenche lacunas taxonômicas importantes e contribui para o conhecimento da fauna de Baetidae em Minas Gerais.

Seção II – *Cloeodes tovauna*: a new species previously identified as *Cloeodes aymore* Massariol & Salles, 2011 (Ephemeroptera: Baetidae) (Zootaxa, publicado)

Apresenta a descrição de uma nova espécie do gênero *Cloeodes*, anteriormente descrita junto à *C. aymore*. Com base em novas coletas no sudeste de Minas Gerais e reanálise de material original, foi possível estabelecer diferenças morfológicas que justificam a separação. O artigo contribui para a delimitação de espécies do gênero e amplia o conhecimento sobre a diversidade regional.

Seção III – Expanding the knowledge of *Americabaetis* Kluge, 1992 (Ephemeroptera: Baetidae): description of three new species and supplementary description of *Americabaetis labiosus* Lugo-Ortiz & McCafferty, 1996 (*Neotropical Entomology*, publicado)

Três novas espécies de *Americabaetis* são descritas para o Brasil, uma delas de Minas Gerais e duas de Santa Catarina. A seção também atualiza a descrição de *A. labiosus* e apresenta uma chave interativa para as ninfas sul-americanas do gênero. O estudo reforça a riqueza do grupo na região e amplia sua representação em Minas Gerais.

Seção IV – Baetidae (Ephemeroptera) in Minas Gerais: Known Diversity, Sampling Gaps, and Taxonomic Potential (em processo para submissão para *Neotropical Entomology*)

Apresenta uma análise integrada de dados originais e bibliográficos sobre Baetidae em Minas Gerais, incluindo mapas de distribuição por gênero e espécie. O artigo busca responder: (i) qual o nível atual de conhecimento da família no estado; (ii) qual o potencial oculto da fauna local; e (iii) quais áreas e biomas requerem maior atenção em estudos futuros.

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**SEÇÃO I – COMPREHENSIVE DESCRIPTION OF NEW AND
KNOWN STAGES OF *AMERICABAETIS TITTHION* LUGO-ORTIZ &
MCCAFFERTY (EPHEMEROPTERA: BAETIDAE) (ZOOTAXA,
PUBLICADO)**

Comprehensive description of new and known stages of *Americabaetis titthion* Lugo-Ortiz & McCafferty (Ephemeroptera: Baetidae)

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Abstract

The male imago of *Americabaetis titthion* is described for the first time. It can be distinguished from other male

imagos of the genus by the following combination of characteristics: turbinate portion of the eyes with upper surface ellipsoidal and separated by approximately the width of a lateral ocellus; costal area of fore wings tinged with reddishbrown; presence of pairs of soft, setose protuberances on the meso- and metasternum; subgenital plate slightly concave; forceps with segment I/II slightly tapering medioapically. Supplementary descriptions for the nymph and female imago are provided, as well as the first description of the eggs of a species of the genus.

Key words: Taxonomy, mayfly, Neotropical Region, Brazil, adult stage

Introduction

Americabaetis Kluge, 1992 is a Pan-American genus of Baetidae (Ephemeroptera) distributed from South America to southern Texas (Domínguez *et al.* 2006; Wiersema & McCafferty 1999). The genus was initially erected as a subgenus of *Baetis* Leach, 1815 based on nymphs and adults from Cuba (Kluge 1992). Later, it was revised and elevated to generic level by Lugo-

Ortiz & McCafferty (1996), who transferred five species previously assigned from *Acerpenna* Waltz & McCafferty (1987) to *Americabaetis* and described five new species, most of them based on the nymphal stage.

Currently, the genus comprises 20 species, with 13 of them documented in South America (Salles *et al.*, 2024). *Americabaetis bridarolli* (Navás, 1932), *Americabaetis jorgenseni* (Esben-Petersen, 1909), *Americabaetis oldendorffi* (Weyenbergh, 1883), *Americabaetis peterseni* (Hubbard, 1974), and *Americabaetis weiseri* (Navás, 1926) are known exclusively from adults (future assignments to them, however, are very unlikely due to incomplete original descriptions [Lugo-Ortiz & McCafferty 1999; Domínguez *et al.* 2006]); *Americabaetis maxifolium* Lugo-Ortiz & McCafferty, 1996 and *Americabaetis mecistognathus* Salles & Raimundi, 2010 are known exclusively based on nymphs; *Americabaetis alphas* Lugo-Ortiz & McCafferty, 1996, *Americabaetis itatiaia* Marulanda-Lopez & Salles, 2023, *Americabaetis labiosus* Lugo-Ortiz & McCafferty, 1996, *Americabaetis longetron* Lugo-Ortiz & McCafferty, 1996, *Americabaetis robacki* Lugo-Ortiz & McCafferty, 1994, and *Americabaetis titthion* Lugo-Ortiz & McCafferty, 1996 are known for both nymphs and adults (Lugo-Ortiz & McCafferty 1996; Waltz & McCafferty 1999; Salles *et al.* 2004; Salles & Boldrini 2008; Salles *et al.* 2010b; Marulanda-Lopez & Salles 2023). In the case of *A. itatiaia*, only subimagos are known, while for *A. titthion* the only adult described is the female imago.

Americabaetis titthion is currently endemic to Brazil, with nymphs described from Santa Catarina and the female imago from Rio de Janeiro (Lugo-Ortiz & McCafferty 1996; Salles *et al.* 2004). The species has been recorded from the states of Rio de Janeiro, Espírito Santo and at the border between Minas Gerais and Espírito Santo (Francischetti *et al.* 2003; Salles *et al.* 2010a, Massariol *et al.* 2014; Salles *et al.* 2023). Recently, based on an ongoing project aiming to investigate the composition of mayflies at the Parque Estadual da Serra do Brigadeiro, Minas Gerais, a single male adult of *A. titthion* was found. Since only the female

imago and the nymph were described for this species, the aim of this paper is to describe the previously unknown male imago and egg, and to complement the descriptions of the nymph and female imago.

Materials and methods

The habitus of the collected specimens was captured using a LEICA M205 A stereomicroscope with an attached LEICA MC170 HD digital camera. Nymphs were dissected in 80% ethanol and then briefly treated with Cellosolve for 5 minutes. After the treatment, permanent slides were prepared using Euparal® and photographed with an Olympus CX31 microscope equipped with a Moticam A5 digital camera. All images were processed using Adobe Photoshop® 2024 and arranged in Adobe Illustrator® 2024. The pterothorax description follows the terminology proposed by Kluge (1994).

To obtain the eggs, the abdomen of a female imago was dissected using tweezers. The eggs were kept in 80% ethanol, transferred to hexamethyldisilazane (HMDS) for 10 min and air dried for the micrographs. After fixated on aluminum stubs, the samples were covered with gold (20 nm thick) and analyzed with a LEO 1430VP scanning electron microscope at 12 kV in the Núcleo de Microscopia e Microanálise da Universidade Federal de Viçosa. The terminology used for egg follows Koss & Edmunds (1974). Permanent slides and specimens preserved in 80% ethanol are deposited in the Museu de Entomologia at the Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil (UFVB).

Results

Americabaetis titthion **Lugo-Ortiz & McCafferty, 1996**
(Figs 1–5)

Americabaetis titthion Lugo-Ortiz & McCafferty 1996: 167; Francischetti *et al.* 2003: 69; Salles *et al.* 2004: 23; Domínguez *et al.* 2006: 72; Salles *et al.* 2010a: 302; Salles *et al.* 2010b: 26.

Diagnoses. Male adults (modified from Salles *et al.* 2004). 1) turbinate portion of eyes orange, separated by approximately the width of a lateral ocelli, upper surface ellipsoidal (Fig. 1b); 2) costal and subcostal area of fore wing tinged with reddish-brown (as in Fig. 2e); 3) pairs of soft, setose protuberances present on meso- and metasternum (Figs. 1a, c); 4) subgenital plate slightly concave (Fig. 1f); 5) forceps brown, with segment I/II slightly tapering medioapically and segment III light brown (Fig. 1f). Nymphs (modified from Domínguez *et al.*, 2006 and Salles *et al.*, 2010b). 1) frontal keel absent (Fig. 4b); 2) lingua broadly pointed apically (Fig. 3g); 3) labium with glossa 0.8× length of paraglossa (Fig. 3i); 4) apex of paraglossa with 3 rows of pectinate setae; 5) segment II of labial palp with a moderate distomedial projection (Fig. 3i); 6) meso and metasternum with a setose paired protuberance (Fig. 4c); 7) tarsal claw with 10–12 denticles; 8) posterior margin of abdominal terga with rounded spines (Fig. 5d).

Descriptions

Male imago (Fig. 1). Lengths (in mm). Body: 6.0; Forewings: 5.9. Head (Figs. 1a, b). Brown, with cream lateral mark. Antenna light yellowish-brown, flagellum thickened at the base. Lateral and middle ocelli surrounded with black. Ventral portion of compound eye gray. Turbinate eyes separated approximately by the width of lateral ocellus; upper surface ellipsoidal and orange, except for brown edges; basal $\frac{1}{3}$ of stalk brown, remainder cream. Thorax (Figs. 1b, c). Pronotum brown with lateral margin cream. Mesoscutum predominantly brown; anteronotal protuberance with lateral cream mark; anteronotal transverse impression and medioscutum dark brown; sublateroscutum with anterior portion cream; scuto-scutellar impression cream. Katepisterna brown with cream spot; meso and metasterna light brown, both

with pair of triangular protuberances covered with small setae. *Wing*. Forewing hyaline (as in Fig. 2e); costal, subcostal and basal area reddish-brown, more pigmented between Sc and RA; veins yellowish-

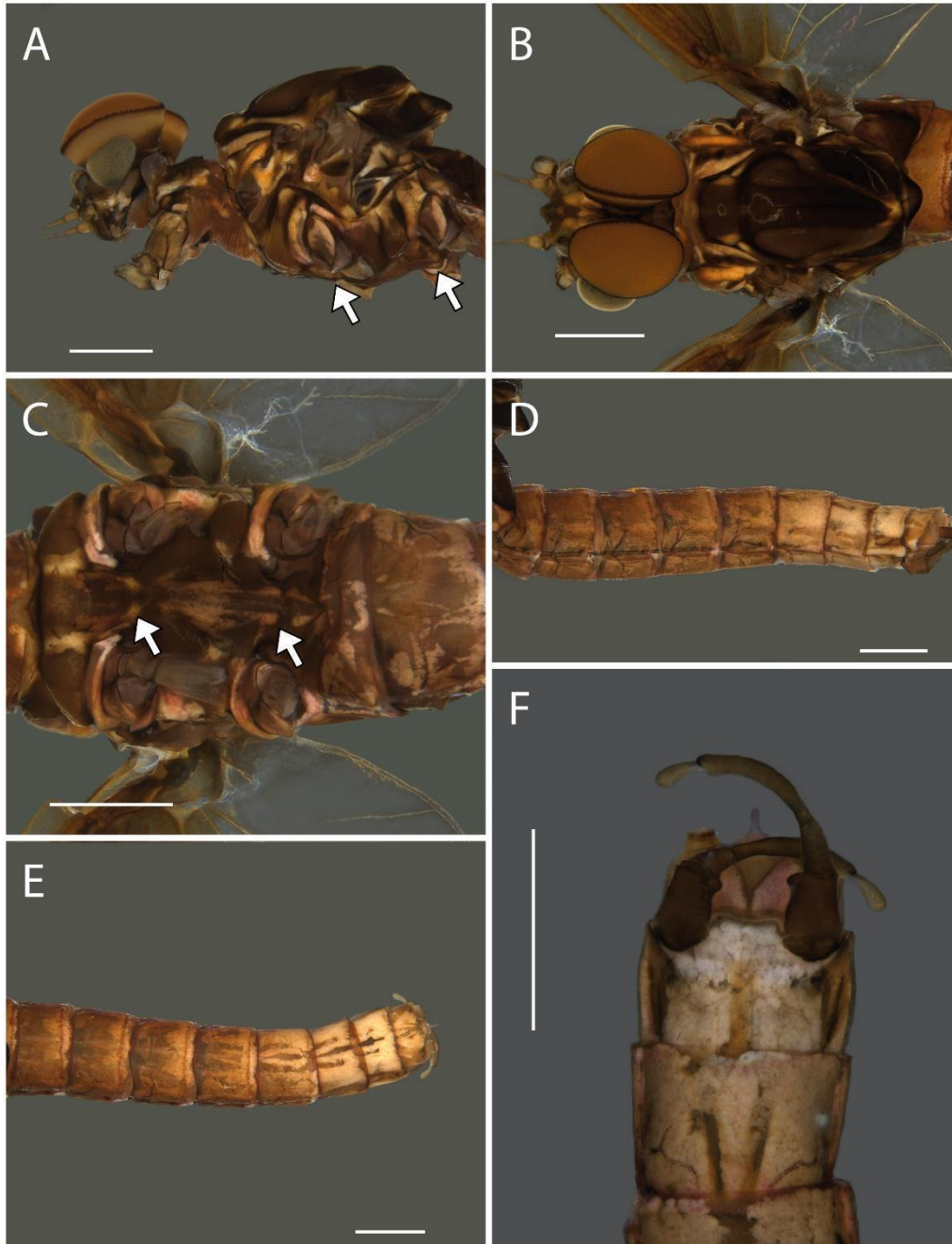


FIGURE 1a–f. Male imago of *Americabaetis titthion*. a. Head and thorax (lateral view); b. Head and thorax (dorsal view); c. Thorax (ventral view); d. Abdomen (lateral view); Abdomen (dorsal view); f. Genitalia. (Scale bars: 0.5 mm; white arrows indicate mesosternal and metasternal projection).

brown; stigmatic area with 8–9 short veins, some incomplete; marginal intercalary veins paired, except between ICu2 and A. *Legs*. Foreleg 5.1 mm; coxa brown with cream marks; trochanter, femur, tibia and tarsi brown; tarsus segments in decreasing order: 2, 3, 4, 5, 1; mid and hindleg similar, cream; tarsal segments II, III and IV with ventral projection. Abdomen (Figs. 1d–f). Segments I–X brown, VII–X with white inclusions (on terga VI–IX they are absent medially and on sigilla); tracheation black and well visible. Cercus broken-off and lost. Genitalia. Forceps predominantly brown, lighter towards apex. Forceps base with distomedial projection; forceps segment I tapering towards fusion with segment II; forceps segment III elongate; posterior margin of subgenital plate slightly concave.

Female imago (Fig. 2). Length (in mm). Body: 6.0; Forewings: 6.6. Head (Fig. 2a). Cream; antenna and lateral and middle ocelli similar to male imago; compound eye gray; posterior margin of head elevated. Thorax (Figs. 2a, b). Predominantly light brown; prothorax with lateral margin cream; anteronotal transverse impression and anterolateroparapsidal suture brown; apex of scutellum and scuto-scutellar impression cream; meso and metathorax sterna light brown; *Wing* similar to male; *Legs* (Fig. 2c). foreleg 2.6 mm, light brown, slightly longer mid and hindleg; mid and hindleg similar to male, tarsal segments light brown. Abdomen (Fig. 2d). Cercus reddish brown.

Nymph. Length (in mm). Body: 7.00; Cerci: 3.8; Antenna: broken. Head (Fig. 4b). Labrum (Fig. 3a, b). 0.6× wider than long; dorsal surface with scattered short, fine, simple setae and pair of long, submedial simple setae; dorsolateral arc of setae composed of 6–9 + 1 long simple seta; ventral surface with 8–10 spine-like setae near lateral margin; lateral margin with short, fine, simple setae. Hypopharynx (Fig. 3g). Lingua longer than superlinguae, apex acute covered with fine setae; superlinguae expanded. Maxilla (Fig. 3h). Proximal inner margin of galealacinia with one row of 7–9 simple, fine setae. Labium (Fig. 3i). Glossa with 3–4

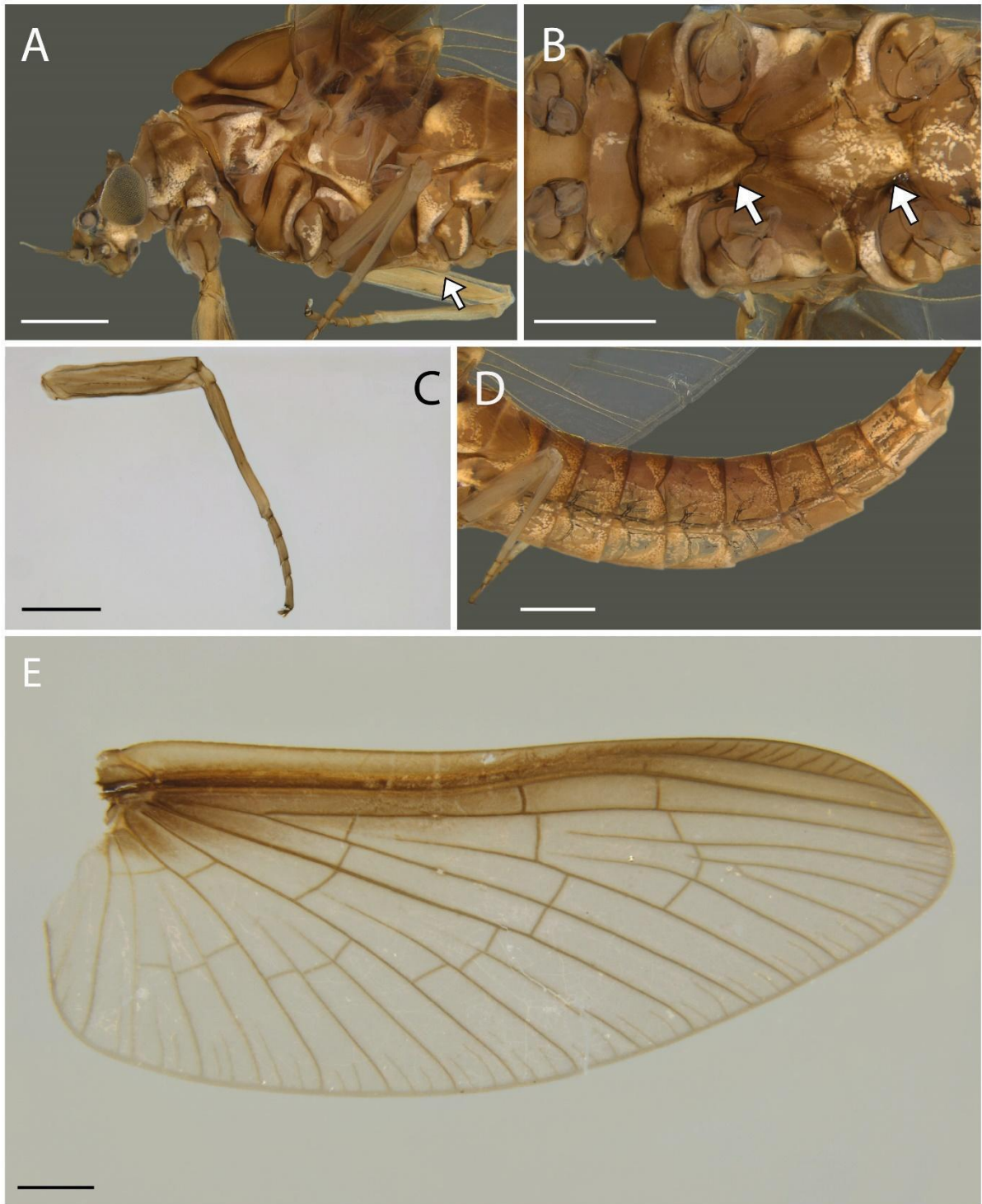


FIGURE 2a–e. Female imago of *Americabaetis titthion*. a. Head and thorax (lateral view); b. Thorax (ventral view); c. Foreleg; d. Abdomen (lateral view); e. Right wing. (Scale bars: 0.5 mm; white arrows indicate mesosternal and metasternal projection).

pectinate setae in distal outer margin; apex of paraglossa with pectinate setae. Abdomen.

Gills II–V broader and larger than VI and VII, gills VII small and rounded (Figs. 4a, 5a); margins of sterna VII–IX with blunt spines (Figs. 5b).

Eggs (Figs. 5e, f): Diameter: 51.5 μm ; Height: 103.7 μm . Oblong; chorion with small irregular cells net-like. Micropyle unknown.

Material examined: BRAZIL, Minas Gerais, Araponga, Pousada Remanso, 1 male imago and 2 female imagos; 20° 39' 18'' S 42° 27' 12'' W 1062 m.a.s.l.; 21/iii/2023; F.F. Salles col. BRAZIL, Minas Gerais, Araponga, Cachoeira do Boné, 2 nymphs; 20° 38' 45'' S 42° 27' 26'' W 945 m.a.s.l.; 24/ix/2018; F.F. Salles; D. Belicchi; M.I. Passos; J.F. Marulanda-Lopez cols. BRAZIL, Santa Catarina, São Joaquim, Rio Pelotas, 5 nymphs; 28° 26' 50.3'' S 49° 52' 58.3'' W 936 m.a.s.l.; 31/viii/2009; N. Hamada; P. Cruz; R. Boldrini.

Discussion

Salles *et al.* (2004) published the description of the female imago, and despite the nymph not being reared to the adult stage, the association was supported by the presence of the meso and metasternum projections in the same region and the abundance of nymphs in the sampled area. The authors also suggested that the male imago possibly shares the same characteristics, which would be sufficient to differentiate it from other *Americabaetis* species. The specimen examined herein exhibits the same traits (Fig. 1c) and the wing color pattern of the male matches those of the females obtained from the sample site (Fig. 2e). Furthermore, the analyzed genitalia have a slightly concave posterior margin of the subgenital plate (Fig. 1f), a conspicuous trait not yet described in *Americabaetis*.

The nymph of *A. titthion* shares some characteristics with *A. labiosus* and *A. mecistognathus*, such as the absence of a front keel, rounded spines at the posterior margin of the

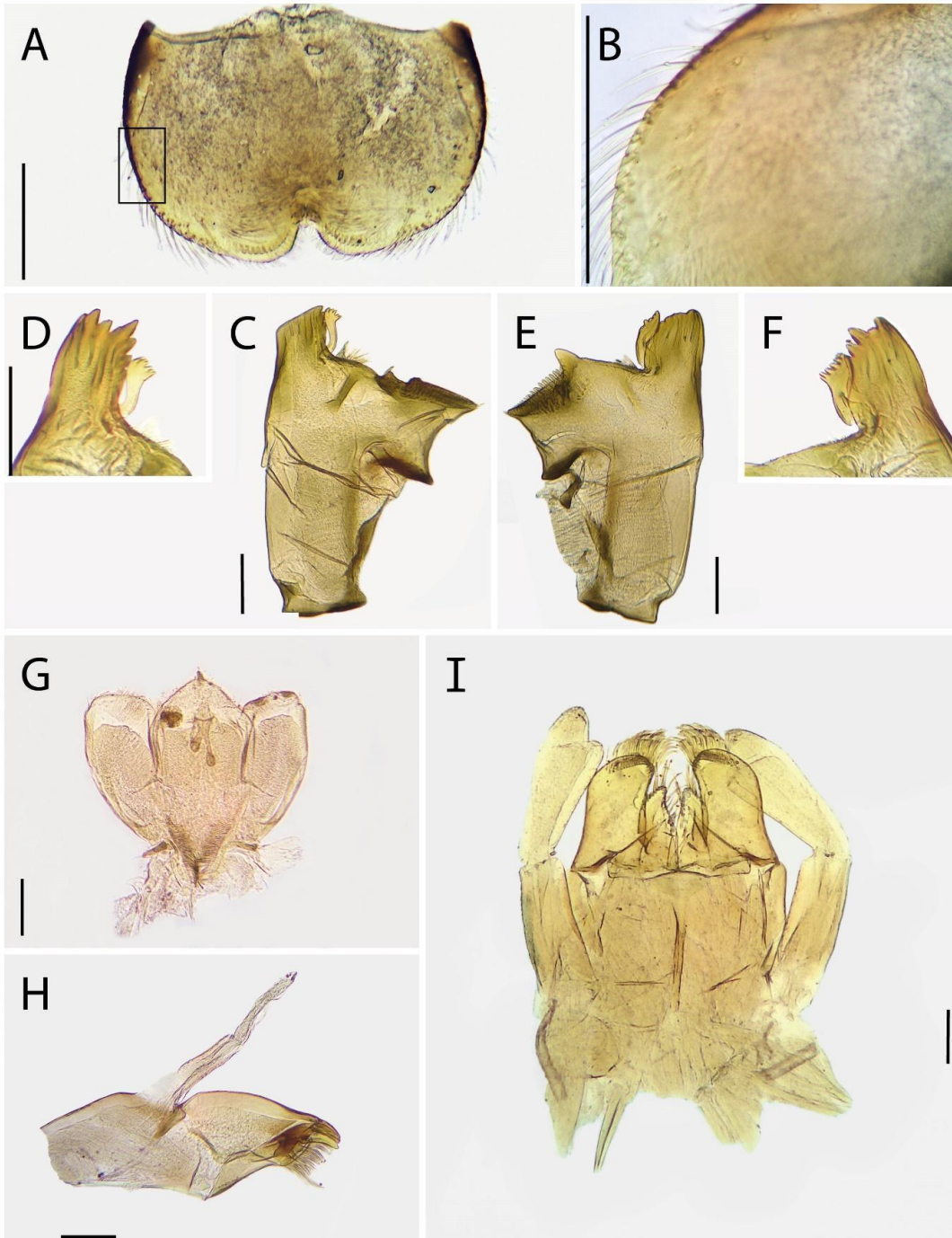


FIGURE 4a–f. Nymph of *Americabaetis titthion*. a. Habitus; b. Head (frontal view); c. Meso and metathorax (ventral view); d. Fore leg; e. Middle leg; f. Hind leg. (Scale bars: 1 mm).

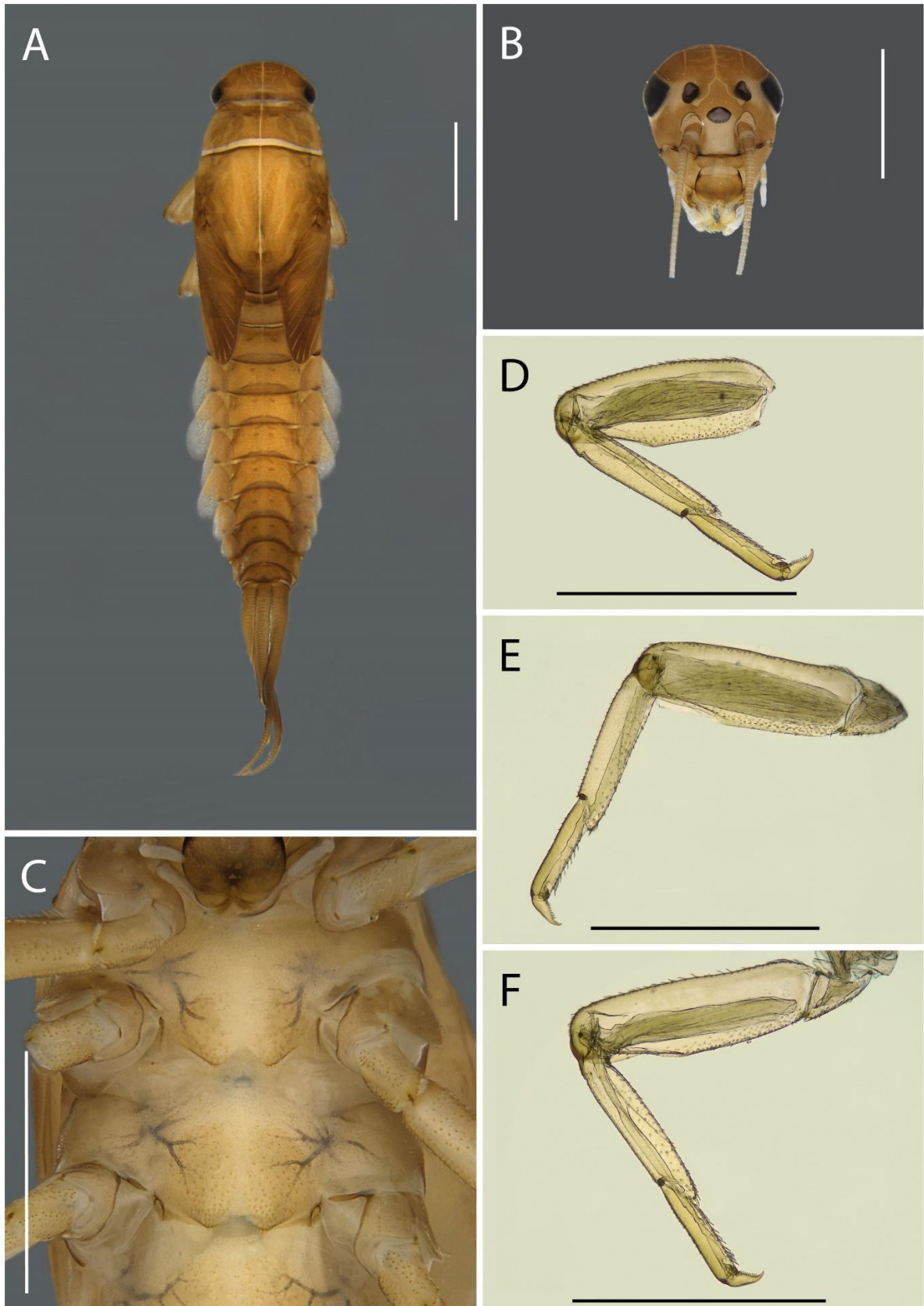


FIGURE 4a–f. Nymph of *Americabaetis titthion*. a. Habitus; b. Head (frontal view); c. Meso and metathorax (ventral view); d. Fore leg; e. Middle leg; f. Hind leg. (Scale bars: 1 mm).

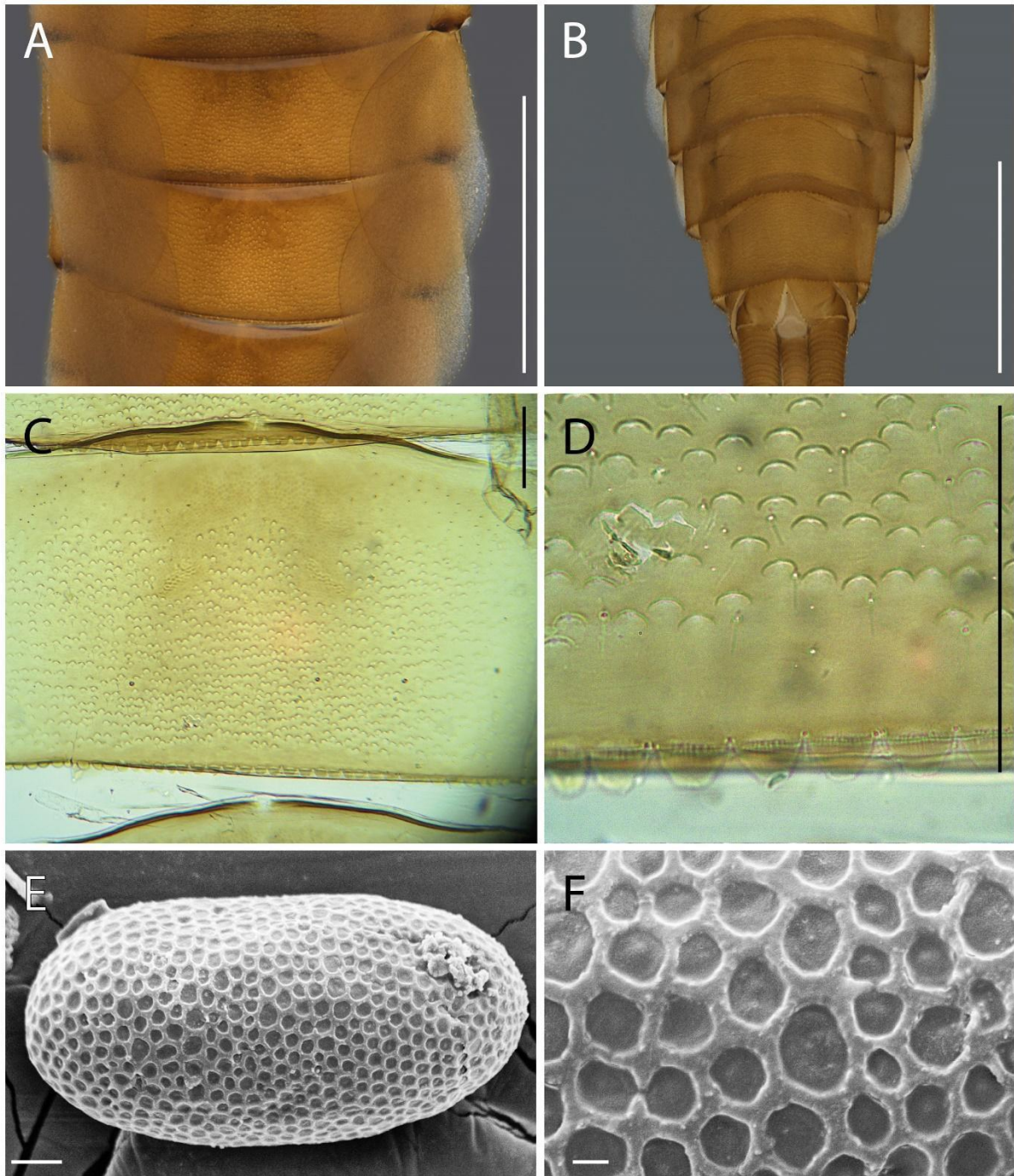


FIGURE 5a-f. Nymph and egg of *Americabaetis titthion*. a. Dorsal view of abdominal segments III–VI; b. Ventral view of abdominal segments VI–IX; c. Tergum VI; d. Detail of tergum IV; e. egg; f. chorion detail. (Scale bars: a, b: 1 mm; c, d: 100 μ m; e: 10 μ m; f: 2 μ m).

abdominal terga, a moderate distomedial projection on segment II of the labial palp, pectinate setae at the apex of the paraglossa, and robust legs. However, it differs from those species in that its mouthparts are not elongated, with the labrum being rounded and wider than long. Additionally, there are two pairs of soft, setose protuberances present in the meso- and metasternum. Salles *et al.* (2010b) propose that this character probably aids the nymph to withstand in the typical habitat of shallow areas with moderate to fast water. When comparing nymphs from Minas Gerais to those from Santa Catarina, no morphological differences were detected. This suggests that, despite the geographical separation, the diagnostic characteristics of these populations remain consistent.

All collected nymphs presented some degree of wear on the incisors and prostheca (Figs. 3c, e). Baptista *et al.* (2006) assigned *Americabaetis* species and other baetids to the collector-grazer functional feeding group, which are capable of removing periphyton with the tips of their mouthparts. Based on this observation and the substrate where the species were collected, the wear can be associated with the habit of removing the periphytic layer from the stone substrate.

Egg description of the genus *Americabaetis* is presented for the first time. The only visible characters are the chorion surface and the oblong shape, with no micropyle or adhesive structure. It is possible that the chorion relief may vary compared to other species, as observed by Kluge (2015) in the genus *Rhithroclaeon* Gillies, 1985. This represents an initial effort to describe and utilize *Americabaetis* eggs as a taxonomic character to differentiate species.

Acknowledgements

The authors wish to express their gratitude to Og De Souza (Termitology Laboratory of the Universidade Federal de Viçosa) for allowing the use of optic equipment; Isabel Cristina Hernandez and Rodrigo Braga Gastaldo for assistance during photographs processes; Ana Pes,

Neusa Hamada, Paulo Cruz and Rafael Boldrini for having collected and yielded the sample from Santa Catarina; Ana Dária Viana Leite for the made suggestions on the text; Núcleo de Microscopia e Microanálise da Universidade Federal de Viçosa for providing the micrographs pictures; to Instituto Estadual de Florestas (IEF) for collection permission (number 058/2021); Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) for providing a scholarship to Igor Ferreira Amaral; We would like to the Conselho Nacional de Desenvolvimento Científico e tecnológico do Brasil (CNPq) for a productivity grant to FFS (process 309666/2019-8) and Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG, processes. APQ 05461-18 and APQ-01591-23).

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**SEÇÃO II – *CLOEODES TOVAUNA*: A NEW SPECIES PREVIOUSLY IDENTIFIED
AS *CLOEODES AYMORE* MASSARIOL & SALLES, 2011 (EPHEMEROPTERA:
BAETIDAE) (ZOOTAXA, PUBLICADO)**

***Cloeodes tovauna*: a new species previously identified as *Cloeodes aymore* Massariol & Salles, 2011 (Ephemeroptera: Baetidae)**

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Abstract

In this study, material previously attributed to *Cloeodes aymore* Massariol & Salles is recognized and described as a distinct new species. The description is based on nymphs and reared adults collected in the State of Minas Gerais, Southeastern Brazil. The key characteristics that differentiate this new species from its congeners in nymphal stage are: a) body color pattern dark brown on head, thorax and abdominal segments; b) inner margin of labial palp segment III with robust pectinate setae; c) terga with spines present on posterior margins of segments II–X. The adults can be distinguished by the following characteristics: a) thorax dark brown; b) abdominal segments I, VII–X brown; terga IV with median pair of brown spots; c) single intercalary vein between RA-RP₁ (sometimes paired), ICu₁-ICu₂ and ICu₂-CuP; d) hind wings present; e) forceps segment III oval; posterior margin of subgenital plate slightly convex at middle. The interactive key to the South American species of the genus was updated to include the new species.

Key words: Mayflies, Atlantic Forest, Neotropical region, South America, Taxonomy

Introduction

Cloeodes Traver, 1938 is a Pan-American genus of Baetidae (Ephemeroptera) initially established to include two winged species from Puerto Rico. After the establishment of the genus, several papers have revised and updated its status, addressing the taxonomy, phylogenetic aspects, and distribution of the group (Waltz & McCafferty, 1987a; Waltz & McCafferty, 1987b; Domínguez *et al.* 2006; Nieto & Richard, 2008; Massariol & Salles, 2011; Nieto & Emmerich, 2011; Massariol *et al.* 2013; Salles *et al.* 2015; Salles *et al.* 2016; Kluge, 2017). Nowadays, the genus is recognized as exclusive to the New World, comprising 43 valid species distributed across North, Central, and South America and constituting one of the most species-rich genera of Baetidae in the Neotropical region (Salles *et al.* 2016; Jacobus & McCafferty, 2024; Salles *et al.* 2024).

Massariol & Salles (2011) described two four-winged species of *Cloeodes* from southeastern Brazil, *Cloeodes itajara* Massariol & Salles, 2011 and *Cloeodes aymore* Massariol & Salles, 2011. In that paper, *C. aymore* was described as having two variations: one with a general yellowish-white coloration pattern and with the posterior margin of abdominal terga having long and slanted spines often intercalated by short spines (Figs. 7, 8 and 32a in Massariol & Salles, 2011); and another one with a dark brown coloration pattern, with the posterior margin of terga having spines of the same length and not slanted (Figs. 9, 10 and 32b in Massariol & Salles, 2011). These variations were treated as intraspecific within the species, since the specimens were frequently found together and no additional distinguishing morphological characteristics were identified (Massariol & Salles, 2011).

During an ongoing project aimed at investigating the composition of mayflies in the state of Minas Gerais, specimens of the dark brown variation of *C. aymore* were collected. After comparing this fresh material with those examined by Massariol & Salles (2011), we concluded that there are sufficient characteristics to separate the dark variation into a distinct

new species, which is described in the present paper based on nymphs and reared adults. The new species is also included in the interactive key proposed by Salles *et al.* (2015).

Material and Methods

The nymphs were collected in streams using a D-frame net or a sieve with a maximum mesh size of 1.0 mm. Samples were collected in three municipalities of Minas Gerais: Araçuaia, Ouro Preto and Catas Altas. All these areas are part of the Atlantic Forest biome (Fig.1).

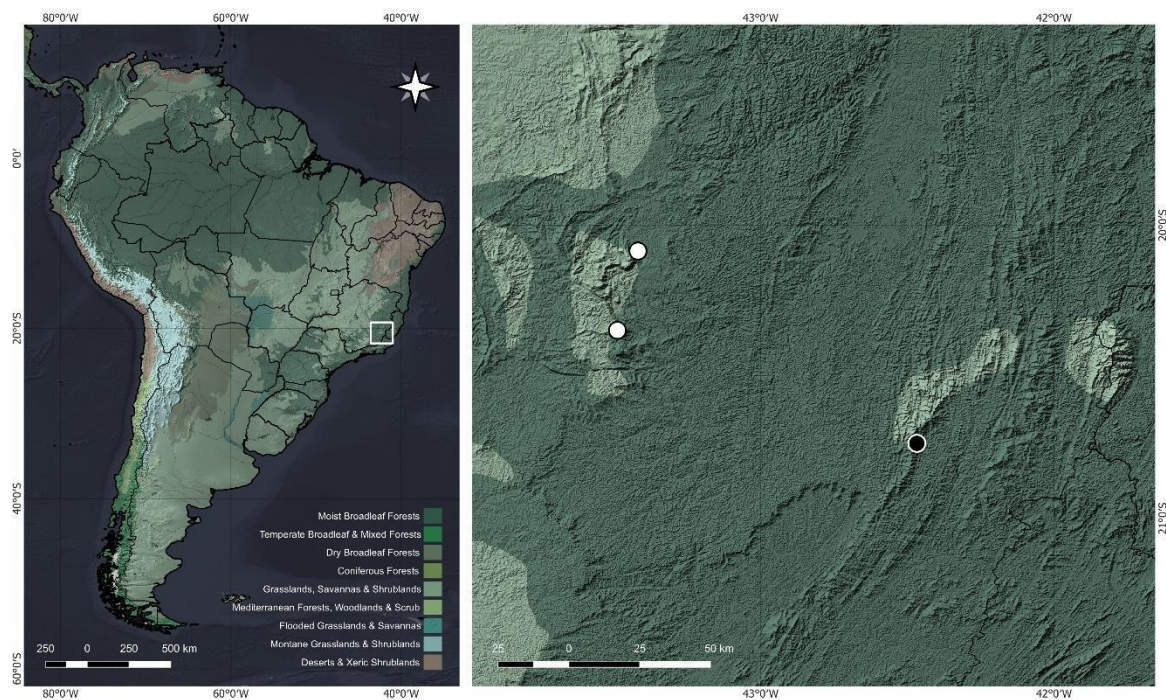


FIGURE 1. Sample sites. A, Map of South America with white rectangle highlighting the southeast of State of Minas Gerais; B, Sample sites in Minas Gerais: Araçuaia (Parque Estadual Serra do Brigadeiro, black circle); Catas Altas (Cachoeira da Santa, white circle); Ouro Preto (Parque Natural Municipal das Andorinhas, Cachoeira Vêu das Noivas, white circle).

Pictures of the habitus of the collected specimens were captured using a LEICA M205 A stereomicroscope with an attached LEICA MC170 HD digital camera. Nymphal exuviae and three nymphs were dissected directly in 2-Etoxiethanol. Permanent slides were prepared for mouth parts, legs, terga and filaments using Euparal® and photographed with an Olympus CX31 microscope equipped with a Moticam A5 digital camera. Wings were mounted dry and photographed in Leica Ivesta 3 with an integrated camera. All images were processed using Adobe Photoshop® 2024 and subsequently mounted with Adobe Illustrator® 2024. All material studied was fixed and is preserved in 80% ethanol and are deposited at the Museu de Entomologia, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil (UFVJ) and Museu Nacional do Rio de Janeiro (MNRJ/UFRJ).

Results

Cloeodes tovauna Amaral, Cifuentes-Vargas & Salles, sp. nov.

(Figs. 2–4)

Diagnosis. Nymph. 1) Body size 5.5–6.0 mm; 2) Body color pattern dark brown on head, thorax and abdominal segments I, V, VI and X; 3) Labrum with dorsal arc of setae composed of 1 + 0 + 3 setae (Fig. 3A); 4) Inner margin of labial palp segment III with robust pectinate setae (Fig. 3I); 5) Hind wing pads present; 6) Fore femur with apex projected, with 2 blunt setae (Fig. 4A); 7) Posterior margins of terga II–X with spines of the same length; 8) Paraprocts with 15–19 spines (Figs. 4E, F); 9) Cercus with spines on every two segments. Adults. 1) Turbinate eyes of males separated by approximately the width of a lateral ocelli; upper surface oblong, yellowish-brown (Fig. 5A); 2) Thorax dark brown (Fig. 5A); 3) Terga I, VII–X brown; tergum IV with median pair of brown spots; 4) Hind wing present (Fig. 5C); 5) Forceps brown, lighter towards apex, forceps segment III oval; 6) Posterior margin of subgenital plate slightly convex at middle.

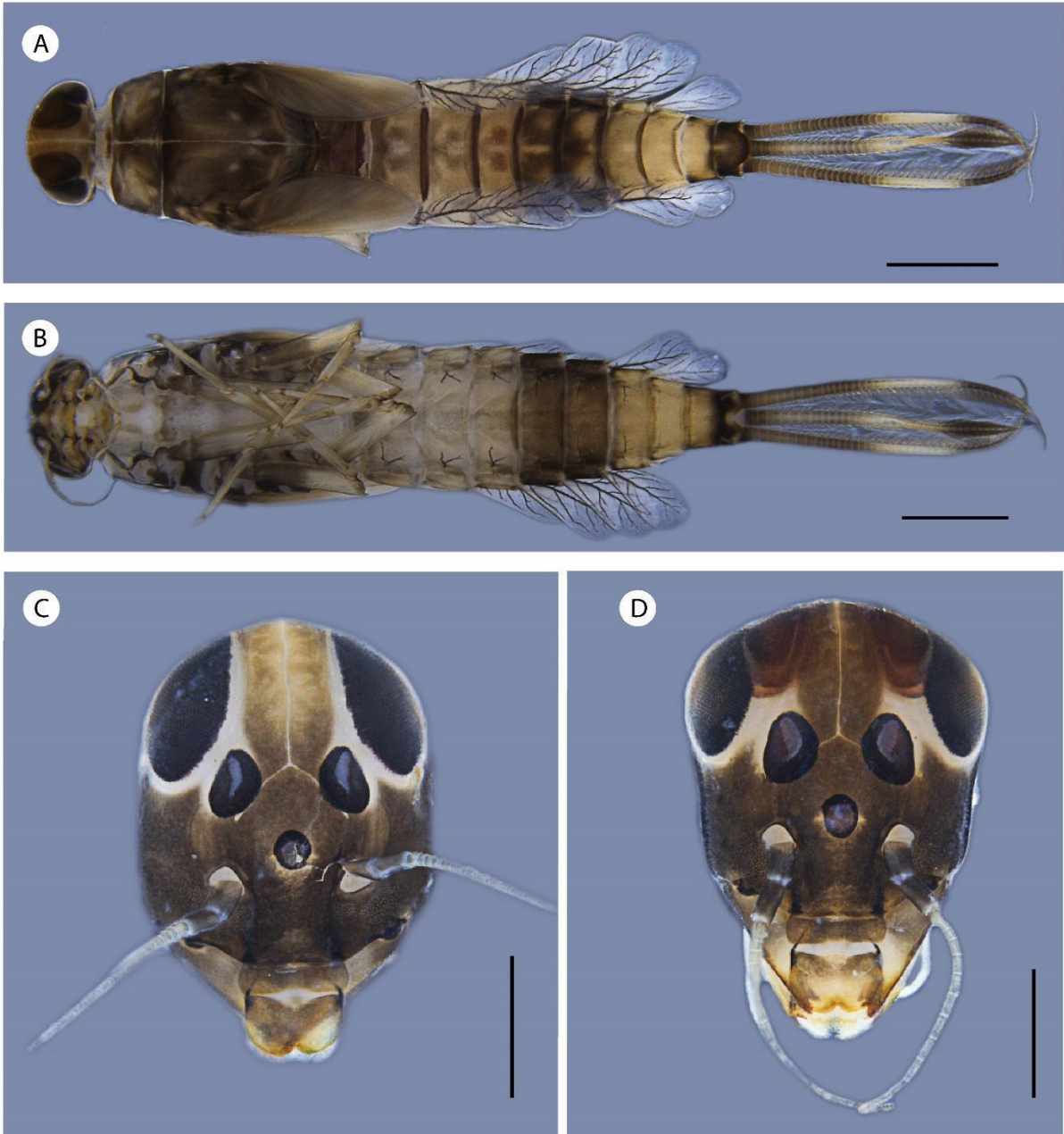


FIGURE 2. *Cloeodes tovauna* sp. nov., paratype nymph. A, Habitus, dorsal view; B, Habitus, ventral view; C, Female head, frontal view; D, Male head, frontal view. (Scale bar: A–B: 1 mm; C–D; 0.5 mm).

Description.

Nymph. Length (in mm). Body: 5.5–6.0; 1.9; cerci: 2.7; terminal filament: 2.9; antenna: 1.9.

Coloration (Fig. 2). General coloration dark brown with yellowish-white (Fig. 2A, B). Head dark brown with yellowish-white stripe between inner margin of compound eye and lateral ocellus (in males, reaching the base of turbinate eyes). Labrum and mandible darkish brown; hypopharynx, maxilla and labium light brown (Figs. 2 C, D). Thorax dark brown to light brown. Fore wing pads light brown at base and yellowish-white distally. Legs yellowish-white, mid and hind femora with apical dark brown band reaching $\frac{1}{2}$ of its length. Abdominal segments I, V, VI and X dark brown; segments II, III, IV, VII, VIII and IX yellowish-white; terga II and III with sublateral marks light brown; tergum IV with sublateral marks orangish brown; tergum V with anteromedial subtriangular yellowish white mark; tergum VI with yellowish-white sublateral area. Sterna yellowish-white, except for V, VI and X dark brown. Filaments light brown, with a yellowish-white band subdistally and a brown band distally. **Head.** Labrum (Fig. 3A). Length about $0.7 \times$ maximum width; dorsal arc of setae composed of $1 + 0 + 3$ long setae; ventrally with 6–10 spine-like setae near lateral margin. *Left mandible* (Figs. 3B, C). Margin between prosthema and mola slightly convex. *Right mandible* (Figs. 3D, E). Prosthema slender and pectinate, bifurcated at the middle; inner lobe long, outer lobe divided in the middle. Margin between prosthema and mola slightly convex. Hypopharynx as in Fig. 3F. Maxilla (Fig. 3G, H). Canines and distal dentiseta stout. Medially with 1 spine-like seta + 6 apically pointed setae. Maxillary palp as long as galea-lacinia; palp segment II $1.5 \times$ length of segment I. Labium (Fig. 3I, J). Base of glossa expanded (reaching at least half of paraglossa); inner and outer margins, respectively, with around 17 and 12 pointed setae increasing in length apically; ventral surface with one row of 7 short setae near the inner margin. Paraglossa apex with 2 rows of spine-like setae; outer margin with 3 pectinate setae; dorsally with arc of 3 setae close to inner margin; ventrally with arc of 7–8 setae close to inner margin. Labial palp with segment

I $0.8 \times$ length of segments II and III combined; segment II dorsally with oblique row of 6–7 setae; segment III rounded with 2–5 robust pectinate setae in inner margin; ventrally covered with several spine-like simple setae along margins and ventral surface. **Thorax.** Hind wing pad present. Fore leg (Fig. 4A). Ratio 1.1:1(0.6mm):1:0.2. Femur. Length about $4.4 \times$ maximum width; outer margin with row of 8–9 clavate setae (length of setae about $0.1 \times$ maximum width of femur); anterior and posterior margins parallel; submarginal setae absent; anterior surface and inner margin with around 36 simple spine-like setae; posterior surface with around 27 scattered setae near inner margin; apex projected; distal projection $0.1 \times$ width of femur; with 2 blunt, distally expanded setae. Tibia. Outer margin with few simple setae; inner margin with two serrate setae on apex; subtending bristle blunt, distally expanded, extending apex of tibia. Tarsus. Ventrally with row of 13–15+1 spine-like short setae. Tarsal claw. $0.2 \times$ length of tarsus. Mid and hind legs (Figs. 4B, C). Similar to fore leg, except for subapical projections of femur less developed and type of setae on inner apex of tibia on (simple instead of serrate). **Abdomen.** Terga (Fig. 4D). Spines present on posterior margins of segments II–X (occasionally reduced in segment II); spines approximately with the same length and not slanted, larger spines $2.5 \times$ longer than wide. Sterna. Spines present on posterior margin of segments IV–IX. Gills. Outer margin serrated on distal $1/4$; inner margin slightly serrated; few secondary tracheae extending from main trunk to inner and outer margins. Gill I about $3/4$ length of segment II, oval. Gill IV $1\ 1/2$ length of segment V, asymmetric, broad at the middle. Gill VII about $1\ 1/2$ length of segment VIII. Paraproct (Figs. 4E–F) with 15–19 spines. Cercus with large spines on every two segments. Terminal filament without large spines.

Male imago (Fig. 5). Length (in mm). Body: 5.8–6.0; antenna: 0.9; fore wing: 6.5; hind wing: 1.13–1.15; tibia I: 2.1; tibia II: 0.9; tibia III: 0.8; caudal filaments: broken.

Coloration (Fig. 5). Head dark brown with yellowish-white stripe between inner margin of compound eyes to base of antenna; yellowish-brown mark between inner margin of lateral

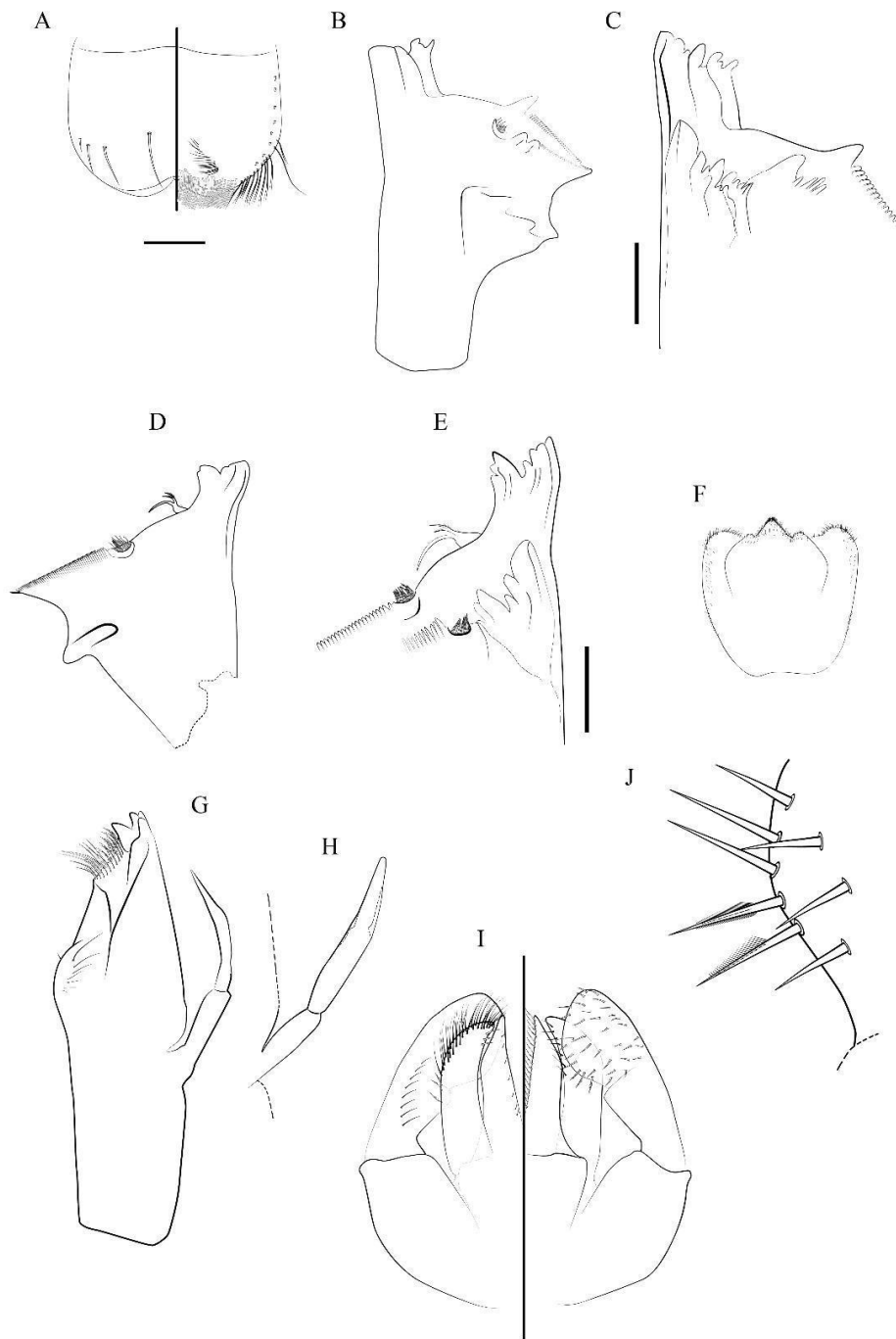


FIGURE 3. *Cloeodes tovauna* **sp. nov.**, mouthparts of holotype nymph (except details). A, Labrum, dorsal view; B, Left mandible; C, Left incisors and prosthema (paratype); D, Right mandible; E, Right incisors and prosthema (paratype); F, Hypopharynx (paratype); G, Left maxilla; H, Maxillary palp, detail; I, Labium; J, Third labial palp segment (detail, paratype). (Scale bars: 100 μ m)

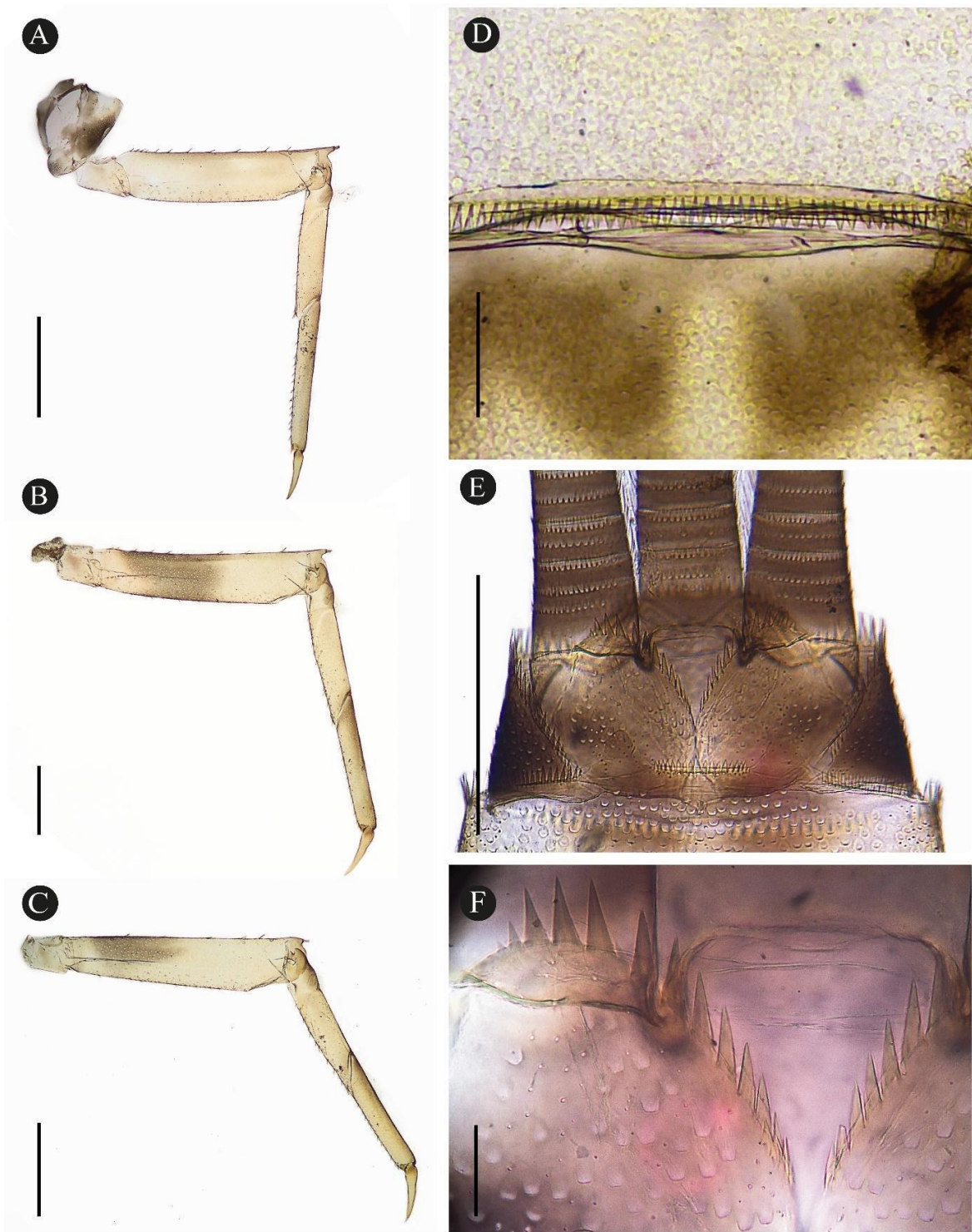


FIGURE 4. *Cloeodes tovauna* **sp. nov.**, holotype nymphal exuvia. A, Fore leg; B, Middle leg; C, Hind leg; D, Posterior margin of tergum IV; E, Paraprocts; F, Left paraproct detail. (Scale bar: A–E: 0.5 mm; F: 0.2 mm).

ocelli and surrounding middle ocelli. Antenna light brown. Lateral ocelli cream, surrounded with black. Compound eye cream. Turbinate eyes yellowish-brown; basal $\frac{1}{2}$ of stalk brown, remainder cream. Pronotum dark brown. Mesothorax mostly dark brown; antelateroparapsodal and recurrent scuto-scutellar sutures cream. Metanotum dark brown. Fore wing hyaline; veins light brown, dark brown in distal $\frac{1}{2}$ of C–MP. Hind wing hyaline; veins light brown. Foreleg trochanter yellowish brown with subapical orange mark; trochanter, femur, tibia and tarsi light brown; mid and hindleg similar, light brown. Terga I, VII–X brown; II–V cream; VI light brown; terga II–VI with lateral brown area; tergum IV with median pair of brown spots; posterior margin of terga II–VI with membrane tinged with brown. Sterna I, VII–X brown; II–VI cream. Tracheation black. Forceps predominantly brown, lighter towards apex.

Head (Fig. 5A). Turbinate eyes separated approximately by the width of lateral ocellus; inner margin parallel; upper surface oblong; length $1.35 \times$ width; stalk height $0.66 \times$ width of dorsal portion. **Thorax (Fig. 5B).** Anteronotal protuberance rounded. Metascutellar protuberance posteriorly pointed. Fore wing (Fig. 5C). Stigmatic area with 7 short veins, some incomplete; marginal intercalary veins paired, single between RA-RP₁ (sometimes paired), ICu₁-ICu₂ and ICu₂-CuP, absent between veins Sc-RA and CuP-A. Hind wing (Fig. 5C). With 2 complete longitudinal veins. Costal process hooked, located on basal third. Legs. Foreleg: tibia $0.6 \times$ length of femur; tarsi $0.05 \times$ length of femur; tarsus segments in decreasing order: 2, 3, 4, 5, 1; mid and hindleg similar. **Abdomen (Fig. 5B).** Genitalia. (Fig. 5D). Forceps segment I subrectangular; $0.4 \times$ length of segment II; distance between base of forceps $1.0 \times$ distance between lateral margins of forceps. Segment II of forceps with medial constriction. Segment III oval. Posterior margin of subgenital plate slightly convex at middle.

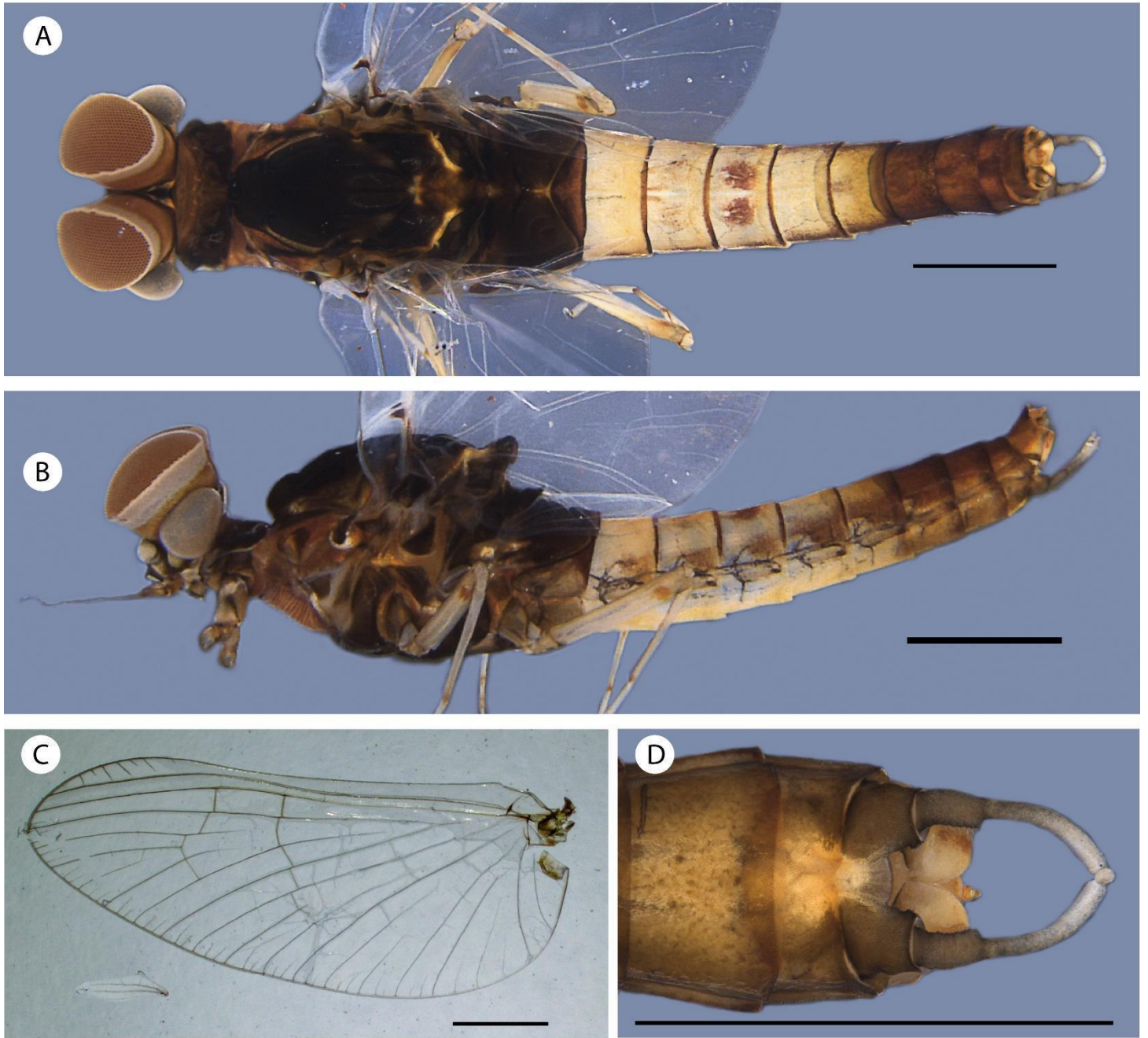


FIGURE 5. *Cloeodes tovauna* sp. nov., holotype male imago. A, Habitus, dorsal view; B, Habitus, lateral view; C, Wings; D, Genitalia, ventral view. (Scale bars: 1 mm).

Female imago (Fig. 6A) Length (in mm). Body: 6.2; antenna: broken; fore wing: 6.4; hind wing: 1; tibia I: 0.9; tibia II: 0.8; tibia III: 0.8; caudal filaments: broken.

Head (Fig. 6A). Coloration light brown; compound eyes, lateral and middle ocelli similar to male imago. Antenna light brown. **Thorax (Fig. 6B).** Pronotum light brown with brown marks. Mesothorax predominantly brownish-grey; antelateroparapsodal and medioparapsidal sutures cream; mediolongitudinal suture brown. Metanotum brown. Forewing (Fig. 6C). Hyaline; longitudinal and cross yellowish-brown. Stigmatic area with 5 to 7 cross veins touching or almost touching subcostal vein and 2 veins not touching subcostal vein; marginal intercalary veins similar to the male imago. Hindwing (Fig. 6C). Similar to male imago. Legs. Foreleg 2.9 mm; trochanter yellowish-brown with subapical orange mark; trochanter, femur, tibia and tarsi light brown; middle and hindleg similar. **Abdomen (Fig. 6B).** Tergum I dark brown; terga II, V–X brown; terga III and IV light brown; tergum IV with median pair of brown spots. Sterna light brown with sublateral dark brown subtriangular marks on segments II–VIII.

Female subimago (Figs. 7A–B). Body color pattern and lengths similar to female imago but opaque.

Type Material. Holotype: Male imago (in alcohol) with corresponding nymphal exuviae on slide, BRAZIL, Minas Gerais, Araçuaçu, Parque Estadual da Serra do Brigadeiro; Trilha para Pedra do Pato (20° 44' 38" S; 42° 28' 03" W), 23/VI/2024, Amaral, I.F., Cifuentes-Vargas, E.T., Salles, F.F. & Lima M.M. cols. (UFVB:EP02956). Paratypes: One female imago with corresponding nymphal exuviae and one female subimago with corresponding nymphal exuviae on slide, same data as holotype (MNRJ). 3 nymphs, Brazil, Minas Gerais, Araçuaçu, Parque Estadual da Serra do Brigadeiro; início Trilha Pedra do Pato (20° 43' 59" S 42° 28' 12" W), 07/VI/24, Salles, F.F., Neto, P.B., Sarmiento, F.R.P.,

Cifuentes-Vargas, E.T. & Alvim, J.B. cols. (UFVB:EP02958). 6 nymphs (three dissected),
Brazil, Minas Gerais,

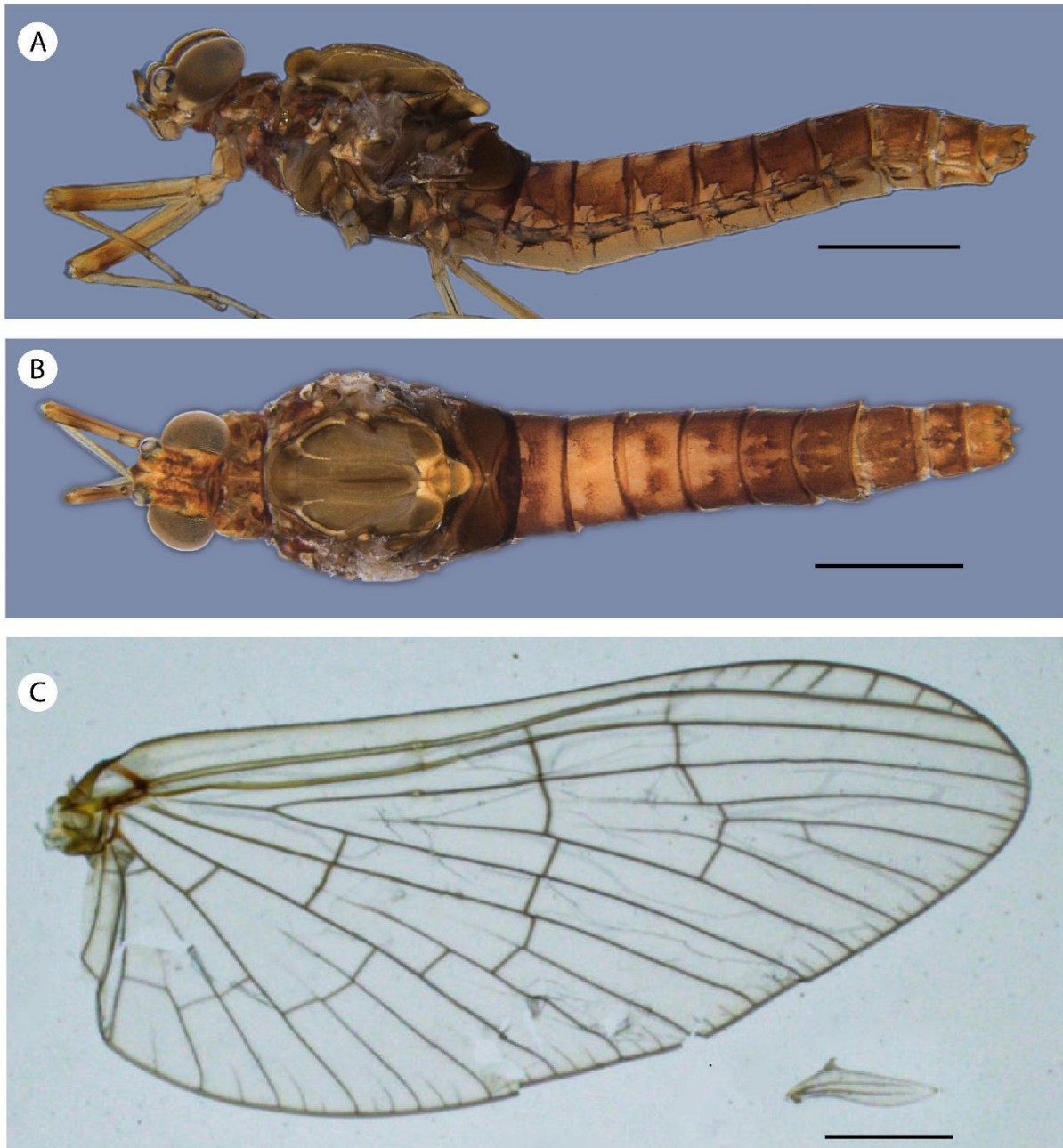


FIGURE 6. *Cloeodes tovauna* **sp. nov.**, paratype female imago. A, Habitus, dorsal view; B, Habitus, lateral view; C, Wings. (Scale bars: 1 mm).



FIGURE 7. *Cloeodes tovauna* sp. nov., paratype female subimago. A, Habitus, dorsal view; B, Habitus, lateral view. (Scale bar: 1 mm).

Araponga, Parque Estadual da Serra do Brigadeiro; Trilha das águas (20° 43' 52" S; 42° 27' 54" W), 28/V/2024, Amaral, I.F., Viana, A.D.L. & Correia, M.C.D. cols. (UFVB:EP02959).

One female imago with corresponding nymphal exuviae on slide, Brazil, Minas Gerais, Araponga, Parque Estadual da Serra do Brigadeiro; Trilha das águas (20° 43' 52" S; 42° 27' 54" W), 28/V/2024, Amaral, I.F., Viana, A.D.L. & Correia, M.C.D. cols. (UFVB:EP02957).

Additional material. 7 nymphs (two dissected) and 1 male imago, Brazil, Minas Gerais, Catas Altas, Cachoeira da Santa (20° 05' 17" S; 43° 25' 06" W), 25/I/2015, Salles, F.F. col. UFVB:EP02962. 2 nymphs, Brazil, Minas Gerais, Ouro Preto, Parque das Andorinhas, Cachoeira Vêu das Noivas (20° 21' 30" S; 43° 29' 18" W), 18/X/2023, Amaral, I.F., Morais, C.M.A. & Domingues, S.P. cols. UFVB:EP02963. One nymph (dissected), Brazil,

Minas Gerais, Ouro Preto, Parque das Andorinhas, Cachoeira Veu das Noivas (20° 21' 30" S; 43° 29' 18" W), 15/II/2024, Amaral, I.F., Silva, E.F. cols. UFVB:EP02964.

Material examined of *C. aymore*: Holotype. Male imago with corresponding nymphal exuviae, BRAZIL, Espírito Santo, Parque Nacional do Caparaó, Ibitirama, Pedra Roxa River (20° 23' 48.1" S; 41° 44' 08.1" W), 20/ IV/2008, Salles F.F., Massariol, F.C., Boldrini, R., Lima, M.M. & Britto, P.V.A. cols. (INPA). Paratype. Nymphal exuviae on slide, BRAZIL, Espírito Santo, Parque Nacional do Caparaó, Ibitirama, Tecnotruta River, propriedade "Sonho meu", 21/iv/2008, rock, moderate current, Salles F.F., Massariol, F.C., Boldrini, R., Lima, M.M. & Britto, P.V.A. cols. Slide of nymph PT 09, Brazil, Espírito Santo, Espera Feliz, Rio São Domingos, Cachoeira do Aurélio (20° 28' 57.5" S, 41° 50' 14.5" W 1800m), 22/IV/2008. Slide of nymph PT 11, Brazil, Espírito Santo, Espera Feliz Rio São Domingos, Cachoeira Sete Pilões (20° 28' 57.1" S, 41° 49' 50.4" W 1850m), 25/III/2009.

Etymology. The specific epithet is a combination of words derived from the Tupi-Guarani: 'tova' (face) and 'una' (black), alluding to the color pattern of the head. Name in apposition.

Distribution. Southeastern Brazil, Minas Gerais State (Araponga, Catas Altas, Ouro Preto); Espírito Santo State (Alto Caparaó, Espera Feliz).

Discussion

Massariol & Salles (2011) interpreted that *C. aymore* exhibits some morphological variations, with some specimens generally darker and with regular spines on the posterior margin of the terga at the nymphal stage. Despite these observations, the authors treated these variations as intraspecific, as they considered all other characteristics to be similar among the specimens, both on nymphs and adults. After analyzing the dark variant of the species in Minas Gerais, the following additional differences were noted in nymphs: a) the presence of



FIGURE 8. *Cloeodes tovauna* **sp. nov.**, living specimens. A, Male imago; B, Female imago. Photographs by Frederico Salles.

robust pectinate setae on the inner margin of labial palp segment III, instead of absent; d) spines absent in terminal filament, instead of present. In addition, we analyzed the holotype and paratype of *C. aymore*, including additional material from type locality with the dark variant. After analysis, the same differences were observed, leading us to conclude that the

variant is, in fact, a distinct species. Besides the characteristics shared with *C. aymore*, *C. tovauna* sp. nov. shares several characteristics with the nymphs of two other species found in Southeastern Brazil, *Cloeodes boldrinii* Salles, Massariol & Angeli, 2015, and *Cloeodes ioachimi* Salles, Massariol & Angeli, 2015. These shared features include the presence of hind wing pads, the length of the distal projection on fore femur, the dorsal arc of the labrum with a single medial seta, regular spines on the posterior margin of segments II–X, and cerci with large spines every two segments. The new species can be distinguished from *C. boldrinii* and *C. ioachimi* by the following features: dark brown color pattern on the head and terga I, V, VI, and X; 8 to 9 clavate setae on the outer margin of femora; spines on the posterior margin of the terga 2.5× longer than wide and with subequal length; distal projection of the fore femur not exceeding apex of femur. The interactive key proposed by Salles *et al.* (2015), available at <https://app.xper3.fr/xper3GeneratedFiles/publish/identification/7947968707478046661/mkey.html>, has been updated in order to include the new species.

Acknowledgments

We extend our gratitude to the Parque Estadual da Serra do Brigadeiro (PESB) and its managers, as well as to the Parque Natural Municipal das Andorinhas, for granting us access to study these areas. We also extend our thanks to Og De Souza from the Termitology Laboratory at the Universidade Federal de Viçosa for providing optical equipment. We are grateful to our colleagues Amanda de Souza Santos and João Victor Ladislau, from UFV, for their valuable contributions to this work. This research was supported by Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG, grant #APQ-01591-23; proc. APQ 05461-18), Conselho Nacional de Desenvolvimento Científico e Tecnológico do Brasil (CNPq, grants 408346/2023-0 and 309666/2019), and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES). Fieldwork was conducted under authorization from the Sistema

de Autorização e Informação em Biodiversidade (SISBIO/ICMBio), and we also thank the Instituto de Meio Ambiente e Recursos Hídricos (IEMA) and Instituto Estadual de Florestas (IEF) for their permission to collect specimens.

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**SEÇÃO III– EXPANDING THE KNOWLEDGE OF *AMERICABAETIS* KLUGE, 1992
(EPHEMEROPTERA: BAETIDAE): DESCRIPTION OF THREE NEW SPECIES
AND SUPPLEMENTARY DESCRIPTION OF *AMERICABAETIS LABIOSUS* LUGO-
ORTIZ & MCCAFFERTY, 1996 (NEOTROPICAL ENTOMOLOGY, ACEITO)**

Expanding the knowledge of *Americabaetis* Kluge, 1992 (Ephemeroptera: Baetidae): description of three new species and supplementary description of *Americabaetis labiosus* Lugo-Ortiz and McCafferty, 1996

Neotropical Entomology

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Abstract

Based on material collected in Brazil, three new species of *Americabaetis* are described based on nymphal stage. Two of them, *Americabaetis puri* sp. nov. and *Americabaetis anapes* sp. nov., present a remarkable characteristic previously reported only in *Americabaetis titthion* Lugo-Ortiz & McCafferty: a pair of setose protuberances on meso- and metasterna. They can be distinguished from each other based on the following characteristics: shape of the meso- and metasternum protuberances; shape of the spines on the posterior margin of the abdominal terga; number of denticles on the tarsal claws; gill shape; and number of spines on the paraproct. The third species, *Americabaetis urubici* sp. nov., can be distinguished, among other things, by the large body size, presence of frontal keel, gills with tracheae pigmented, extending from main trunk to inner and outer margins, and paraprocts with 21 marginal spines. To enhance the knowledge of the group, this paper also provides a supplementary description for the nymphs of *Americabaetis labiosus* based on extensive fresh material collected near its type locality. Finally, We present the first interactive identification key for species of the genus occurring in South America, based on the nymphal stage.

Keywords: Linnean shortfall, Neotropical, Atlantic Forest, Mayfly, Taxonomy

Introduction

Americabaetis Kluge 1992, is a Neotropical genus of Baetidae currently comprising 21 species (Jacobus and McCafferty 2025; Salles *et al.* 2025). The greatest species diversity is assigned to South America, which accounts for 14 species. Among them, six have both nymphs and adults described (*Americabaetis alphas* Lugo-Ortiz and McCafferty, 1996; *Americabaetis itatiaia* Marulanda-López and Salles, 2023; *Americabaetis labiosus* Lugo-Ortiz and McCafferty, 1996; *Americabaetis longetron* Lugo-Ortiz and McCafferty, 1996; *Americabaetis robacki* Lugo-Ortiz and McCafferty, 1994; and *Americabaetis titthion* Lugo-Ortiz and McCafferty, 1996 — in the case of *A. itatiaia*, only the subimago was described). Three species are known only from nymphs (*Americabaetis maxifolium* Lugo-Ortiz and McCafferty, 1996; *Americabaetis mecistognathus* Salles and Raimundi, 2010; and *Americabaetis boquiensis* Salinas in Salinas *et al.*, 2025), and five are known only from the adult stage [*Americabaetis bridarolli* (Navás, 1932), *Americabaetis jorgenseni* (Esben-Petersen, 1909), *Americabaetis oldendorffi* (Weyenbergh, 1883), *Americabaetis peterseni* (Hubbard, 1974), and *Americabaetis weiseri* (Navás, 1926)]. However, the descriptions of these adults are very incomplete, and future assignments to them are highly unlikely (Amaral and Salles, 2024).

Recent studies on the genus have focused on these species occurring in South America, exploring its diversity, distribution across the countries, and the description of new species and semaphoronts, while also complementing previous species descriptions. (Salles *et al.* 2010b; Marulanda-Lopes and Salles 2023; Amaral and Salles 2024; Salinas-Jiménez *et al.* 2025). These works have not only enhanced our understanding of *Americabaetis*, but have also helped reduce taxonomic shortfalls within the genus, given that most part of the original descriptions are succinct and only for a few species the adults have been described.

After conducting fieldwork in the Brazilian states of Minas Gerais and Santa Catarina, three new species of the genus were discovered. Two of them exhibit pairs of setose protuberances — a very conspicuous character previously known only in *A. titthion*. The third species is notable for the large size of its nymphs. Besides that, fresh and extensive material of *Americabaetis labiosus* Lugo-Ortiz and McCafferty 1996, has been collected close to the type-locality. Given the necessity of expanding the knowledge about the group, this article aims not only to describe new species, but also to complement the description of *A. labiosus*, and to provide the first interactive key for nymphs of the genus, including all species occurring in South America.

Material and Methods

Samples were collected in three municipalities of Brazil: Araponga, in Minas Gerais; São Joaquim and Urubici, in Santa Catarina. All these regions belong to the Atlantic Forest biome (Fig. 1 and 2).

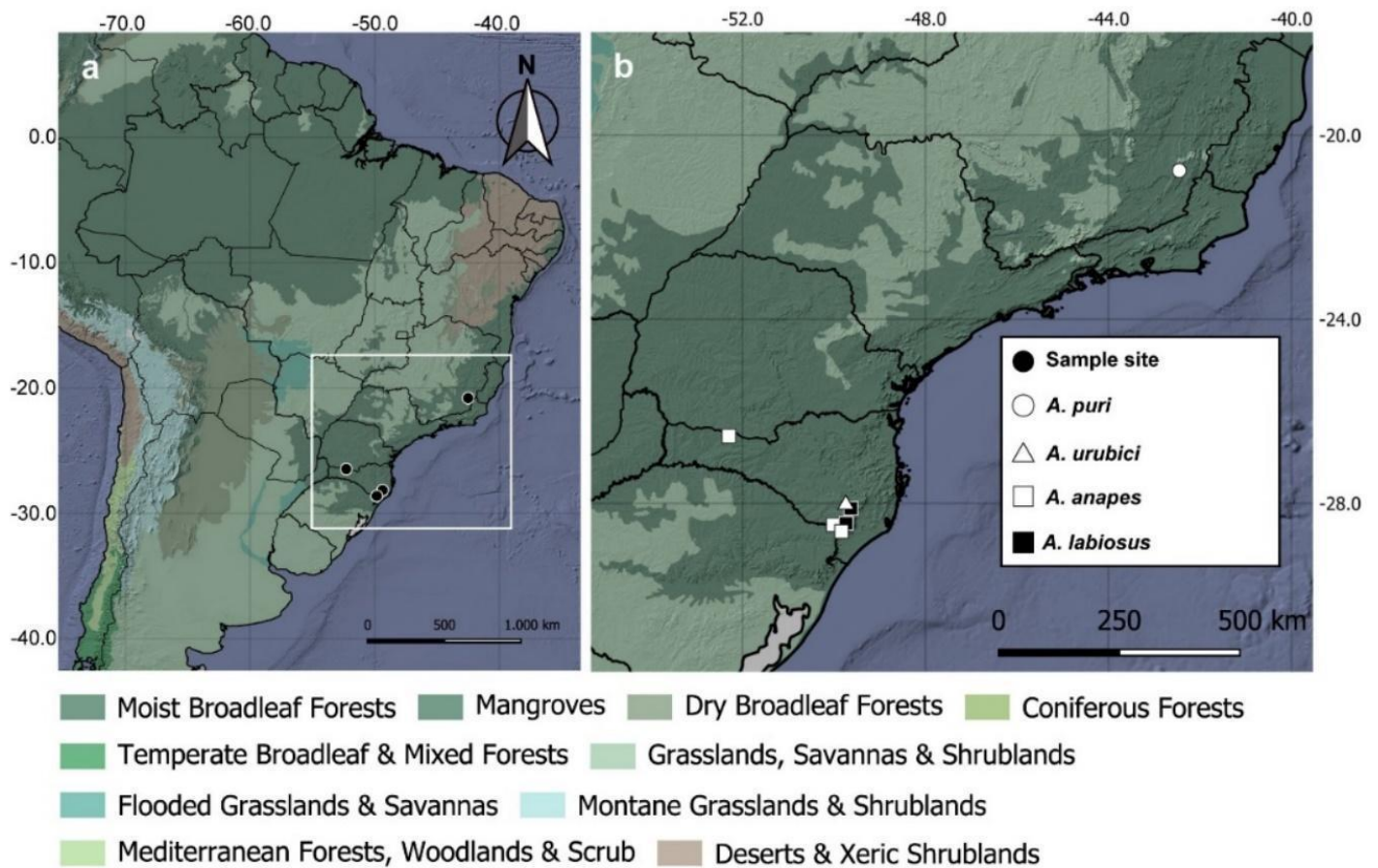


Fig. 1 Sampling locations. **a.** Partial map of South America showing Brazil and the boundaries of its states. White square highlighting sample localities. **b.** Partial map of Southeastern Brazil showing the distribution of the species analysed herein.



Fig. 2 Type localities of the sp. nov. **a.** *Americabaetis anapes* sp. nov.; **b.** *Americabaetis puri* sp. nov.; **c.** *Americabaetis urubici* sp. nov.

The habitus of the nymphs were captured using a LEICA Investa 3 (integrated camera) and processed in the Helicon Focus 8®. The nymphs were dissected directly in 2-Etoxiol, and permanent slides of mouth parts, legs, terga, and filaments were mounted using Euparal®. Subsequently, they were photographed with an Olympus CX31 microscope equipped with a Moticam A5 digital camera.

One nymph of each species with ventral thoracic projections was dissected to photograph the thorax using Scanning Electron Microscope (SEM). The thorax were kept in 80% ethanol, gradually transferred to acetone 100%, and subsequently to hexamethyldisilazane (HMDS) for 10 min and air dried for projection microscopy. After fixated on aluminum stubs, the samples were covered with gold (20 nm thick) and analyzed with a LEO 1430VP scanning electron microscope at 12 kV in the Núcleo de Microscopia e Microanálise da Universidade Federal de Viçosa.

Images were edited using Adobe Photoshop® 2024 and line-drawings of mouth parts and plates were prepared in Adobe Illustrator® 2024. All studied material was fixed and preserved in 80% ethanol and is deposited at the Museu de Entomologia, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil (UFVB) and Museu Nacional do Rio de Janeiro (MNRJ/UFRJ).

The interactive key was created using Xper3 (<http://www.xper3.fr/>). It incorporates all species occurring in South America that have been described in the nymphal stage, including *A. alphas* Lugo-Ortiz and McCafferty 1996; *A. boquiensis*; *A. itatiaia*; *A. labiosus*; *A. longetron*; *A. maxifolium*; *A. mescistognathus*; *A. robacki*; and *A. titthion*, as well as the new species described in this study. The following characteristics were selected: labrum shape, distomedial projection on the second segment of the labial palp, frontal keel, body shape, pairs of protuberances on the thorax, third gill shape, third gill length, gill tracheation, tracheae pigmentation, abdominal coloration, apex of abdominal spines on the posterior margin of the

terga, number of spines on the paraprocts, and number of denticles in the tarsal claws. The interactive key is available online at link (<https://app.xper3.fr/xper3GeneratedFiles/publish/identification/4915952397733481615/mkey.htm>) and will be updated according to the description of new species.

Results

Americabaetis anapes Amaral, Santos and Salles, sp.nov.

(Figs. 3–6)

<https://zoobank.org/NomenclaturalActs/49bda58e-b899-4807-bd57-4c56d7f7a6de>

Diagnosis. Nymphs: 1) frontal keel absent (Fig. 3c); 2) segment II of labial palp with a moderate distomedial projection (width $0.4 \times$ the base of segment III) (Fig. 4g); 3) glossa $0.7 \times$ length of paraglossa (Fig. 4g); 4) metasternum with small, conical paired protuberance (Fig. 5a); 5) tarsal claw with 11–14 denticles (Fig. 6a); 6) posterior margin of abdomen with pointed spines (Fig. 6b); 7) gills with tracheae not pigmented, asymmetric (Fig. 3a). 8) paraproct with 19–24 marginal spines (Fig. 6c).

Description. *Nymph* (male). Length of body: 7.75–9.50mm; cerci: 3.30mm ; terminal filament: 4.30–5.0mm; antennae: broken. Coloration: General coloration yellowish-brown. Head brown with yellowish-white area between inner margin of antennae and mid ocellus (Fig. 3c). Labrum and mandible yellowish-white; hypopharynx, maxilla and labium light yellow. Thorax (Fig. 3a, b and d) yellowish-brown. Pronotum with anterolateral white marks; mesonotum with a “U”-shape mark, extending from basal part of fore wing pad to metanotum; metasternum protuberances cream. Legs (Fig. 3b) yellowish-brown; anterior surface of femura with 4 brown spots. Abdomen general yellowish-brown (Fig. 3a and b). Cerci and terminal filament yellowish-brown. **Head:** Frontal keel absent (Fig. 3c); labrum



Fig. 3 *Americabaetis anapes* sp. nov., paratype nymph. **a.** Habitus, dorsal view; **b.** Habitus, ventral view; **c.** Head, frontal view; **d.** Protuberances in metasternum (Scale bars: 1 mm).

(Fig. 4a) rectangular; (length about $0.7 \times$ wider than long); dorsally with short, fine, simple setae scattered over surface (omitted in the Fig. 3c); dorsolateral arc of setae composed of 7–8 + 1 long, spine-like setae; lateral margin with pectinate and bifid setae; ventral surface with 8–9 spine-like setae near lateral margin; lateral margin with short, fine, simple setae. Left mandible (Fig. 4b). Inner and outer set of incisors with 3 + 4 denticles; angle between incisors and mola obtuse; margin between prostheca and mola with tuft of setae and with small crenulation close to subtriangular process; subtriangular process wide, above level of area between prostheca and mola; apex of mola with three fine, simple setae. Right mandible (Fig. 4c). Inner and outer set of incisors respectively with 4 + 4 denticles; dorsal surface with one row of simple, fine and long setae close to the medial margin; angle between incisors and mola obtuse; margin between prostheca and mola with row of setae, tuft of spine-like setae at base of mola present; apex of mola with strong pectinate setae. Hypopharynx (Fig. 4d). Lingua subequal to superlinguae, apex acute covered with fine setae; superlinguae not expanded with short, fine, simple setae scattered over lateral and distal margin. Maxilla (Fig. 4e and f). Medial protuberance of galea with 4 + 1 simple setae. Maxillary palp as long as galea-lacinia; with short, fine, simple setae scattered over surface; palp segment II $1.4 \times$ length of segment I. Labium (Fig. 4g). Glossa basally broad, narrowing apically and shorter than paraglossa ($0.7 \times$ length of paraglossa); inner margin with 12–13 spine-like setae, outer margin with 8–9 long spine-like setae increasing in length apically; paraglossa sub-rectangular, 3–5 long, simple setae close to inner margin, apex with three rows of apically pectinate setae. Labial palp segment I $0.8 \times$ the length of segments II and III combined, exceeding the base of paraglossa; segment I covered with short, simple setae on outer and inner margins and micropores along outer margin; segment II with moderate and rounded distomedial projection (width of distomedial protuberance $0.4 \times$ the base of segment III); inner margin with short simple setae, more numerous at distomedial protuberance; outer margin with few, short, simple setae and

dorsally with row of 4-5 fine and simple setae;

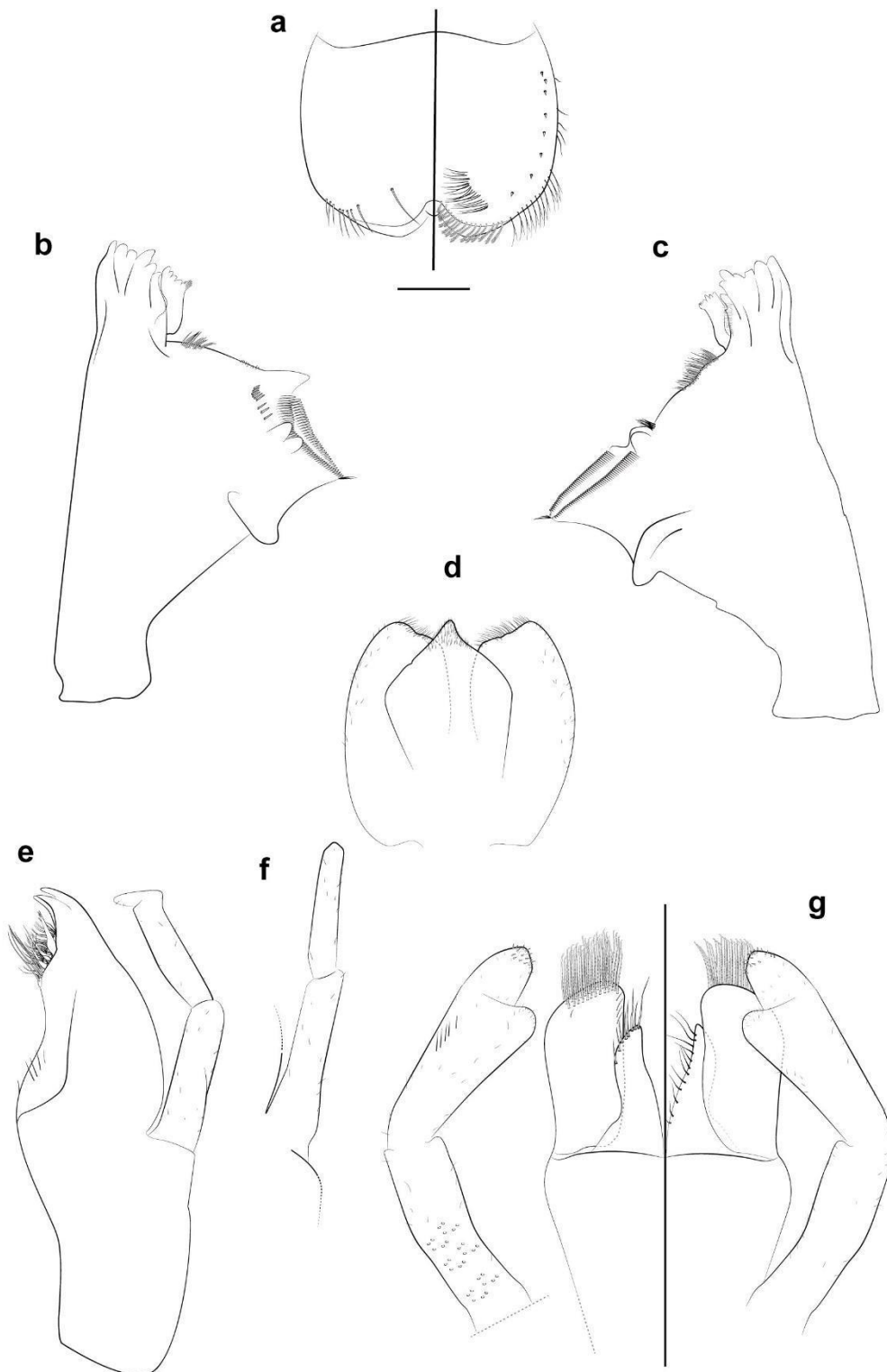


Fig. 4 *Americabaetis anapes* sp. nov., mouthparts of nymph. **a.** Labrum (left: dorsal view; right: ventral view); **b.** Left mandible; **c.** Right mandible; **d.** Hypopharynx; **e.** Right maxilla; **f.**

Paratype maxillary palp detail; **g.** Labium (left: dorsal view; right: ventral view). (Scale bar: 100 μ m).

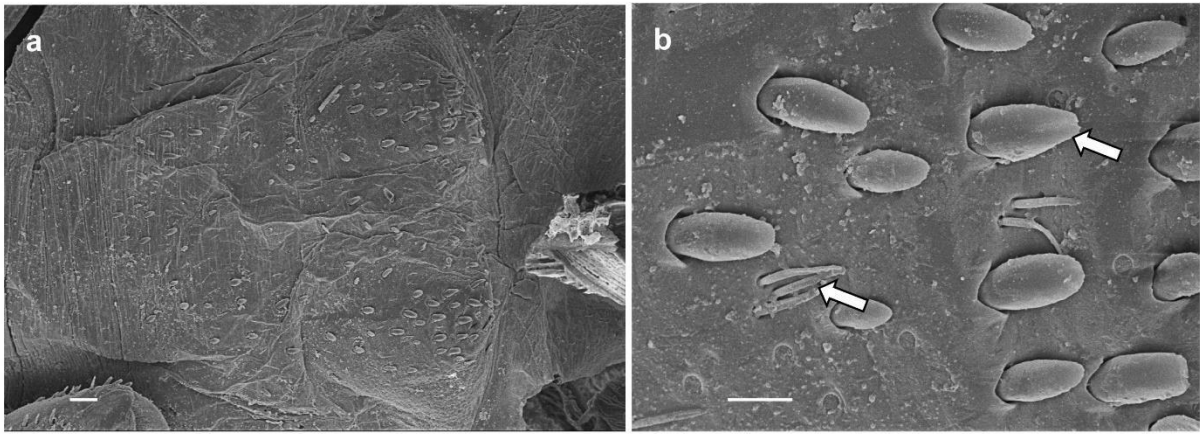


Fig. 5 *Americabaetis anapes* sp. nov., nymph, SEM pictures of thorax. **a.** pairs of protuberances in meso- and metasternum SEM; **b.** Detail of protuberances. (Scale bars: a, 100 μ m; b, 10 μ m).

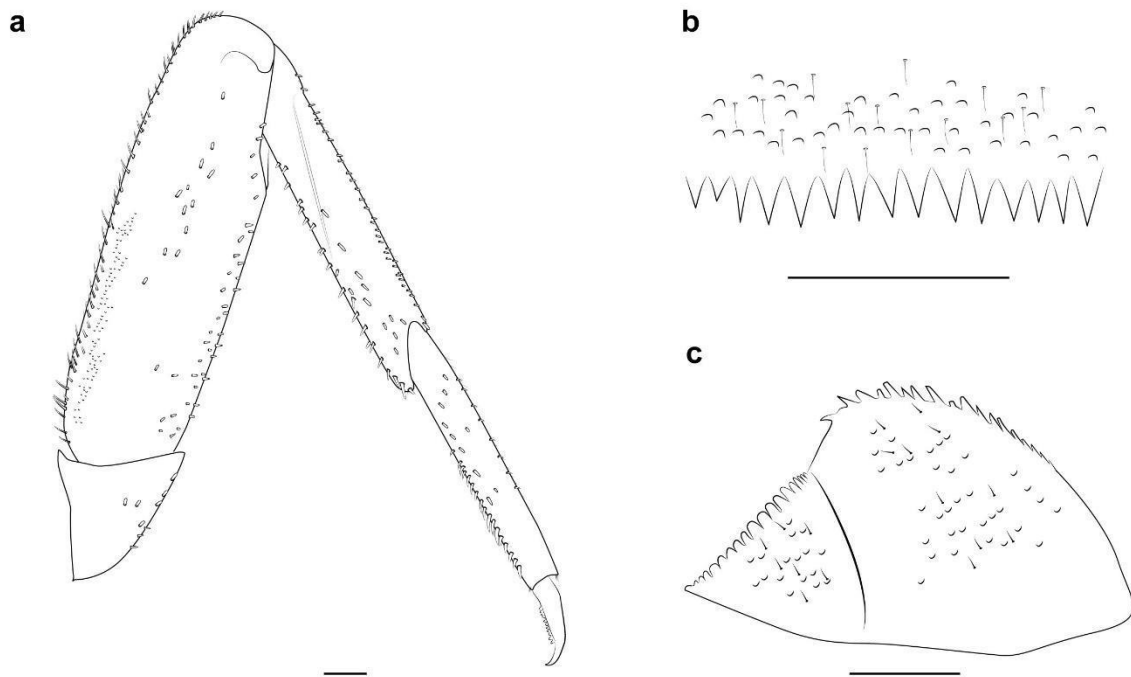


Fig. 6 *Americabaetis anapes* sp. nov., nymph. **a.** Fore leg, dorsal view; **b.** Posterior margin of tergum IV; **c.** Paraproct. (Scale bars: 100 μ m).

segment III distally conical, length $1.5 \times$ width; covered with spine-like and fine, simple setae.

Thorax: (Fig. 5^a and b) Small paired of protuberances on metasternum present, conical, ventrally projected with rounded apex; surface with two types of sensilla, one thin and long (trichoid) and other thick (basiconic), more numerous in the apex. Foreleg (Fig. 6a). Ratio of foreleg 1.3:1(1.0):0.75:0.25; forefemur length about $3.25 \times$ maximum width; outer margin with row of 56–62 apically long spine-like setae; anterior surface with scattered short blunt setae; inner margin with short, spine-like setae. Tibia outer margin with numerous short, spine-like setae; inner margins with 21 short, spine-like setae increase in length apically; anterior surface with scarce short blunt setae; tibio-patellar suture present. Tarsus outer margin with scarce short simple setae and 7–8 short spine-like setae; inner margin with one row of 17 spine-like setae, increase in length apically; anterior surface with scarce short blunt setae. Tarsal claw with 11–16 denticles. Mid and hind legs similar to foreleg. **Abdomen:** Terga. Surface with abundant scales and scale-bases; posterior margin with pointed spines (Fig. 6b). Gills asymmetric (costal margin straight, anal margin strongly curved) (Fig. 3a); margin with narrow spines intercalating short, fine, simple setae, tracheae not pigmented. Sterna. Posterior margin of II–VI without spines, VII–IX with pointed spines. Paraproct (Fig. 6c). 19–24 marginal spines; surface with scale or scale-bases; posterolateral extension with 10–16 robust marginal spines. Caudal filaments. Terminal filament $0.6 \times$ length of cerci; posterior margin of segments with short spines on each segment.

Adults. Unknown.

Distribution. BRAZIL, Santa Catarina.

Biology. The majority of the material of this new species was found in São Joaquim, in southern Santa Catarina, very close to the border with Rio Grande do Sul. The nymphs were collected in the Rio Pelotas or one of its tributaries. While the Rio Pelotas is about 50 meters wide, its tributary measures around 30 meters. Both rivers feature numerous rocks and slabs as substrate.

During a recent attempt to collect additional specimens from the tributary of the Rio Pelotas in 2024, the rocks were covered with moss and sediment, and nymphs of the new species were not found.

Etymology. The name of the species honours our friend and trichoptero-logist from the National Institute for Amazonian Research (INPA), collector of many mayflies studied by the senior author, Dr. Ana Maria Pes.

Material examined. HOLOTYPE: male nymph (on slide), BRAZIL, Santa Catarina; São Joaquim, Rio Pastinho, afluyente do Rio Pelotas (28° 26' 29.5" S; 49° 53' 16.5" W, 923 m.a.s.l.) 01/IX/09, Pes, A.M., da Silva, J.O. & Hamada, N. cols. (UFVB:EP03674). Paratypes: 1 female nymph (on slide) 2 male nymphs, 3 female same data as holotype (UFVB:EP03675). 1 male nymph same data as holotype (MNRJ). Other examined material: 2 nymphs (male and female), Brazil, Santa Catarina; São Joaquim, Rio Pelotas (28° 26' 50.3" S 49° 52' 58.3" W, 936 m.a.s.l.; 31/VIII/2009, Pes, A.M., da Silva, J.O. & Hamada, N. cols. (UFVB:EP03676). 1 male nymph, Brazil, Santa Catarina; São Joaquim, Rio Pelotas (28° 26' 50.3" S 49° 52' 58.3" W, 936 m.a.s.l.; 31/VIII/2009, Pes, A.M., da Silva, J.O. & Hamada, N. cols. (UFVB:EP03677). 2 nymphs (male and female), Brazil, Santa Catarina; Abelardo Luz, afluyente do Rio Chapecó (26° 33' 07" S 52° 19' 14.5" W, 751 m.a.s.l.; 06/IX/2009, Pes, A.M., da Silva, J.O. & Hamada, N. cols. (UFVB:EP03678).

Remarks

The nymphs of *Americabaetis anapes* new species are similar to those of *Americabaetis labiosus* and *Americabaetis titthion*, as these species share several characteristics such as the absence of a frontal keel (Fig 3c), the moderate size of the distomedial projection on segment II of the labial palp (Fig. 4g), and gills with unpigmented trachea (Fig. 3a). Nevertheless, *A. anapes* differs from both species by the presence of numerous setae in the outer margin of the femora (ranging from 60–63 setae) (Fig. 6a), small pair of conical protuberances on

metasternum (Fig. 3d and Fig. 5a), pointed spines on the posterior margin of terga (Fig. 6b), and numerous spines on paraprocts (ranging from 19–24 spines). A white “U”-shaped mark on the mesonotum is also very distinctive in the new species.

***Americabaetis puri* Amaral, Santos and Salles, sp.nov.**

(Figs. 7–10)

<https://zoobank.org/NomenclaturalActs/a0c46b4d-4550-41a3-b4a0-3ff55ffc5e0b>

Diagnosis. Nymphs: 1) frontal keel absent (Fig. 7c); 2) segment II of labial palp with a moderate distomedial projection (width $0.5 \times$ the base of segment III) (Fig. 8f); 3) glossa $0.7 \times$ length of paraglossa (Fig. 8f); 4) lingua with apex acute and covered with fine setae (Fig. 8d); 5) meso and metasternum with a setose paired protuberances (Fig. 7d); 6) tarsal claw with 7–9 denticles (Fig. 10a); 7) symmetrical gill, with tracheae not pigmented (Fig. 7a); 8) posterior margin of abdominal sterna VIII and IX with blunt spines; 9) paraproct with 12–16 spines (Fig. 10c).

Description. *Nymph.* Length (in mm). Body: 4.50–5.65; cerci: 3.80–3.64; terminal filament: 1.80–2.60; antennae: 1.50–1.60. Coloration: General coloration brown to greyish-brown (Fig. 7a). Head (Fig. 7c) greyish-brown with yellowish-white area between inner margin of antenna and mid ocelli. Labrum brown, mandible yellowish-white, hypopharynx, maxilla and labium light brown. Thorax (Fig. 7a) brown to light brown. Meso- metasternum protuberances greyish-brown (Fig. 7d); fore wing pad with costal area reddish-brown (Fig. 7b). Legs yellowish-brown. Abdominal (Fig. 7a and b) tergum II light brown; terga I and III–IX brown; terga II–IX with anterior sigilla dark brown; terga III–IX with posteromedial

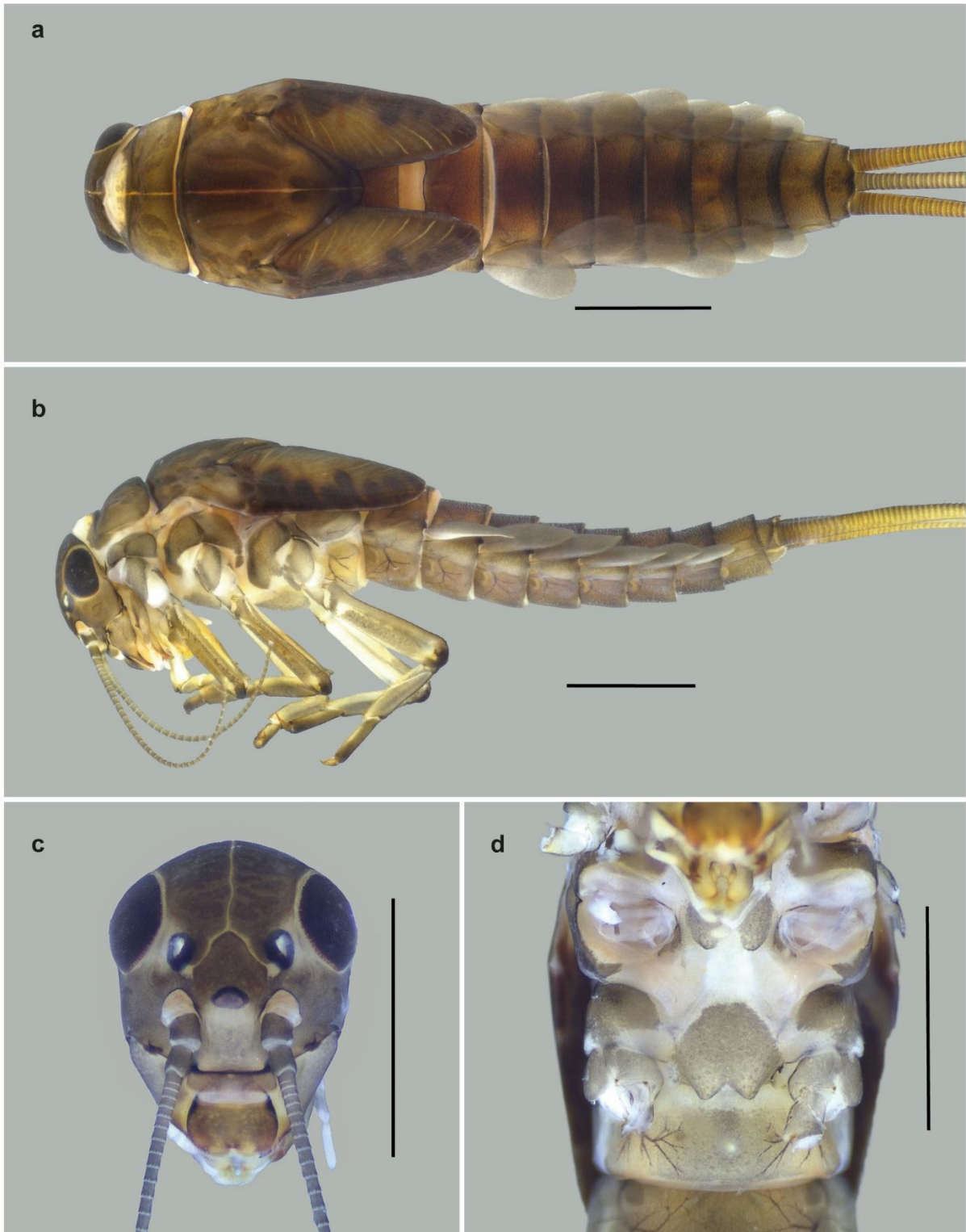


Fig. 7 *Americabaetis puri* sp. nov., holotype nymph. **a.** Habitus, dorsal view; **b.** Habitus, lateral view; **c.** Head, frontal view; **d.** Protuberances in meso- metasternum (Scale bars: 1 mm).

dark brown mark; tergum III with light brown sublateral area. Sterna yellowish-white. Cerci and terminal filament light brown.

Head: Frontal keel absent (Fig. 7c); labrum (Fig. 8a) rectangular, broader than longer (length about $0.6 \times$ wider than long); dorsally with short, fine, simple setae scattered over surface (omitted in Fig. 8a); dorsolateral arc of setae composed of 6–8 + 1 long, spine like setae; lateral margin with bifid setae; ventral surface with 4–5 spine-like setae near lateral margin; lateral margin with short, fine, simple setae. Left mandible (Fig. 8b). Inner and outer set of incisors with 3 + 3 denticles; angle between incisors and mola obtuse; margin between prostheda and mola with tuft of setae and with small crenulation close to subtriangular process; subtriangular process wide, above level of area between prostheda and mola; apex of mola with strong pectinate setae. Right mandible (Fig. 8c). Inner and outer set of incisors respectively with 4 + 4 denticles; inner margin of incisors with longitudinal row of simple, fine setae on dorsal surface; prostheda robust, apically denticulate; angle between incisors and mola obtuse; margin between prostheda and mola with tuft of fine, simple setae, tuft of spine-like setae at base of mola present; apex of mola with three pectined setae. Hypopharynx (Fig. 8d). Lingua subequal to superlingua in length, apex acute covered with fine setae; superlinguae expanded with short, fine, simple setae scattered over lateral and distal margin. Maxilla (Fig. 8e). Medial protuberance of galea with 4–5 + 1 simple setae; outer margin of stipe with scattered long, fine, simple setae. Maxillary palp as long as galea-lacinia, with short, fine, simple setae scattered over surface; palp segment II subequal to segment I. Labium (Fig. 8f). Glossa basally broad, narrowing apically and shorter than paraglossa ($0.7 \times$ length of paraglossa); inner margin with 8 spine-like setae increasing in length apically, outer margin with 8–9 long spine-like setae increasing in length apically; paraglossa sub-rectangular, apex with three rows of apically pectinate setae. Labial palp segment I $0.9 \times$ the length of segments II and III combined; segment I covered with short, simple setae on

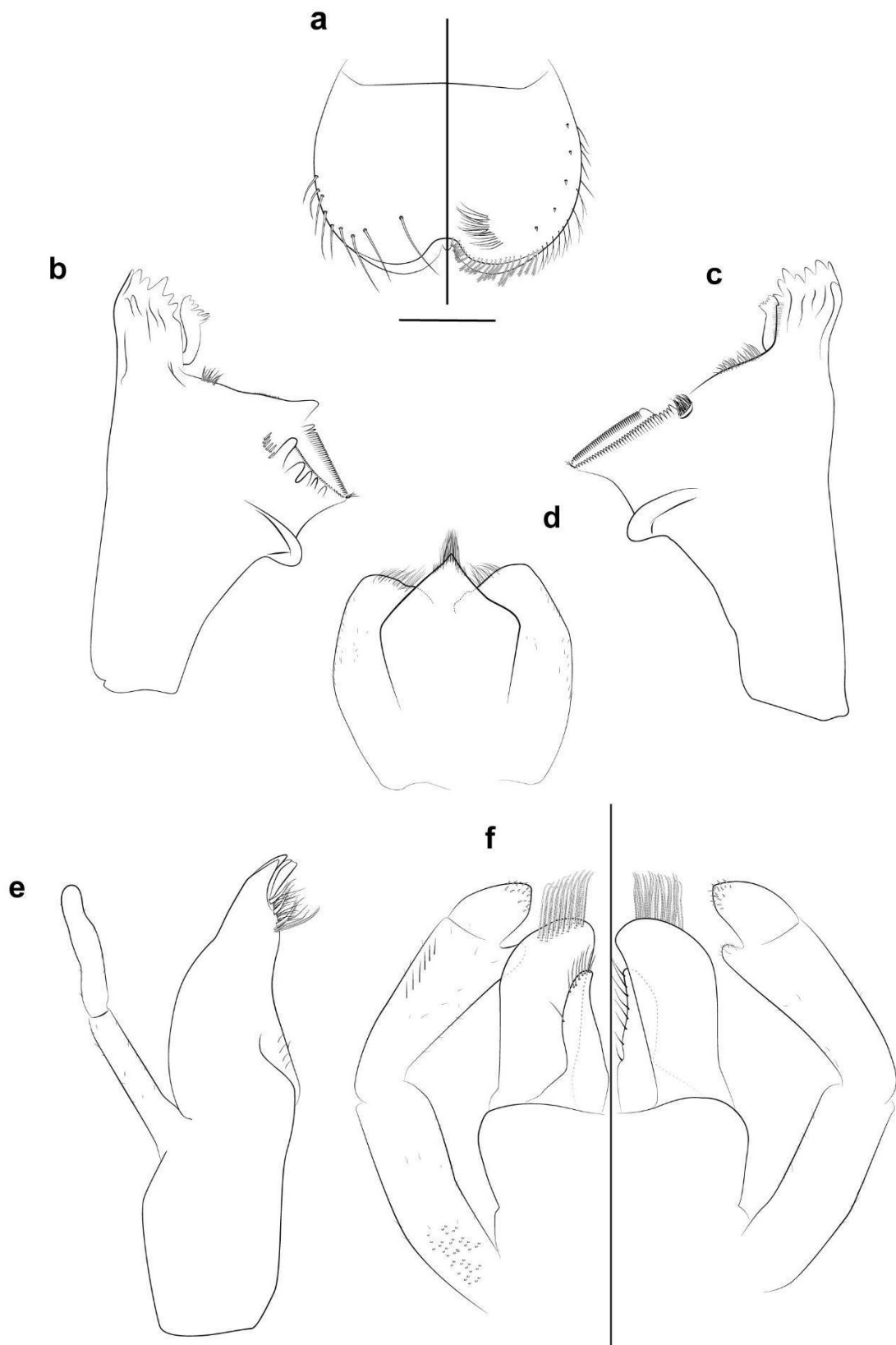


Fig. 8 *Americabaetis puri* sp. nov., mouthparts of nymph. **a.** Labrum (left: dorsal view; right:

ventral view); **b.** Left mandible; **c.** Right mandible; **d.** Hypopharynx; **e.** Left maxilla; **f.** Labium (left: dorsal view; right: ventral view). (Scale bar: 100 μm).

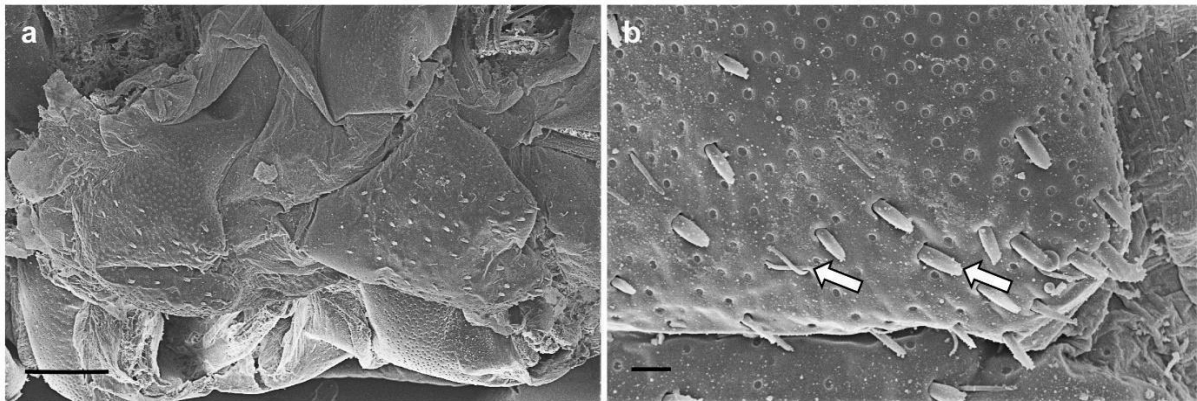


Fig. 9 *Americabaetis puri* sp. nov., nymph, SEM pictures of thorax. **a.** pairs of protuberances in meso- and metasternum; **b.** Detail of protuberances. (Scale bars: a, 100 μm ; b, 10 μm).

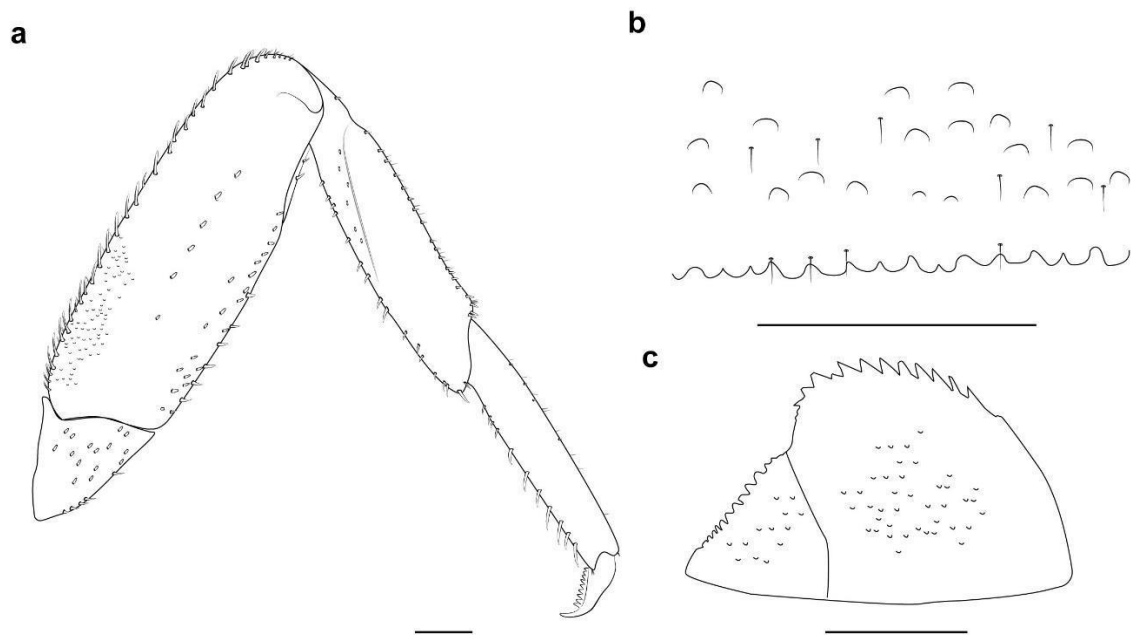


Fig. 10 *Americabaetis puri* sp. nov. **a.** Fore leg, dorsal view; **b.** Posterior margin of tergum IV; **c.** Paraproct (Scale bars: 100 μm).

outer and inner margins and micropores along outer margin; segment II with moderate and rounded distomedial projection (width of distomedial protuberance $0.5 \times$ the base of segment III); inner margin with short simple setae, more numerous at apex; outer margin with few,

short, simple setae and dorsally with row of 6 fine and simple setae; segment III distally conical, length $1.3 \times$ width; covered with spine-like and fine, simple setae.

Thorax: Pairs of robust protuberances on meso- and metasternum (Fig. 9a), projected narrowly pointed posteriorly; surface with two types of sensilla, one thin and long (trichoid) and other thick (basiconic), more numerous at apex (Fig. 9b). Foreleg (Fig. 10a). Ratio of foreleg 1.4: 1 (0.5):0.9:0.28; forefemur length about $2.8 \times$ maximum width; outer margin with row of 32–43 apically acute, simple setae; anterior surface with blunt setae close to inner margin; inner margin with strong spine-like setae in basal half. Tibia outer margin with a row of 20 spine-like setae; inner margin with one row of 17 spine-like setae; tibio-patellar suture present. Tarsus outer margin with scarce short simple setae and 4 short spine-like setae; inner margin with one row of 11 spine-like setae. Tarsal claw with 9 denticles. Mid and hind legs similar to foreleg.

Abdomen: Terga. Surface with abundant scales and scale-bases; posterior margin with blunt spines (Fig. 10b). Gills symmetric (costal and anal margins similarly curved) (Fig. 7a), margin with narrow spines intercalating short, fine, simple setae; tracheae not pigmented. Sterna. Posterior margin of sterna I–VII without spines, VIII–IX with blunt spines. Paraproct (Fig. 10c). 12–14 marginal spines; surface with scale or scale-bases; posterolateral extension with 14 minute marginal spines. Caudal filaments. Terminal filament $0.7 \times$ length of cerci; posterior margin of segments with short spines on each segment.

Adults. Unknown.

Distribution. BRAZIL, Minas Gerais.

Biology. The nymphs of the new species were found exclusively in an elevated area of the Serra do Brigadeiro State Park, known as the Pedra do Pato pools (approximately 1600 meters above sea level). The nymphs were observed during both the dry and rainy seasons. In the rainy season, they were predominantly found in vertical areas with strong currents and in significantly greater abundance. During the dry season, only a few nymphs were found, most

of them immature, restricted to the edges of the only pool that still retained a considerable volume of water. Unlike the rainy season, there was no connection between the pools during the dry season.

Etymology. The specific epithet *puri* honors the Puri indigenous people, historically inhabiting southeastern Brazil, including areas near the species' collection sites. This name acknowledges their cultural significance and connection to the region's ecosystems.

Material examined. HOLOTYPE: female nymph (on slide, abdomen in alcohol), BRAZIL, Minas Gerais; Araponga, Parque Estadual da Serra do Brigadeiro; Piscinas da Pedra do Pato (20° 44' 38" S; 42° 28' 03" W) 11/III/24, Salles, F.F., Cifuentes-Vargas, E.T., Nascimento, G.F. & Amaral, I.F. cols. (UFVB:EP03681). Paratypes: 2 female nymph (on slide), BRAZIL, Minas Gerais; Araponga, Parque Estadual da Serra do Brigadeiro; Piscinas da Pedra do Pato (20° 44' 38" S; 42° 28' 03" W), Salles, F.F., Alvim, J.B., Cifuentes-Vargas, E.T., Neto, P.B., Sarmento, F.R.P. cols (MNRJ); 1 male nymph (on slide), BRAZIL, Minas Gerais; Araponga, Parque Estadual da Serra do Brigadeiro; Piscinas da Pedra do Pato (20° 44' 38" S; 42° 28' 03" W), Salles, F.F., Alvim, J.B., Cifuentes-Vargas, E.T., Neto, P.B., Sarmento, F.R.P. cols. Other examined material: 28 nymphs, 4 male, 24 females same data as paratypes (UFVB:EP03627); 27 nymphs, 8 male and 19 female, BRAZIL, Minas Gerais; Araponga, Parque Estadual da Serra do Brigadeiro; Piscinas da Pedra do Pato (20° 44' 38" S; 42° 28' 03" W), 25/III/2025, Salles, F.F. & Amaral, I.F. cols (MNRJ); 29 nymphs, 10 male and 19 female, BRAZIL, Minas Gerais; Araponga, Parque Estadual da Serra do Brigadeiro; Piscinas da Pedra do Pato (20° 44' 38" S; 42° 28' 03" W), 25/III/2025, Salles, F.F. & Amaral, I.F. cols (UFVB:EP03723).

Remarks

Americabaetis puri new species is most similar to *Americabaetis titthion*, sharing several characteristics: the absence of a frontal keel (Fig. 7c), a moderate distomedial projection on segment II of the labial palp (Fig. 8f), the costal area of the forewing pads tinged with reddish-

brown (visible in mature nymphs) (Fig. 7a, b), the presence of paired setose protuberances on the meso and metasternum (Fig. 7d and Fig. 9), and rounded spines on the posterior margin of the abdominal terga (Fig. 10b). Despite these shared features, *A. puri* can be distinguished by the following characteristics: the presence of 12–16 spines in the paraprocts (versus 16–18 spines in *A. titthion*), blunt spines in posterior margin of sterna VIII–IX (VII–IX in *A. titthion*), the symmetric shape of the gills (Fig. 7a) (asymmetric in *A. titthion*), and the general coloration brown to greyish-brown (brownish-yellow in *A. titthion* [as presented in Fig. 4 by Amaral and Salles (2024)]).

***Americabaetis urubici* Amaral, Santos and Salles, sp.nov.**

(Figs. 11–13)

<https://zoobank.org/NomenclaturalActs/bb2485fb-8977-48a4-bbe8-cccada7a44cc>

Diagnosis. Nymphs: 1) Large body size (> 7.0 mm); 2) frontal keel present (Fig. 11a and c); 3) segment II of labial palp with a moderate distomedial projection (width $0.7 \times$ the base of segment III) (Fig. 12f); 4) glossa $0.7 \times$ length of paraglossa (Fig. 12f); 5) lingua with apex acute covered with fine setae (Fig. 12d); 6) tarsal claw with 9–11 denticles (Fig. 13a and b); 7) gills asymmetric, with tracheae pigmented, extending from main trunk to inner and outer margins (Fig. 11b and d); 8) posterior margin of terga with triangular pointed irregular spines (Fig. 13c); 9) paraprocts with 21 marginal spines (Fig. 13d).

Description. *Nymph.* Length of body: ♂ 7.80–8.50, ♀ 10.00–11.40; cerci: 5.30–7.30; terminal filament: 3.75–4.50; antennae: broken. Coloration: General coloration greyish-brown to brown. Head (Fig. 10a and c) greyish-brown with cream area between inner margin of composed eye to lateral ocellus, frontal keel cream. Labrum and mandible yellowish-white;

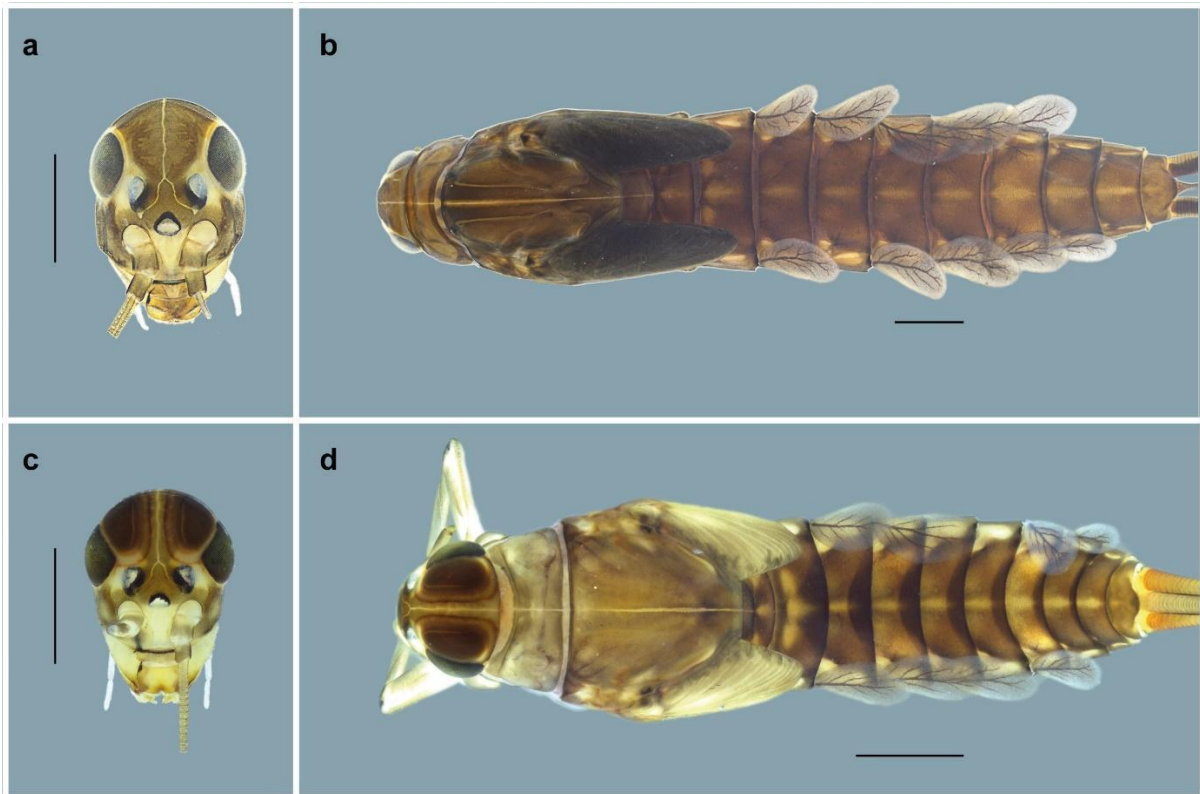


Fig. 11 *Americabaetis urubici* sp. nov., holotype and paratype nymphs. **a.** Female holotype habitus, dorsal view; **b.** Female holotype head, frontal view; **c.** Male paratype habitus, dorsal view; **d.** Male paratype head, frontal view (Scale bars: 1 mm).

hypopharynx, maxilla and labium light brown. Thorax (Fig. 11b and d) greyish-brown to brown; fore wing pads greyish-brown. Legs greyish-brown to brown, anterior surface of femura with 4 brown spots. Abdominal (Fig. 11b and d) terga I–VI brown, tergum VII light brown and VIII–X greyish-brown; terga II–X with anterior sigilla light-brown; terga III–IX with posteromedial dark brown mark; tergum II–IX with light brown white longitudinal discontinuous mid stripe and light brown medial mark sublateral area. Sterna general cream; sterna with reddish-brown sublateral area, mid area light brown. Cerci light brown with base yellowish-brown, terminal light brown. **Head:** Frontal keel present (Fig. 11a and c); labrum (Fig. 12a) nearly quadrangular (length about $0.7 \times$ wider than long); dorsally with short, fine, simple setae scattered over surface (omitted in Fig. 12a); dorsolateral arc of setae composed of

6 + 1 long, spine like setae;

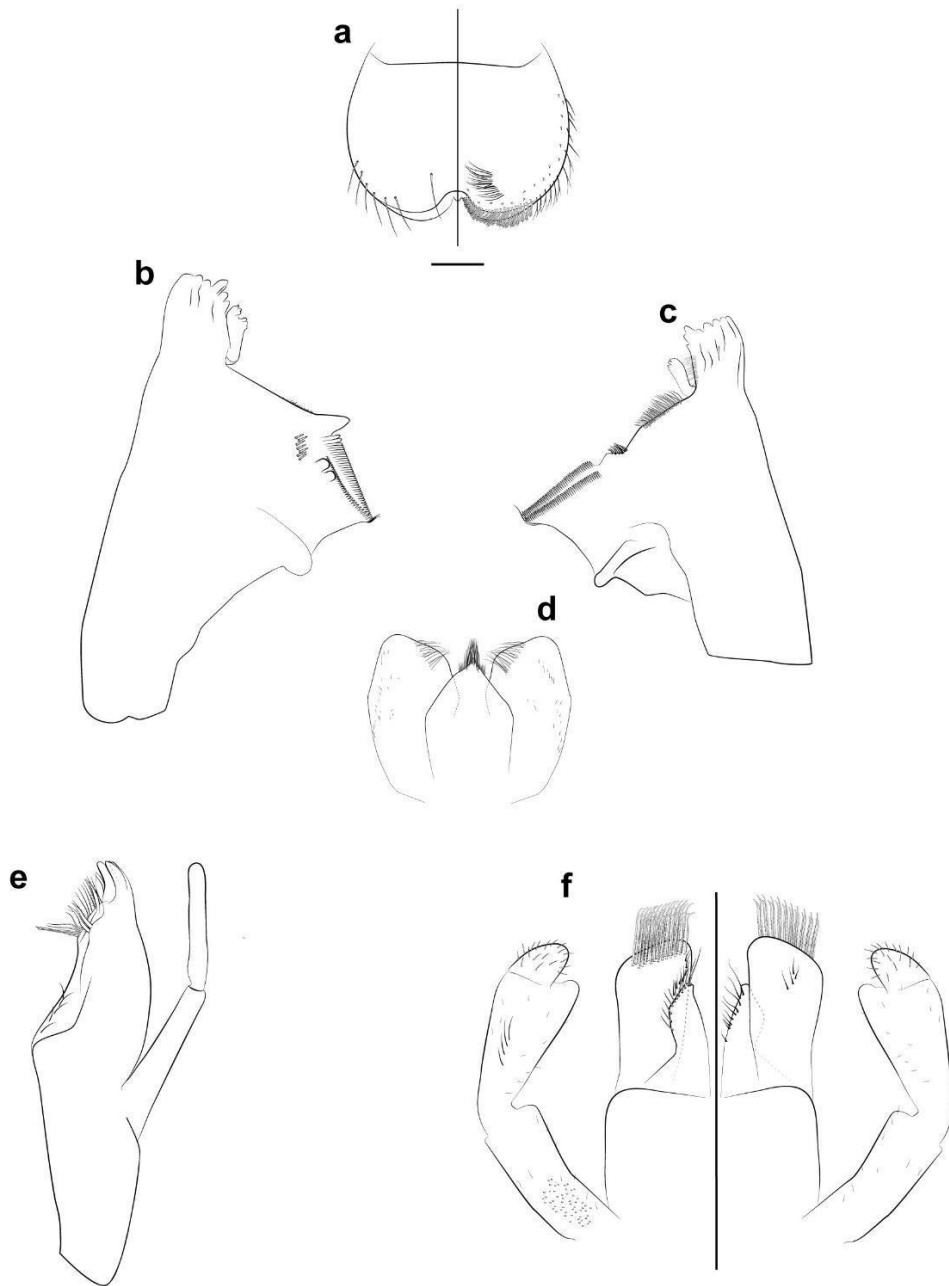


Fig. 12 *Americabaetis urubici* sp. nov., mouthparts of nymph. **a.** Labrum (left: dorsal view; right: ventral view); **b.** Left mandible; **c.** Right mandible; **d.** Hypopharynx; **e.** Right maxilla; **f.** Labium (left: dorsal view; right: ventral view). (Scale bar: 100 μ m).

lateral margin with bifid setae; ventral surface with 10–17 spine-like setae near lateral margin; lateral margin with short, fine, simple setae. Left mandible (Fig. 12b). Inner and outer set of incisors with 3 + 4 denticles; angle between incisors and mola obtuse; margin between prostheda and mola with tuft of setae and with small crenulation close to subtriangular process; subtriangular process wide, above level of area between prostheda and mola; apex of mola with three fine simple setae. Right mandible (Fig. 12c). Inner and outer set of incisors respectively with 4 + 4 denticles; dorsal surface with one row of simple, fine and long setae close to the medial margin; angle between incisors and mola obtuse; margin between prostheda and mola with row of setae, tuft of spine-like setae at base of mola present; apex of mola with robust single setae; row of fine simple setae at base of robust single setae. Hypopharynx (Fig. 12d). Lingua subequal to superlinguae, apex acute covered with fine setae; superlinguae expanded; short, fine, simple setae scattered over lateral and distal margin. Maxilla (Fig. 12e). Medial protuberance of galea with 5 + 1 simple setae. Maxillary palp as long as galea-lacinia; palp segment II same length of segment I. Labium (Fig. 12f). Glossa basally broad, narrowing apically and shorter than paraglossa ($0.7 \times$ length of paraglossa); inner margin with 11–12 spine-like setae, outer margin with 10–11 long spine-like setae increasing in length apically, dorsal surface with 8–10 spine-like setae; paraglossa sub-rectangular, apex with three rows of apically pectinate setae. ventral surface with 7 simple setae close to inner margin, dorsal surface with 4 long, simple setae close to pectinate setae in apex. Labial palp segment I $0.7 \times$ the length of segments II and III combined; segment I covered with short, simple setae on outer and inner margins and micropores along outer margin; segment II with moderate and rounded distomedial projection (width of distomedial protuberance $0.7 \times$ the base of segment III); inner margin with short simple setae, more numerous at apex; outer margin with few, short, simple setae and dorsally with row of 4 fine long simple setae; segment III distally conical, length 1.1

× width; covered with spine-like simple setae. **Thorax:** Foreleg (Fig. 13a). Ratio of foreleg

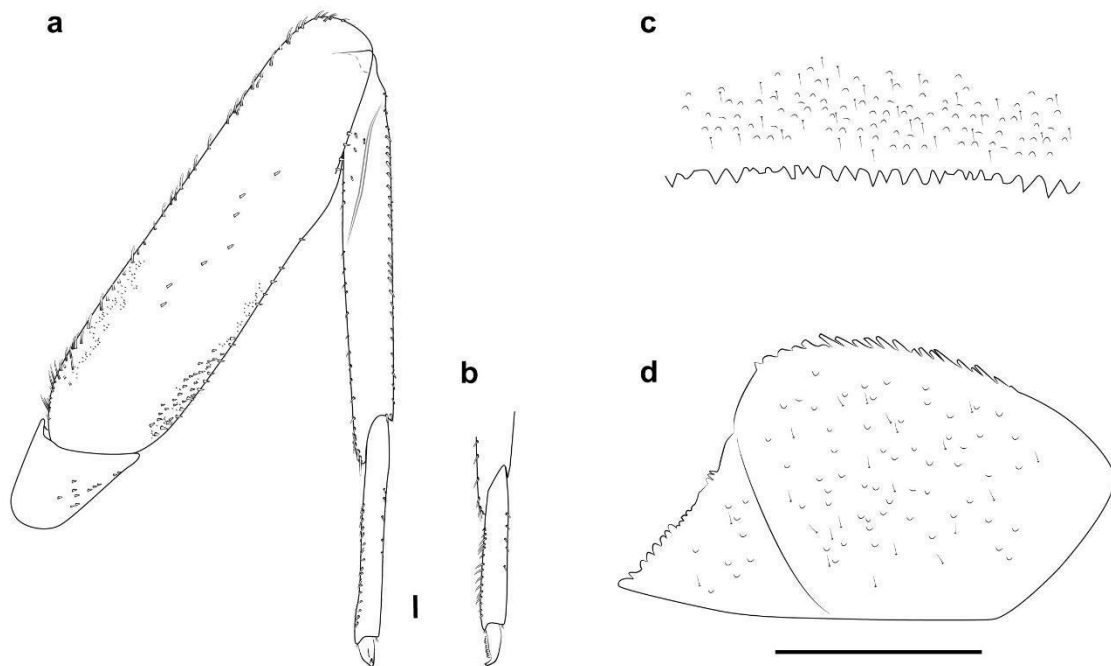


Fig. 13 *Americabaetis urubici* sp. nov., nymph. **a.** Fore leg, dorsal view; **b.** Posterior leg, dorsal view; **c.** Posterior margin of tergum IV; **d.** Paratype paraproct. (Scale bars: 100 μ m).

1.33:1(1.5):0.45:0.15; forefemur length about $5.4 \times$ maximum width; outer margin with row of 57 apically acute, simple setae; anterior surface with scattered blunt; inner margin with short, spine-like setae. Tibia outer margin with a row of spine-like setae; inner margin with a row of spine-like setae, anterior surface with blunt setae; tibio-patellar suture present. Tarsus outer margin with scarce short simple setae and 5 short spine-like setae; inner margin with 16–17 spine-like setae increase apically. Tarsal claw (Fig. 13a and b) with 9–11 denticles. Mid and hind legs similar to foreleg. **Abdomen:** Terga. Surface with abundant scales and scale-bases; posterior margin with triangular pointed irregular spines, size variable (Fig. 13c). Gills asymmetric (costal margin straight, anal margin strongly curved) (Fig. 11b and d) with short, fine, simple setae, tracheae extending from main trunk to inner and outer margins. Sterna.

Posterior margin of II–VI without spines, VII–IX with irregular point spines (small in sternum VII). Paraproct (Fig. 13d). 24 marginal spines; surface with scale or scale-bases; posterolateral extension with 21 minute marginal spines. Caudal filaments. Terminal filament $0.7 \times$ length of cerci; posterior margin of segments with short spines on each segment.

Adults. Unknown.

Distribution. BRAZIL, Santa Catarina.

Biology. The new species was collected exclusively in a well-preserved stream, approximately 4 meters wide, located in São Joaquim National Park. The streambed in the collection area is composed of several loose rocks over a predominantly slab-like substrate. The stream is well-shaded by vegetation typical of the region.

Etymology. The specific epithet alludes to the municipality where Parque Nacional de São Joaquim is located, referring to the species' type locality.

Material examined. HOLOTYPE: female nymph (on slide), BRAZIL, Santa Catarina; Urubici, Parque Nacional de São Joaquim; Cachoeira Três Quedas (28° 08' 43" S 49° 36' 24" W, 1440 m.a.s.l.), 15/XI/24, Salles, F.F., Almeida, L.H., Sarmento, F.R.P. cols. (UFVB:EP03629). Paratypes: 2 female nymph (MNRJ), 2 male nymph same data as holotype (UFVB:EP03630).

Remarks

Given the presence of a frontal keel (Fig. 11a and c), the size of the distomedial projection of the labial palp (Fig. 12f), and the gills with pigmented tracheae (Fig. 11b and d), *Americabaetis urubici* new species resembles *Americabaetis itatiaia*. Despite these characteristics, *A. urubici* can be distinguished by the following characteristics: body size greater than 7.0 mm (versus 5.7 mm in *A. itatiaia*), presence of 24 spines in the paraprocts (versus 12–14 in *A. itatiaia*), and terga with posterior margin with triangular spines, irregular with size variable (versus triangular regular spines in *A. itatiaia*).

***Americabaetis labiosus* Lugo-Ortiz and McCafferty, 1996**

(Figs. 14–16)

Americabaetis labiosus Lugo-Ortiz and McCafferty 1996: 167; Salles *et al.* 2003: 2; Francischetti *et al.* 2003: 69; Salles *et al.* 2004b: 726; Domínguez *et al.*, 2006: 70; Salles *et al.*, 2010a: 302; Salles *et al.* 2010b: 23; Lima *et al.*, 2010: 728; Boldrini *et al.*, 2012: 92; Lima *et al.*, 2012: 305; Massariol *et al.*, 2014: 369.

Diagnoses. Nymphs (modified from Salles *et al.*, 2010): 1) Frontal keel absent (Fig. 14a, c and e); 2) lingua broadly acute apically (Fig. 15d); 3) glossa $0.6 \times$ length of paraglossa (Fig. 15g), 4) apex of paraglossa with rows of pectinate setae (Fig. 15g); 5) segment II of labial palp with a moderate distomedial projection (width $0.4 \times$ the base of segment III) (Fig. 15g); 6) posterior margin of abdominal terga with rounded spines (Fig. 16b); 7) gills with tracheae not pigmented (Fig. 14b, d and f); 8) paraprocts with 16–19 marginal spines (Fig. 16c). Male imago: 1) turbinate eyes anteriorly divergent and widely separated from each other, upper surface ellipsoidal; 2) terga light whitish brown, lateral margins darker; 3) forceps with first segment constricted medioapically; 4) posterior margin of subgenital plate with a small rounded projection; 5) length of body relatively small (4.0 mm).

Complementary description. *Nymph.* Length of body: 5.50–6.60; cerci: 2.50–4.00; terminal filament: 2.50–3.50; antennae: 1.50–2.50. Coloration (Fig. 14). (in alcohol) General coloration greyish-brown to brown (Fig. 14b, d and f). Head (Fig. 14a, c and e) greyish-brown to brown; cream area between inner margin of composed eye to lateral ocellus, reddish-brown spot between scapo and lateral ocellus, cream area between inner margin of antennae and mid ocellus. Labrum and mandible brown to greyish-brown; hypopharynx, maxilla and labium yellowish-brown. Thorax (Fig. 14b, d and f) greyish-brown to brown; fore wing pads greyish-

brown to dark brown. Legs light brown to brown, anterior surface of femura with 4 brown spots.

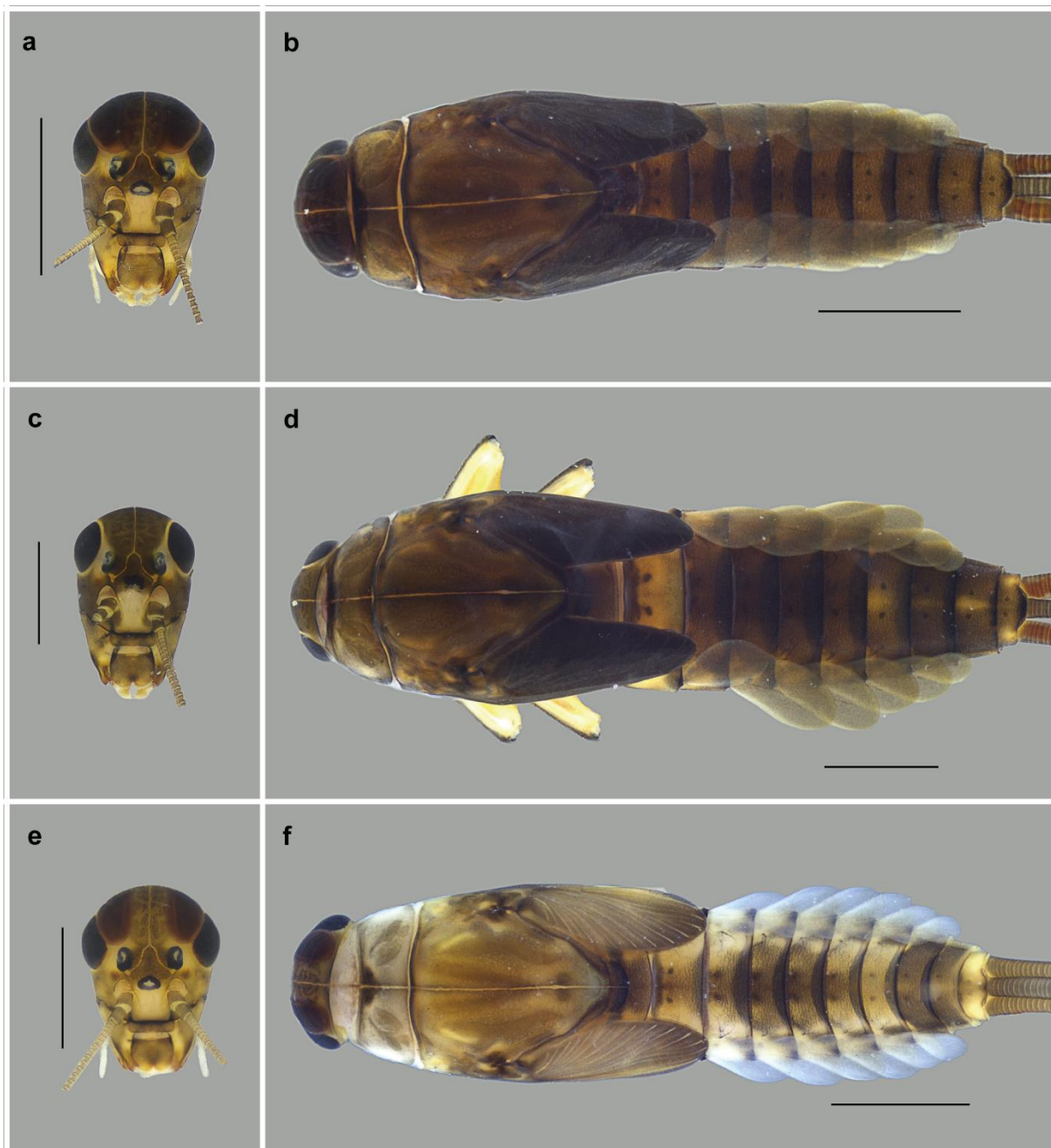


Fig. 14 *Americabaetis labiosus*. **a.** Male head, frontal view; **b.** Male habitus, dorsal view; **c.** Female head, frontal view; **d.** Female habitus, dorsal view; **e.** Male head, frontal view; **f.** Male habitus, dorsal view (Scale bars: 1 mm).

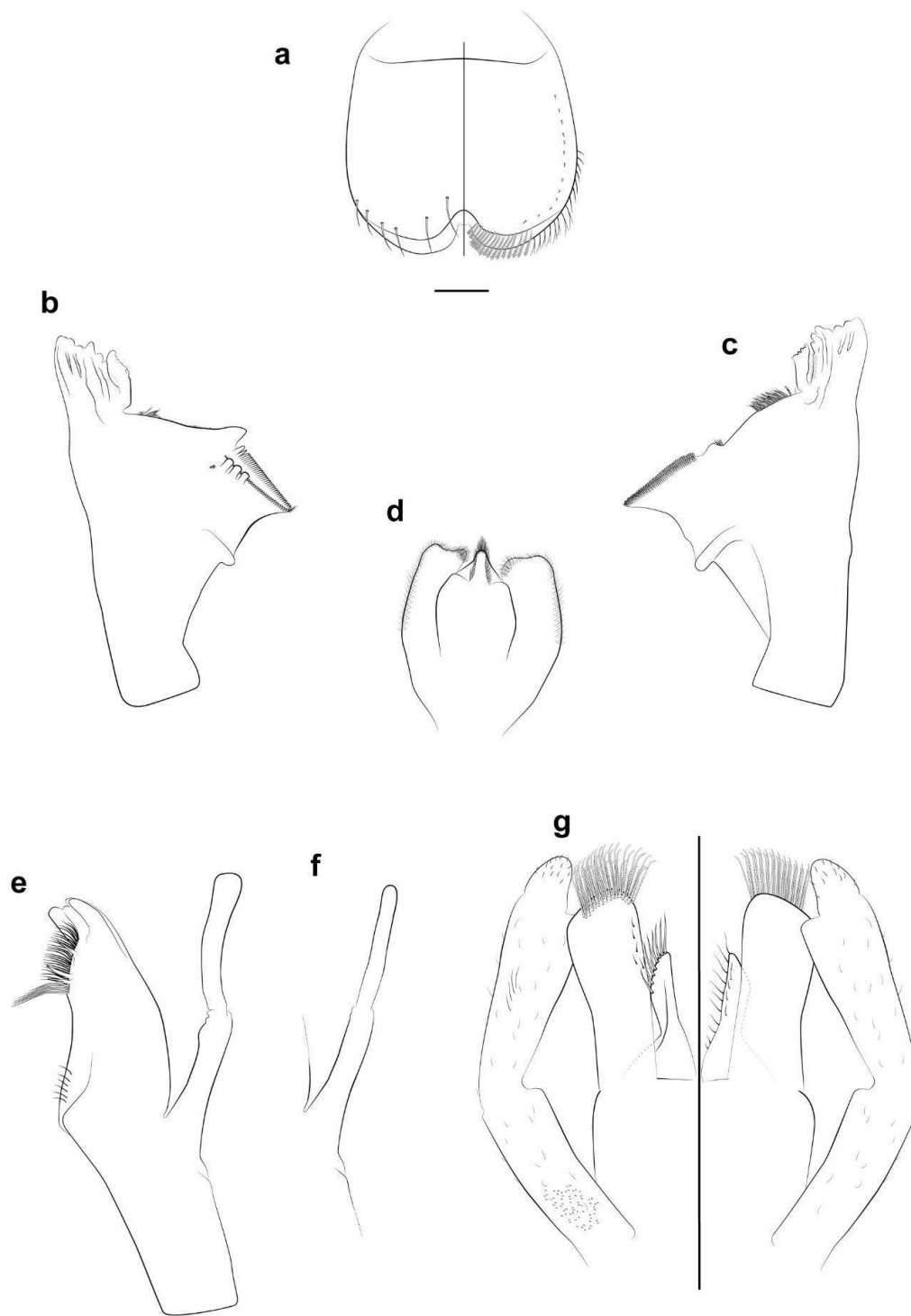


Fig. 15 *Americabaetis labiosus*, mouthparts of nymph. **a.** Labrum (left: dorsal view; right: ventral view); **b.** Left mandible; **c.** Right mandible; **d.** Hypopharynx; **e.** Right maxilla; **f.** Maxillary palp detail; **g.** Labium (left: dorsal view; right: ventral view). (Scale bar: 100 μ m).

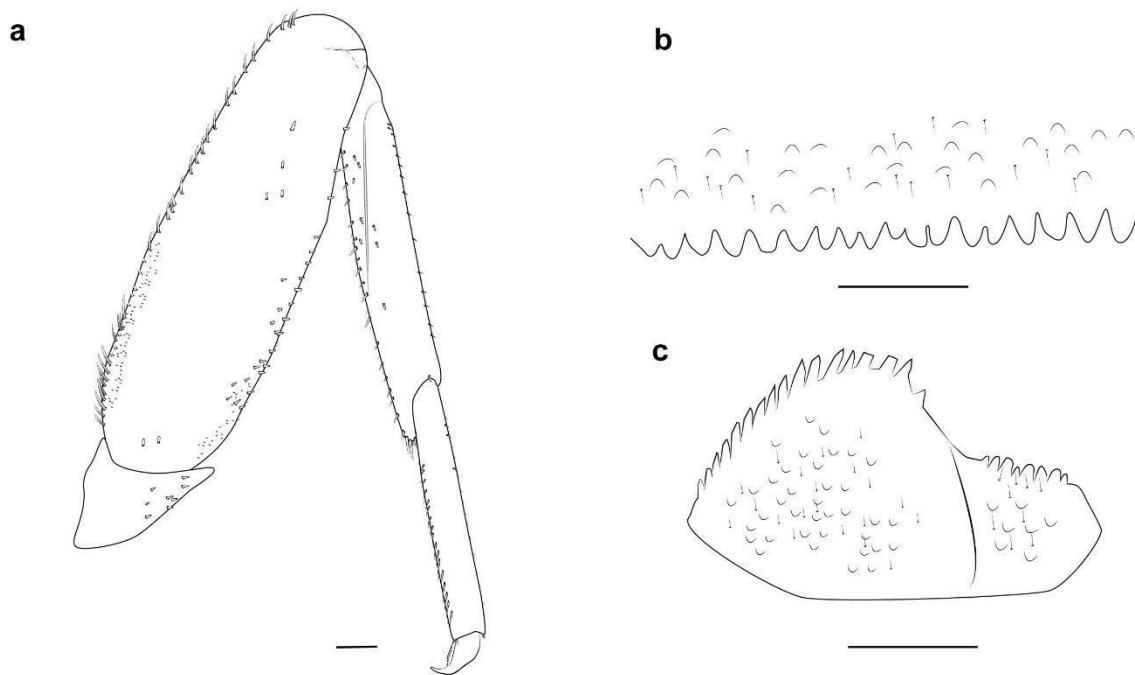


Fig. 16 *Americabaetis labiosus*, nymph. **a.** Fore leg; **b.** Posterior margin of tergum IV; **c.** Paraproct (Scale bars: 100 μ m).

Abdomen of males (Fig. 14b and f) with terga I–X brown or I–III, VII and X light brown, terga IV–VI greyish-brown light brown sublateral area, VIII and IX greyish-brown; terga II–X with anterior sigilla light-brown; terga III–IX with posteromedial dark brown mark; female (Fig. 14d) with I and III–X terga brown, II tergum light brown, IX tergum with light brown longitudinal mid stripe. Sterna general brown to light brown. Cerci and terminal filament light brown or greyish-brown. **Head:** Labrum (Fig. 15a) nearly rectangular, $1.18 \times$ wider than long; dorsally with short, fine, simple setae scattered over surface; dorsolateral arc of setae composed of 4–5 + 1 long, spine like setae; lateral margin with bifid setae; ventral surface with 9–13 spine-like setae near lateral margin; lateral margin with short, fine, simple setae. Left mandible (Fig. 15b). Margin between prosthema and mola straight, with crenulations on distal half. Right mandible (Fig. 15c). Dorsal surface with one row of simple, fine and long setae close to the medial margin. Hypopharynx (Fig. 15d). Lingua subequal to superlinguae, apex acute covered

with fine setae; superlinguae not expanded; short, fine, simple setae scattered over lateral and distal margin. Maxilla (Fig. 15e and f). Inner dorsal row of setae with 1 denti-setae stout + 3 pectinate denti-setae; medial protuberance of galea with 6 + 1 simple setae. Maxillary palp as long as galea-lacinia; palp segment II same length of segment I. Labium (Fig. 15g). Glossa with 10–11 spine-like setae in inner margin, outer margin with 8 long spine-like setae increasing in length apically, dorsal surface with 4–5 spine-like setae close to inner margin; paraglossa sub-rectangular, apex with three rows of apically pectinate setae; ventral surface with 4–5 simple setae close to inner margin; labial palp segment II with moderate distomedial projection (width of distomedial protuberance $0.4 \times$ the base of segment III). **Abdomen.** Paraproct (Fig. 16c). 16–19 marginal spines; surface with scale or scale-bases; posterolateral extension with 6 minute marginal spines.

Material examined. male and female nymph (on slide), 12 males nymphs and 25 female nymphs, BRAZIL, Santa Catarina; Urubici, Parque Nacional de São Joaquim; Rio Cascatinha (28° 08' 41" S; 49° 37' 10" W, 1380 m.a.s.l.) 16/XI/24, Salles, F.F., Almeida, L.H., Sarmiento, F.R.P. cols. (UFVB:EP). One male nymph (on slide) and 5 male nymphs, BRAZIL, Santa Catarina; São Joaquim (28° 26' 28" S; 49° 53' 17" W, 920 m.a.s.l.) 18/XI/24, Salles, F.F., Almeida, L.H., Sarmiento, F.R.P. cols. (UFVB:EP).

Remarks

The nymphs were collected both from well-preserved streams within São Joaquim National Park, where they are very abundants, and from a river showing visible anthropogenic impacts in the border of Santa Catarina and Rio Grande do Sul states. In both localities, specimens were collected in areas with moderate current. The nymphs of *A. labiosus* resemble those of *A. titthion* and *A. puri* new species by the absence of a frontal keel and the posterior margin of the terga bearing blunt spines. However, *A. labiosus* can be easily distinguished from both species by the absence of pairs of robust setose protuberances.

Discussion

So far, *A. titthion* has been the only described species of the genus in which pairs of protuberances are present on the meso- and metasternum. The nymphs of the new species, *A. anapes* and *A. puri*, also have pairs of setose protuberances in the same region (Fig. 3d and Fig. 7d), although with morphological differences in the protuberances of *A. anapes* new species. Lugo-Ortiz and McCafferty (1996) defined the structures present in *A. titthion* as setose and soft. SEM analysis revealed that in *A. anapes* new species (Fig. 3) and *A. puri* new species (Fig. 9), this appearance is due to the presence of two types of sensilla and pores beneath the cuticular surface of the thoracic meso- and metasternum. This new analysis suggests that this characteristic not only helps nymphs withstand lotic environments but also serves a sensory function. Although the images provided insights into the morphology of these sensilla, their exact function remains uncertain, requiring further studies to determine the specific type of sensilla present in this species. Nonetheless, this study represents an initial effort to understand the presence of these protuberances in *Americabaetis* species.

In all analyzed species, a row of setae parallel to the inner margin of the incisor is present on the right mandible. The same character is depicted in line drawings of *Americabaetis naranjoi* Kluge 1992, and in all species described as *Acerpenna* by Lugo-Ortiz & McCafferty 1994. Among the species described by Lugo-Ortiz & McCafferty 1996 in *Americabaetis*, we analyzed *A. labiosus*, *A. titthion*, *A. alphas*, and *A. longetron*, all of them exhibit the same character. This character, therefore, seems to have been overlooked since the establishment of the genus by Lugo-Ortiz & McCafferty 1996, and it is possible that all species of the genus possess this character.

Acknowledgements

The authors sincerely thank the managers of Serra do Brigadeiro State Park and São Joaquim National Park for their support and authorization for specimen collection. We also extend our gratitude to the Microscopy Center of the Federal University of Viçosa for providing the necessary infrastructure for the analyses. We are grateful to the collectors Neusa Hamada, Ana Pes, Jeferson Oliveira da Silva, Rafael Boldrini, Paulo Cruz, Felipe Sarmiento, Lucas Almeida, Juliana Alvim, Erika Cifuentes-Vargas, and Pedro Bonfá Neto for their essential assistance in specimen collection. A special thanks to Professor José Eduardo Serrão for his valuable comments on sensilla and to our colleague Dayvson Ayala-Costa for his help with the scanning electron microscopy procedure. Fieldwork was conducted under authorization from the Sistema de Autorização e Informação em Biodiversidade (SISBIO/ICMBio, proc. 92744-1), and we also thank the Instituto Estadual de Florestas (IEF, proc. 058/2021) for the permission to collect specimens.

Author contribution

IFA: conceptualization, investigation, methodology, project administration, visualization & writing – original draft. IPS: investigation, methodology, visualization & writing – original draft. FFS: conceptualization, funding acquisition, project administration, resources, supervision & writing – review & editing

Declarations

Conflict of interest The authors declare no competing interests.

Ethical Approval Not applicable

Clinical trial number Not applicable

Funding Financial support for this research was provided by the funding agencies Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), Conselho Nacional de Desenvolvimento Científico e Tecnológico do Brasil (CNPq, processes 408346/2023-0, 309666/2019-8, 310205/2021-2, and 316547/2021-2) and Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG, processes APQ 05461-18 and APQ-01591-23).

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**SEÇÃO IV – BAETIDAE (EPHEMEROPTERA) IN MINAS GERAIS: KNOWN
DIVERSITY, SAMPLING GAPS, AND TAXONOMIC POTENTIAL (EM
PROCESSO PARA SUBMISSÃO PARA *NEOTROPICAL ENTOMOLOGY*).**

Baetidae (Ephemeroptera) in Minas Gerais: Known Diversity, Sampling Gaps, and Taxonomic Potential

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Abstract

The family Baetidae is one of the most diverse groups within Ephemeroptera, comprising around 1,100 species worldwide. In Brazil, more than 150 species across 24 genera have been recorded, largely due to taxonomic advances over the past 25 years. However, knowledge gaps remain, especially in states like Minas Gerais, despite being in the most studied region of the country. This study aims to expand knowledge on Baetidae diversity in Minas Gerais using field surveys conducted between 2018 and 2025 and data from the literature.

Collections were made in the Atlantic Forest, Cerrado, and ecotonal areas. Species records and updated distribution maps were generated based on collected material and database surveys. A total of 45 species across 13 genera were identified, including 18 putative new species, one new genus, and five new state records. With these additions, Minas Gerais now has the highest number of Baetidae records in Brazil, with 76 species and 550 occurrence points. The most species-rich genera are *Cloeodes*, *Paracloeodes*, *Americabaetis*, *Baetodes*, and *Camelobaetidius*. While most studies have focused on the Atlantic Forest and the Rio Doce basin—driven by specialist presence and post-disaster research—our findings reveal significant diversity in the Cerrado and transition zones. Sampling in these areas uncovered 41 species, broadening known distributions. Nevertheless, large portions of the Cerrado and

the entire Caatinga biome remain underexplored, reinforcing the need for further surveys to fully understand the state's Baetidae diversity.

Keywords New taxa, Neotropical, Linnean shortfall, Wallacean shortfall, mayfly.

Introduction

The family Baetidae is one of the most diverse within the aquatic insect order Ephemeroptera, comprising approximately 1,100 species across 113 genera (Sartori & Brittain, 2015; Cruz et al., 2021). Nymphs inhabit a wide range of freshwater habitats—including waterfalls, riffles, slow-flowing waters, lakes, and temporary pools—and are considered effective bioindicators due to their abundance, sensitivity to environmental changes, and ease of sampling (Buss & Salles, 2007; Nieto, 2010; Jacobus et al., 2019).

In Brazil, Baetidae is one of the most diverse mayfly families, with over 152 species recorded across 24 genera (Boldrini et al., 2025; Salles et al., 2023; Salles et al., 2025a). Much of this diversity has been revealed by studies conducted over the past 25 years, beginning with Lugo-Ortiz et al. (2002) and Salles and collaborators (2003, 2004a, 2004b), who were among the first to investigate the family in southeastern Brazil. They described new species, created species lists, and provided tools to identify nymphs. Since then, the number of researchers and publications on Ephemeroptera has grown, with many studies focused on Baetidae distribution and diversity in different parts of the country (e.g., Salles et al., 2010a; Falcão et al., 2011; Boldrini et al., 2012; Boldrini & Cruz, 2014; Francischetti et al., 2015; Angeli et al., 2015; Oliveira et al., 2023; Cruz et al., 2023; Mugnai et al., 2024). Nevertheless, due to the country's vast territorial extension, these advances remain insufficient to adequately represent the national fauna (Falcão et al., 2011).

The Southeastern Region (which includes the states of Espírito Santo, Minas Gerais, Rio de Janeiro, and São Paulo) has the highest concentration of faunistic and taxonomic research on Ephemeroptera in Brazil, accounting for nearly half of the national scientific output between 1992 and 2011, and nowadays, the region encompass more than 800 records to Baetidae. (Shimano et al., 2013; Salles et al., 2023; Salles et al., 2025a; Alvim et al., unpublished data). Yet, significant disparities exist among its states. Espírito Santo, for instance, accounts for 476 Baetidae records, far exceeding Minas Gerais (332), Rio de Janeiro (46), and São Paulo (17) (Alvim et al., unpublished data; Salles et al., 2023; Salles et al., 2025a), despite occupying only 0,6% of the region's area (IBGE, 2023).

Minas Gerais, encompassing over 586,000 km² and featuring a broad altitudinal range (50–2,891 m), includes three major biomes—Cerrado, Atlantic Forest, and Caatinga—and five hydrographic basins (IBGE, 2021; Rodrigues et al., 2023). Although 53 species have been recorded—currently the highest number among southeastern states—this figure is likely underestimated considering the ecological complexity and vast territory of Minas Gerais. While some studies have explored ecological parameters and the role of Ephemeroptera as bioindicators (Galdean et al., 2000; Barbosa et al., 2001; Goulart & Callisto, 2005), few focus specifically on the taxonomy of Baetidae in Minas Gerais, most of which are limited to the Rio Doce basin and the Atlantic Forest biome (Francischetti et al., 2015; De Lima et al., 2022; Viana et al., 2024; Alvim et al., unpublished data).

While a few Baetidae species have been described from the state, such as *Apobaetis fiuzai* Salles & Lugo-Ortiz, 2002; *Cloeodes ioachimi* Salles, Massariol & Andeli, 2015; *Callibaetis (Abaetetuba) cochlea* Cruz, Salles & Hamada, 2017; and *Callibaetis (Cunhaporanga) imperator* Cruz, Salles & Hamada, 2017, the studies responsible for these descriptions did not specifically focus on exploring the taxonomic potential of Minas Gerais

and remain insufficient to represent the state's Baetidae fauna. Even with important efforts such as the EPT Doce study on Ephemeroptera, Plecoptera, and Trichoptera in the Rio Doce Basin (Alvim et al., 2025, unpublished data), significant knowledge gaps remain regarding protected areas, other biomes, and ecotonal zones, which are still poorly represented and hinder a comprehensive understanding of Baetidae diversity in Minas Gerais.

This study aims to broaden the current knowledge on Baetidae diversity in Minas Gerais through a survey of several areas in the state, supported by literature data. Specifically, we ask: What is currently known about the family's diversity in the state? What is its potential? Which areas require further attention?

Materials and Methods

Literature Review

With the aim of compiling all literature-based records and registered species of Baetidae from the state of Minas Gerais, data were obtained primarily from the EphemBrazil website (Salles et al., 2025a, see in <https://edelponte.shinyapps.io/ephembrazil/>) — a database designed to provide distributional and basic taxonomic information on Ephemeroptera species recorded in Brazil, with all data extracted from peer-reviewed literature. The filters applied on the site were Family – Baetidae and State – Minas Gerais. An Excel file was generated containing the following information: family, species name, latitude, longitude, municipality, biome, author of the record, and year of the record. In addition, data from the EPTDoce website were used — a database that follows the same information model as EphemBrazil but includes records for

the orders Ephemeroptera, Plecoptera and Trichoptera in Rio Doce Basin (Alvim et al., 2025 unpublished data, see in <https://entomologiaufv.shinyapps.io/EPTDoce/>).

Collecting Methods and Material Examined

The specimens examined in the study were collected in various locations in the south, southeastern and central of Minas Gerais state between 2018 and 2025. In total, samples were collected at 45 sites across 8 municipalities and 7 conservation units. All collection sites are listed in Table 1 and represented in the map of Table 1.

Table 1. Sample site at southeastern region of Minas Gerais state, following by site, coordinates, locality, municipality and altitude. SP = State Park; NP= National Park; MP= Municipal Park; PNHR= Private Natural Heritage Reserve.

Site	Coordinates	Locality	Municipality	Altitude
P1	20°38'45"S 42°27'26"W	Cachoeira do Boné	Araponga	950 m
P2	20°39'15"S 42°27'14"W	Pousada Fazenda Remanso, Ponto Cafezal	Araponga	1062 m
P3	20°39'18"S 42°27'12"W	Pousada Fazenda Remanso	Araponga	1064 m
P4	20°39'20"S 42°27'11"W	Pousada Fazenda Remanso, Ilha	Araponga	1068 m

P5	20°39'28"S 42°27'05"W	Pousada Fazenda Remanso, Cachoeira Barypenthus	Araponga	1124 m
P6	20°40'08"S 42°27'03"W	Trilha do pico do Boné	Araponga	1350 m
P7	20°42'16"S 42°29'19"W	Road to SP Serra do Brigadeiro	Araponga	1200 m
P8	20°43'52"S 42°27'54"W	SP Serra do Brigadeiro, Trilha das Águas, Poço do Pato	Araponga	1120 m
P9	20°43'15"S 42°28'45"W	SP Serra do Brigadeiro, Cachoeira do Moinho	Araponga	1330 m
P10	20°43'15"S 42°28'59"W	SP Serra do Brigadeiro, Trilha do Encontro	Araponga	1320 m
P11	20°43'45"S 42°28'11"W	SP Serra do Brigadeiro, Trilha das Águas, Poço do Cipó	Araponga	1180 m
P12	20°43'55.04"S 42°28'0.78"W	SP Serra do Brigadeiro, Cachoeira da Entrada da Ponte	Araponga	1158 m
P13	20°43'59"S 42°28'12"W	SP Serra do Brigadeiro, Primeira Cachoeira para Pedra do Pato	Araponga	1235 m
P14	20°44'38"S 42°28'03"W	SP Serra do Brigadeiro, Piscinas da Pedra do Pato	Araponga	1620 m

P15	20°43'52"S 42°27'50"W	SP Serra do Brigadeiro, Trilha das Águas, Ponto da malaise	Araponga	1110 m
P16	21°42'10"S 43°53'30"W	SP Ibitipoca, Afluente Lago do Espelho	Conceição do Ibitipoca	1380 m
P17	21°42'13"S 43°53'25"W	SP Ibitipoca, A Montante Lago do Espelho	Conceição do Ibitipoca	1400 m
P18	21°42'13"S 43°53'29"W	SP Ibitipoca, Lago Espelho	Conceição do Ibitipoca	1370 m
P19	21°42'25"S 43°53'39"W	SP Ibitipoca, Lago Negro	Conceição do Ibitipoca	1360 m
P20	21°42'34"S 43°53'38"W	SP Ibitipoca, Prainha	Conceição do Ibitipoca	1350 m
P21	19°00'11.9"S 43°37'09.5"W	Peixe Tolo	Conceição do Mato Dentro	840 m
P22	22°22'11"S 44°42'33"W	NP Itatiaia, Córrego Pedra do Camelo	Itamonte	2350 m
P23	22°22'15"S 44°42'21"W	NP Itatiaia, Córrego na Estrada Km12	Itamonte	2380 m
P24	22°27'10"S 44°36'37"W	NP Itatiaia, Casa do Pesquisador 2	Itamonte	790 m

P25	19°15'33"S 43°31'19.9"W	NP Serra do Cipó, Córrego Indaiá #1	Jaboticatubas	1310 m
P26	19°18'54"S 43°36'00"W	NP Serra do Cipó, Trilha dos Escravos ponto acima da cachoeira Véu de Noiva	Jaboticatubas	988 m
P27	19°20'55.3"S 43°36'20.7"W	NP Serra do Cipó, Córrego das Pedras (próx. alojamento)	Jaboticatubas	802 m
P28	19°22'38.7"S 43°36'34.7"W	NP Serra do Cipó Córrego das Pedras (Capão dos Palmitos)	Jaboticatubas	912 m
P29	19°15'35.10"S 43°31'14.60"W	NP Serra do Cipó, Córrego Indaiá #2	Jaboticatubas	1279 m
P30	20°20'41"S 43°29'54"W	MP Cachoeira das Andorinhas, Praia do Rancheiro	Ouro Preto	1079 m
P31	20°20'58"S 43°29'29"W	MP Cachoeira das Andorinhas, Folhinha	Ouro Preto	1111 m
P32	20°21'51"S 43°29'23"W	MP Cachoeira das Andorinhas, Sede	Ouro Preto	1266 m
P33	20°23'5"S 43°32'34W	Tripuí State Ecological Station	Ouro Preto	1180 m
P34	20°21'29"S 43°29'20"W	MP Cachoeira das Andorinhas, Véu da Noiva	Ouro Preto	1171 m

P35	20°21'28"S 43°29'21"W	MP Cachoeira das Andorinhas, Vale do Véu da Noiva	Ouro Preto	1166 m
P36	20°4'14"S 43°29'20"W	PNHR Santuário do Caraça, Cascatona	Santa Bárbara	1060 m
P37	20°4'54"S 43°30'20"W	PNHR Santuário do Caraça, Taboões	Santa Bárbara	1180 m
P38	20°5'39"S 43°30'0"W	PNHR Santuário do Caraça, Casculo	Santa Bárbara	1290 m
P39	20°6'10"S 43°28'57"W	PNHR Santuário do Caraça, Ponte sobre Afluente do Ribeirão Caraça	Santa Bárbara	1260 m
P40	20°6'15"S 43°28'56"W	PNHR Santuário do Caraça, Ponte de Pedra	Santa Bárbara	1250 m
P41	20°6'23"S 43°28'28"W	PNHR Santuário do Caraça, Cascatinha	Santa Bárbara	1260 m
P42	20°6'36"S 43°29'27"W	PNHR Santuário do Caraça, Brejo na trilha para o Banho de Belchior	Santa Bárbara	1270 m
P43	20°6'52"S 43°29'29"W	PNHR Santuário do Caraça, Banho de Belchior	Santa Bárbara	1270 m
P44	20°7'25"S 43°27'55"W	PNHR Santuário do Caraça, Bocaina	Santa Bárbara	1290 m

P45

20°45'10.2"S

Bairro Belvedere

Viçosa

700 m

42°52'23.1"W

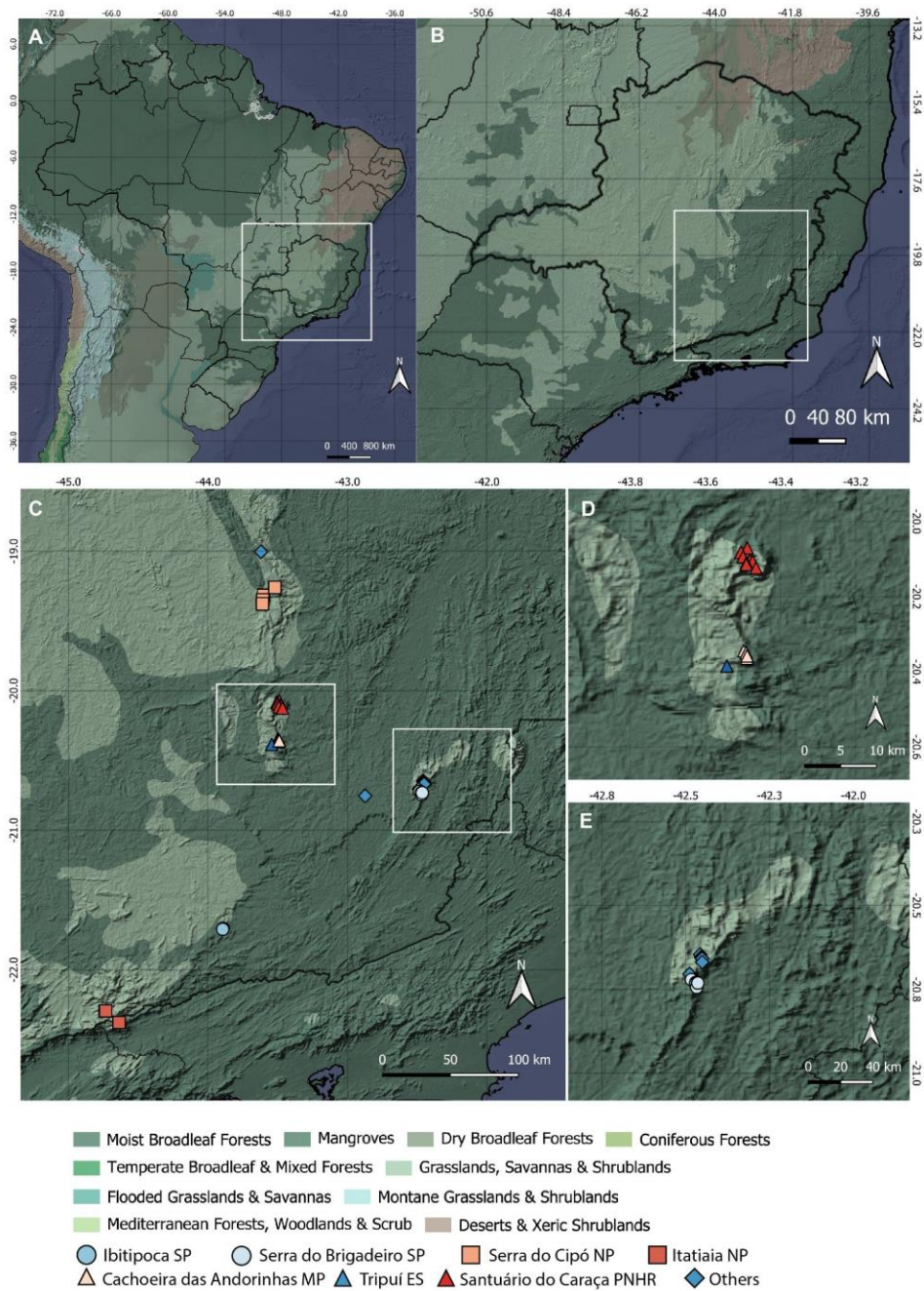


Figure 1. **A.** Partial view of the map of South America highlighting country limits and Brazilian state limits; **B.** Partial view of the map of Brazil (broader lines delimiting the Minas Gerais. White rectangle showing the study area); **C.** Partial view of the map of southeastern Brazil. Colored forms showing the sampling sites in Minas Gerais with a white rectangle

highlighting the location of Andorinhas Municipal Park and Santuário do Caraça Private Natural Heritage Reserve (D), and Serra do Brigadeiro State Park and adjacent areas (E).

The Serra do Brigadeiro State Park is located in the southeastern part of the state, more precisely between 42°40'–40°20' W and 20°33'–21°00' S, occupying parts of the municipalities of Ervália, Fervedouro, Sericita, Araponga, Miradouro, Pedra Bonita, Muriaé, and Divino, within the so-called Zona da Mata Mineira, a zone well recognized by Atlantic Forest. It covers an area of 14,984 ha. The altitude ranges from 945 m to 1,985 m, and the park is part of the Mantiqueira Mountain Range. The vegetation is characterized as Semideciduous Seasonal Forest, with formations exhibiting ombrophilous characteristics. At higher elevations, significant patches of High-altitude Grasslands occur. The park is also located between two major river basins: the Paraíba do Sul and Doce River basins (IEF, 2007a).

The Ibitipoca State Park is located in the southern part of Minas Gerais, at coordinates 21°42' S and 43°54' W, and is part of the municipalities of Lima Duarte and Santa Rita do Ibitipoca. The park also belongs to the Zona da Mata region and covers an area of 1,488 ha, within the Paraíba do Sul River Basin. Altitudes range from 1,200 m to 1,784 m, and the park is part of the Mantiqueira Mountain Range. The vegetation is characterized by different physiognomies of Atlantic Forest and Cerrado, with the presence of Rupestrian Grasslands and Ombrophilous Forest (IEF, 2007b).

The Itatiaia National Park is located between the states of Minas Gerais and Rio de Janeiro, at latitudes 22°14' N–22°27' S and longitudes 44°34'E–44°46' W. The part of the park located in Minas Gerais includes the municipalities of Bocaina de Minas and Itamonte. The park covers an area of 30,000 ha, with altitudes ranging from 540 m to 2,791 m, and is part of the Mantiqueira Mountain Range. The park is situated between two river basins, essentially acting as a divide between the Rio Grande and Paraíba do Sul River Basins. The

vegetation is Atlantic Forest characterized by High-Montane Ombrophilous Dense Forest (ICMBio, 2013a; ICMBio, 2013b).

Serra do Cipó National Park is located in the central region of Minas Gerais and represents an important transitional zone between the Cerrado and Atlantic Forest biomes. The park spans the municipalities of Jaboticatubas, Santana do Riacho, Morro do Pilar, and Itambé do Mato Dentro, between latitudes 19°03'–19°36' S and longitudes 43°22'–43°42' W. It covers an area of 31,000 ha, with altitudes ranging from 591 m to 1,704 m, in the southern portion of the Espinhaço Mountain Range. The park lies between two major river basins, the São Francisco and Doce River basins, and its vegetation is primarily characterized by Rupestrian Grasslands, along with various physiognomies of Cerrado and Atlantic Forest (ICMBio, 2009).

Cachoeira das Andorinhas Municipal Park is located in the municipality of Ouro Preto, in the southeastern portion of central Minas Gerais, at coordinates 21°21'51" S and 43°29'23" W. It lies at the southernmost tip of the Espinhaço Mountain Range, within the so-called Quadrilátero Ferrífero, with altitudes ranging from 920 m to 1,754 m. The Park covers a total area of 557 ha. It is an important conservation area because the headwaters of the Rio das Velhas—a sub-basin of the São Francisco River basin—are located within its boundaries. The vegetation is primarily characterized by the presence of Rupestrian Grasslands and High-Montane Forests, representing a transitional zone between the Atlantic Forest and Cerrado biomes (MYR, 2017)

Tripuí State Ecological Station is located in the municipality of Ouro Preto, in the southeastern portion of central Minas Gerais, at coordinates 20°23'45" S and 43°34'33" W. It lies at the southernmost end of the Espinhaço Mountain Range, within the Quadrilátero Ferrífero, with altitudes ranging from 1,100 m to 1,428 m. The station covers an area of 337 ha and is situated at the watershed divide between the São Francisco and Doce River basins. The

vegetation is characterized by Mesophytic Forest and Shrubby Grassland physiognomies, representing transitional zones between the Atlantic Forest and Cerrado biomes (FEAM, 1995)

The Santuário do Caraça Private Natural Heritage Reserve is located between the municipalities of Catas Altas and Santa Bárbara, in the southeastern portion of central Minas Gerais, at coordinates 20°5'44" S and 43°29'20" W. It is situated in the southern part of the Espinhaço Mountain Range, within the Quadrilátero Ferrífero region, with altitudes ranging from 720 m to 2,068 m. The reserve covers an area of 10,187 ha and is located at the watershed divide between the São Francisco and Doce River basins. The vegetation is characterized by transitional zones between the Cerrado and Atlantic Forest biomes, with physiognomies including principally Rupestrian Grasslands and Shrubby Grasslands, and various types of Ombrophilous Forests and Semideciduous Forests (Província Brasileira da Congregação da Missão, 2013).

Collections were also carried out in the municipalities of Araponga, Conceição do Mato Dentro, and Viçosa, which are represented as “Others” on the map. Araponga shares the same environmental characteristics as Serra do Brigadeira State Park. Viçosa is located in the Zona da Mata region, however, sample were made within an urban area. Conceição do Mato Dentro is located on the eastern side of the Espinhaço Mountain Range and shares similar characteristics with Serra do Cipó National Park.

Aquatic D-nets and hand sieves were used to collect nymphs. Whenever possible, mature nymphs were reared to obtain adults. Additionally, light traps — either white sheet or Pennsylvania-type traps equipped with UV and LED lights — were used to collect adult specimens.

Identification and Deposition of Biological Material

Specimens, including both adults and nymphs, were identified based on multiple sources, including dichotomous keys, interactive keys, comprehensive catalogs, and detailed taxonomic descriptions (e.g. Domínguez et al., 2006; Salles et al., 2010b; Salles et al., 2011; Boldrini, 2015.; Souza, 2015; Salles et al., 2015; Salles et al., 2016; Cruz et al., 2017; Kluge, 2017; Derka and Nieto, 2018; Cruz et al., 2018). All specimens were examined under a stereomicroscope while preserving 80% ethanol. At least one nymph of each species collected were dissected in 2-ethoxyethanol, and permanent slides of the mouthparts, legs, terga, and caudal filaments were mounted in Euparal®. The slides were subsequently examined under an OLYMPUS CX31 microscope to confirm species-level identifications. Once the adult stage presents characters too generalized to adequately characterize most taxa within the family (Lugo-Ortiz & McCafferty, 1999c), whenever possible, imagos and subimagos specimens collected in light traps were identified. All specimens were incorporated in the collection of Museu de Entomologia, Universidade Federal de Viçosa, Viçosa, Minas Gerais, Brazil (UFVB), and have received a code number with all information of identification (determiner, locality, coordinates, altitude, collection date, collectors, number of specimens, lifestage, conservation status). All these data are recorded in the collection archives of the Museu de Entomologia da UFV.

Distribution of Baetidae in the State of Minas Gerais

To better visualize the distribution of all species from both the examined material and database records, distribution maps for the genus were created using QGIS 3.40.3. Protected areas within the state were also included in the maps to visualize species distribution across different contexts. Different symbols were used to distinguish new records from those previously reported in the literature. Whenever possible, species of the same genus were kept together in the same map. Genus with low records were grouped to synthesize the numbers of maps.

Results

The reference databases accounted for 332 records for 53 species distributed in 14 genera. The first species described from the state was *Apobaetis fiuzai* Salles & Lugo-Ortiz, 2002. One year later, a monotypic genus of the family was described: *Tupiara ibirapitanga* Salles, Lugo-Ortiz, da-Silva & Francischette, 2003. At that time, Salles et al. (2004b) published the first study including records and a key to nymphs from Southeastern Brazil. The last study conducted in the state focusing on the distribution of the Baetidae family was carried out by Francischette et al. (2015). The most recent species described from the state is *Cloeodes tovauna* Amaral, Cifuentes-Vargas & Salles, 2025, as a result of recent efforts to broaden knowledge of the family in the state.

In the present study, 4,054 individuals were examined, of which 3,852 consisted of nymphs or adults reared from nymphs. Among the examined material, 45 known species were identified, spread in 13 genera. One new genus was identified and 18 new species and two morphospecies (potentially new species). In total, our study reports 218 new records to the state. Five species are newly recorded from Minas Gerais: *Baetodes proscolus* Souza, Salles & Nessimian, 2011; *Callibaetis (Callibaetis) jocosus* Navás, 1912; *Cloeodes amantkyra* Angeli, Massariol & Salles, 2015; *Cloeodes hydation* McCafferty & Lugo-Ortiz, 1995; and *Paracloeodes carolinae* Cruz, Salles & Hamada, 2018.

A list of the species to the state, including distribution data and material examined, is provided, followed by a map organized by genus (Figs. 2–6). The letters (N) and (A) are used to specify the life stage nymphs and adults, respectively. When necessary, comments on species-specific information are also included.

***Americabaetis alphas* Lugo-Ortiz & McCafferty, 1996**

Distribution: Argentina, Bolívia, Chile, Colômbia, Paraguai, Brasil: Alagoas, Bahia, Espírito Santo, Mato Grosso, Minas Gerais, Paraná, Pernambuco, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, São Paulo, Sergipe.

Municipalities in Minas Gerais: Aimorés, Alto Caparaó, Araponga, Conselheiro Pena, Espera Feliz, Governador Valadares, Guaraciaba, Ipaba, Jaguarapu, Jequeri, Marliéria, Mathias Lobato, Naque, Ouro Preto, Pedra Corrida, Periquito, Pingo D'Água, Ponte Nova, Raul Soares, Resplendor, Santa Bárbara, Santo Antônio, São José do Goiabal, Timóteo, Tumiritinga.

Material examined: P3: (1N) 19.XI.2023, (1A) 20.XI.2023; P4: (3A) 17.XI.2021; P6: (11N) 9.IX.2023; P9: (2N) 10.IX.2023; P10: (1N) 10.IX.2023; P11: (1N) 28.VII.2022; P12: (1N) 07.XII.2022; P15: (3N) 25.V.2022, (5N) 28.VII.2022, (12A) 29.VII.2022; (1N) 19.X.2022; (4N) 03.XI.2022; P30: (6N) 16.VIII.2024; P31: (1N) 17.X.2023, (9N) 15.VIII.2024; P33: (3N) 03.V.2024; P34: (118N) 18.X.2023, (2N) 15.II.2024; P35: (7N) 18.X.2023, (9N) 14.VIII.2024; P38: (22N) 01.IX.2024.

***Americabaetis itatiaia* Marulanda-Lopez & Salles, 2023**

Distribution: Brazil

Municipalities in Minas Gerais: Itamonte

***Americabaetis labiosus* Lugo-Ortiz & McCafferty, 1996**

Distribution: Argentina, Paraguai, Uruguai, Brazil: Bahia, Espírito Santo, Minas Gerais, Pernambuco, Rio de Janeiro, Rio Grande do Sul, Santa Catarina, São Paulo.

Municipalities in Minas Gerais: Aimorés, Alto Caparaó, Araponga, Governador Valadares, Itatiaia, Jaguarapu, Mariana, Naque, Periquito, São José do Goiabal, Timóteo, Turmiritinga.

Material examined: P4: (2A) 17.XI.2021; P9: (1N) 10.IX.2023.

***Americabaetis longetron* Lugo-Ortiz & McCafferty, 1996**

Distribution: Argentina, Paraguai, Uruguai, Brazil: Bahia, Espírito Santo, Goiás, Minas Gerais, Rio de Janeiro, Rondônia.

Municipalities in Minas Gerais: Aimorés, Bom Jesus do Galho, Córrego Novo, Dionísio, Guaraciaba, Marliéria, Ponte Nova, São José do Goiabal, Jaguarapu.

***Americabaetis titthion* Lugo-Ortiz & McCafferty, 1996**

Distribution: Argentina, Brazil: Minas Gerais, Rio de Janeiro, Santa Catarina.

Municipalities in Minas Gerais: Araponga, Caparaó.

***Americabaetis* sp. 1**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Araponga.

Material examined: P14: (30N) 07.VI.2024, (31N) 11.III.2025.

Comments: This morphospecies were considered as a new species of *Americabaetis* and is in process of publication.

***Americabaetis* sp. 2**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Araponga, Jaboticatubas.

Material examined: P25: (10N) 24.IX.2018; P1:(3N) 04.X.2022.

Comments: The morphospecies resembles the recently described species *Americabaetis boquienses* Salinas, 2025. Since the description is very recent and the species was described

from Colombia, it is very uncertain to treat it as the same species. For these reasons, the species was kept as morphospecies.

***Americabaetis* sp. 3**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Ouro Preto.

Material examined: P35: (2N) 14.VII.2024.

Comments: Although the low number of individuals collected, the morphospecies is considered as a new species of *Americabaetis*.

***Apobaetis fiuzai* Salles & Lugo-Ortiz, 2002**

Distribution: Argentina, Brazil: Bahia, Espírito Santo, Maranhão, Mato Grosso, Mato Grosso do Sul, Minas Gerais, Pará, Pernambuco, Piauí, Rio de Janeiro, Rondônia, Roraima.

Municipalities in Minas Gerais: Aimorés, Alto Caparaó, Barra Longa, Ferros, Governador Valadares, Guaraciaba, Ipaba, Juiz de Fora, Marliéria, Mathias Lobato, Periquito, Pingo D'Água, Ponte Nova, Raul Soares, Santo Antônio, São José do Goiabal.

***Apobaetis irai* De Lima, Massariol, Cruz & Hamada, 2022**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Aimorés, Barra do Cuieté, Conselheiro Pena, Governador Valadares, Mariana, Marliéria, Mathia Lobato, Naque, Periquito, Pingo D'Água, Raul Soares, São José.

***Apobaetis pucupi* Cruz & De-Souza, 2014**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Lima Duarte.

***Aturbina beatrixae* Lugo-Ortiz & McCafferty, 1996**

Distribution: Argentina, Uruguai, Brazil: Minas Gerais, Espírito Santo, Goiás, Paraná, Pernambuco, Rondônia, Santa Catarina, São Paulo.

Municipalities in Minas Gerais: Araponga, Ferros, Governador Valadares, Guaraciaba, Ipaba, Jaguaráçu, Marliéria, Mathias Lobato, Pedra Corrida, Periquito, Ponte Nova, Resplendor, Santa Bárbara, Santo Antônio, Timóteo.

Material examined: P1: (4N) 05.IX.2018, (1N) 11.VII.2019, (3N) 20.XI.2020, (2A) 07.IV.2021; P2: (1A) 17-18.XI.2021; P3: (1A) 08.IX.2021; P4: (2A) 17.XI.2020; P38: (2N) 01.IX.2024; P39: (1N) 02.IX.2024; P40: (6N) 30.VIII.2024, (13N) (2A) 19.XII.2024; P43: (10N) 19.XII.2024; P44: (21N) 02.IX.2024.

***Aturbina georgei* Gillies, 2001**

Distribution: Colombia, Guiana Francesa, Paraguai, Brasil: Amazonas, Espírito Santo, Mato Grosso, Minas Gerais, Pará, Rio de Janeiro, Rondônia, Roraima.

Municipalities in Minas Gerais: Marliéria.

***Baetodes proscolus* Souza, Salles & Nessimian, 2011**

Distribution: Brazil: Espírito Santo, Minas Gerais.

Municipalities in Minas Gerais: Araponga, Jaboticatubas, Ouro Preto.

Material examined: P1: (1N) 24.IX.2018, (4N) 11.VII.2019, (1N) 09.VI.2021; P6: (1N) [09.IX.2023](#); P15: (2N) 25.V.2022; P31: (4N) 17.X.2023; P33: (3N) 02.V.2024; P34: (3N) 18.X.2023; P26: (4N) 05.X.2022.

Comments: This represents the first record for the state and the first occurrence of this species outside its type locality.

***Baetodes santatereza* Salles & Polegatto, 2008**

Distribution: Brazil: Espírito Santo, Goiás, Minas Gerais, Pernambuco.

Municipalities in Minas Gerais: Timóteo.

***Baetodes serratus* Needham & Murphy, 1924**

Distribution: Brazil: Bahia, Espírito Santo, Rio de Janeiro.

Municipalities in Minas Gerais: Alto Caparaó

***Baetodes* sp. 1**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Santa Bárbara.

Material examined: P38: (1N) [01.IX.2024](#); P43: (24N) 31.VIII.2024.

Comments: This morphospecies is considered a new species.

***Baetodes* sp. 2**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Santa Bárbara.

Material examined: P43 (3N) 18.XII.2024.

Comments: This morphospecies is considered a new species.

***Baetodes* sp. 3**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Araponga.

Material examined: P1: (1N) 05.IX.2018, (4N) 24.IX.2018, (13N) 11.VII.2019; P3: (1N) 03.VIII.2021, (27N) 28.X.2021, (1N) 21.X.2022; P4: (3N) 17.VI.2021, (1N) 19.XI.2023; P5: (4N) 22.X.2022, (6N) 23.X.2022; P6: (45N) 09.IX.2023; P9: (13N) 10.IX.2023; P10: (6N) 10.IX.2023; P15: (1N) 25.V.2022, (2N) 19.X.2022.

Comments: Based on the identification key provided by Souza (2015), the morphospecies is identified as *B. serratus*. However, given the age of the original description, it is uncertain whether it truly corresponds to the same species.

***Baetodes* sp. 4**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Ouro Preto.

Material examined: P31: (5N) 17.X.2023, (4N) 15.VIII.2024; P34: (3N) 18.X.2023.

Comments: Based on the identification key provided by Souza (2015), the morphospecies is identified as *Baetodes* sp. 13, and is in the process of publication.

***Baetodes* sp. 5**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Ouro Preto.

Material examined: P35: (1N) 14.VIII.2024.

Comments: Although the low number of individuals collected, the morphospecies is considered as a new species of *Baetodes*.

***Baetodes* sp. 6**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Ouro Preto.

Material examined: P34: (20N) 18.X.2023; P35: (5N) 14.VIII.2024.

Comments: This morphospecies is considered a new species.

***Callibaetis (Abaetetuba) capixaba* Cruz, Salles & Hamada, 2009**

Distribution: Brazil: Espírito Santo, Minas Gerais, Santa Catarina.

Municipalities in Minas Gerais: Araponga, Ipaba, Ouro Preto.

Material examined: P1: (4N) 04.IX.2018, (3A) 05.IX.2018, (2N) 24.IX.2018, (37N) 11.VII.2019; P3: (6N) 03.VIII.2021, (1A) 04.XII.2023; P31: (1N) 15.VIII.2024; P33: (11N) 02.V.2024.

***Callibaetis (Abaetetuba) cochlea* Cruz, Salles & Hamada, 2017**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Juiz de Fora.

***Callibaetis (Callibaetis) guttatus* Navás, 1915**

Distribution: Argentina, Brazil: Espírito Santo.

Municipalities in Minas Gerais: Marliéria, Pedra Corrida.

***Callibaetis (Cunhaporanga) imperator* Cruz, Salles & Hamada, 2017**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Conceição do Mato Dentro, Catas Altas, Ouro Preto, Santa Bárbara.

Material examined: P25: (14N) 04.X.2022; P32: (12A) 17-18.X.2023, (4A) 31.X.2023; P34: (12N) 31.VIII.2024, (1A) 24.VIII.2024; P38: (28N) 01.IX.2024; P39: (20N) 02.IX.2024; P40:

(10N) (1A) 03.VIII.2024; P41: (29N) 03.VIII.2024, (14N) 20.XII.2024; P42: (4N) (2A) 18-19.XII.2024.

***Callibaetis (Callibaetis) jocosus* Navás, 1912**

Distribution: Argentina, Paraguai, Brazil: Mato Grosso do Sul, Minas Gerais, Paraná, Santa Catarina, São Paulo.

Municipalities in Minas Gerais: Araponga.

Material examined: P1: (1N) 11.VII.2019

Comments: New record to the State.

***Callibaetis (Abaetetuba) pollens* Needham & Murphy, 1924**

Distribution: Argentina, Chile, Brazil: Bahia, Ceará, Goiás, Maranhão, Mato Grosso do Sul, Minas Gerais, Pernambuco, Piauí

Municipalities in Minas Gerais: Ipaba, Marliéria, Pedra Corrida, Timóteo.

***Callibaetis (Callibaetis) radiatus* Navás, 1920**

Distribution: Argentina, Paraguai, Brazil: Bahia, Minas Gerais.

Municipalities in Minas Gerais: Viçosa.

***Callibaetis* sp. 1**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Santa Bárbara.

Material examined: P40: (1N) 19.XII.2024; P43: (28N) 18-19.XII.2024, (50) 31.VIII.2024.

Comments: This morphospecies could not be identified using the key provided by Cruz et. al (2017). Since the taxonomy of *Callibaetis* is largely based on adult morphology, we were unable to confirm whether it represents a new species.

***Camelobaetidius anubis* (Traver & Edmunds, 1968)**

Distribution: Argentina, Brazil: Espírito Santo, Minas Gerais, Paraná, Rio de Janeiro, Roraima, Santa Catarina.

Municipalities in Minas Gerais: Araponga, Ouro Preto, Santo Antônio

Material examined: P1: (2N) 20.XI.2020; P4: (2N) 17.VI.2021 ;P5: (3N) 22-23.X.2022; P6: (2N) 09.IX.2023; P31: (7N) 17.X.2023, (2N) 15.VIII.2024.

***Camelobaetidius billi* Thomas & Dominique, 2001**

Distribution: Argentina, Guiana Francesa, Venezuela, Brasil: Alagoas, Bahia, Espírito Santo, Manaus, Minas Gerais, Pará, Paraná, Pernambuco, Rio de Janeiro, Rio Grande do Sul, Roraima, Santa Catarina, Tocantins.

Municipalities in Minas Gerais: Araponga, Aimorés, Alto Caparaó, Barra do Cuieté, Catas Altas, Espera Feliz, Governador Valadares, Guaraciaba, Jaguarapu, Marliéria, Mathias Lobato, Naque, Periquito, Pingo D'água, Ponte Nova, Resplendor, Santo Antônio, São José do Goiabal, Timóteo, Tumiritinga.

Material examined: P1: (4N) 24.IX.2018, (62N) 11.VII.2019, (3N) 20.XI.2020; P3: (6N) 19.XI.2023; P9: (2N) 10.IX.2023; P31: (2N) 17.X.2023, (3N) 15-16.VIII.2024; P33: (24N) 3-4.V.2024.

***Camelobaetidius francischettii* Salles, Andrade & Da-Silva, 2005**

Distribution: Brazil: Alagoas, Bahia, Espírito Santo, Goiás, Minas Gerais, Rio de Janeiro, Tocantins.

Municipalities in Minas Gerais: Bom Jesus do Galho, Timóteo.

***Camelobaetidius janae* Dominique & Thomas, 2001**

Distribution: Guiana Francesa, Venezuela, Brazil: Espírito Santo, Mato Grosso, Minas Gerais, Piauí, Rondônia, Roraima.

Municipalities in Minas Gerais: Bom Jesus do Galho, Marliéria.

***Camelobaetidius juparana* Boldrini & Salles, 2012**

Distribution: Brazil: Espírito Santo, Minas Gerais.

Municipalities in Minas Gerais: Bom Jesus do Galho, Pingo D'água.

***Camelobaetidius lassance* Salles & Serrão, 2005**

Distribution: Brazil: Bahia, Minas Gerais, Pernambuco, São Paulo.

Municipalities in Minas Gerais: Lassance.

***Camelobaetidius rufiventris* Boldrini & Salles, 2009**

Distribution: Brazil: Bahia, Espírito Santo, Minas Gerais, Rio de Janeiro.

Municipalities in Minas Gerais: Bom Jesus do Galho, Timóteo.

***Camelobaetidius spinosus* Boldrini & Salles, 2012**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Bom Jesus do Galho.

***Camelobaetidius tuberosus* Lugo-Ortiz & McCafferty, 1999**

Distribution: Argetina, Paraguai, Brazil: Ceará, Mato Grosso, Minas Gerais, Piauí.

Municipalities in Minas Gerais: Lassance.

***Cloeodes aiuruoca* Massariol, Angeli & Salles, 2015**

Distribution: Brazil: Minas Gerais, Rio de Janeiro.

Municipalities in Minas Gerais: Itamonte.

***Cloeodes auwe* Salles & Batista, 2004**

Distribution: Peru, Brazil: Bahia, Manaus, Maranhão, Mato Grosso, Minas Gerais, Rondônia, Roraima.

Municipalities in Minas Gerais: Aimorés.

***Cloeodes amantkyra* Angeli, Massariol & Salles, 2015**

Distribution: Brazil: Minas Gerais, São Paulo.

Municipalities in Minas Gerais: Araponga.

Material examined: P1: (1A) 05.IX.2018, (6N) 24.X.2018, (12N) 11.VII.2019; P3: (1A) 08.IX.2021, (1N) 19.IX.2023; P4: (7N) 17.VI.2021; P5: (3N) 22-23. X.2022; P12: (1N) 07.XII.2022; P15: (2N) 03.IX.2022.

Comments: New record to the State.

***Cloeodes aymore* Massariol & Salles, 2011**

Distribution: Brazil: Espírito Santo, Minas Gerais.

Municipalities in Minas Gerais: Araponga, Conceição do Mato Dentro, Ipaba, Jaboticatubas, Resplendor, Timóteo.

Material examined: P1: (47N) 11.VII.2019, (1N) 20.XI.2020; P15: (2N) 03.XI.2022; P21: (7N) (7A) 30.XI.2020; P27: (1A) 3.X.2022; P28: (2A) 5.X.2022.

***Cloeodes guara* Salles, Massariol & Angeli, 2015**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Catas Altas, Santa Bárbara.

Material examined: P37: (1N) 20.12.2024; P38: (39N) (1A) 09.IX.2024; P40: (2N) 30.VIII.2024, (2N) 19.XII.2024; P41: (44N) (2A) 29-30.VIII.2024; P44: (28N) [02.IX.2024](#).

***Cloeodes hydatation* McCafferty & Lugo-Ortiz, 1995**

Distribution: Brazil: Espírito Santo, Mato Grosso, Minas Gerais, Pernambuco, Roraima.

Municipalities in Minas Gerais: Jaboticatubas, Ouro Preto.

Material examined: P31: (13N) 15.VIII.2024; P26: (2N) 5.X.2022.

Comments: New record to the State.

***Cloeodes ioachimi* Salles, Massariol & Angeli, 2015**

Distribution: Brazil: Minas Gerais

Municipalities in Minas Gerais: Ouro Preto.

***Cloeodes irvingi* Waltz & McCafferty, 1987**

Distribution: Paraguai, Brazil: Bahia, Ceará, Espírito Santo, Goiás, Minas Gerais, Pernambuco, São Paulo.

Municipalities in Minas Gerais: Aimorés, Araponga, Conselheiro Pena, Governador Valadares, Guaraciaba, Marliéria, Mathias Lobato, Periquito, Ponte Nova, Santo Antônio.

***Cloeodes itajara* Massariol & Salles, 2011**

Distribution: Brazil: Espírito Santo, Goiás, Minas Gerais.

Municipalities in Minas Gerais: Espera Feliz, Alto Caparaó, Araponga.

Material examined: P1: (3N) 05.IX.2018, (2N) 11.VII.2019; P3: (2N) 02.VIII.2021; P4: (5N) 17.VI.2021, (1N) 13.IV.2022; P5: (16N) 23.X.2022; P6: (108N) 09.IX.2023; P10 (1N) 10.IX.2023; P12: (2N) 07.XII.2022; P15: (4N) 25.V.2022, (1N) [29.VI.2022](#), (5N) 19.X.2022, (9N) [03.XI.2022](#).

***Cloeodes melanotarsus* Salles, Massariol & Angeli, 2015**

Distribution: Brazil: Minas Gerais

Municipalities in Minas Gerais: Conceição do Mato Dentro

***Cloeodes tovauna* Amaral, Cifuentes-Vargas & Salles, 2025**

Distribution: Brazil: Espírito Santo, Minas Gerais.

Municipalities in Minas Gerais: Alto Caparaó, Araponga, Catas Altas, Ouro Preto.

Material examined: P1: (4N) 05.IX.2018, (4N) 11.VII.2019; P3: (1A) 08.IX.2021; P5: (1N) 22.X.2022; P6: (2N) 09.IX.2023; P8: (1A) (6N) 28.V.2024; P9: (2N) 19.X.2022; P13: (5N) 07.VI.2024.

***Cloeodes tracheatus* Salles, Massariol & Angeli, 2015**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Conceição do Mato Dentro, Jaboticatubas, Ouro Preto, Santa Bárbara.

Material examined: P25: (3N) 04-05.X.2022; P38: (6N) [01.IX.2024](#); P43: (3N) 18.XII.2024.

***Cloeodes* sp. 1**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Santa Bárbara.

Material examined: P36: (17N) (2A) [01.IX.2024](#), (33N) 18.XII.2024; P37: (6N) (1A) 24.VIII.2024, (53N) 31.VIII.2024, (52N) (1A) 20.XII.2024; P38: (42N) (4A) [01.IX.2024](#); P39: (1A) 18.XII.2024; P40: (68N) 30.VIII.2024, (20N) (3A) 19.XII.2024; P41: (124N) 30.VIII.2024, (122N) (11A) 19-20.XII.2024; P43: (70N) 31.VIII.2024, (88N) (1A) 18-19.XII.2024; P44: (108N) (1A).

Comments: This morphospecies is considered a new species.

***Cloeodes* sp. 2**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Santa Bárbara, Conceição do Ibitipoca.

Material examined: P17: (13N) 26.X.2022; P18: (5N) 25.X.2022, (7N) 26-27.X.2022; P20: (13N) 25.X.2022, (2N) 26.X.2022; P37: (2N) 18.XII.2024.

Comments: This morphospecies is considered a new species.

***Cloeodes* sp. 3**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Conceição do Ibitipoca.

Material examined: P17: (29N) (3A) 26.X.2022; P18: (77N) 26-27.X.2022; P19: (1N) 26.X.2022; P20: (30N) (2A) 25-26.X.2022.

Comments: This morphospecies is considered a new species.

***Cloeodes* sp. 4**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Ouro Preto.

Material examined: P31: (298N) 17.X.2023, (163N) 15.VIII.2024, (5N) 16.VIII.2024; P34: (21N) 18.X.2023; P35: (11N) 14.VIII.2024.

Comments: This morphospecies is considered a new species.

***Cloeodes* sp. 5**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Ouro Preto.

Material examined: P31: (16N) 17.X.2023, (2N) 15.VIII.2024.

Comments: This morphospecies is considered a new species..

***Cloeodes* sp. 6**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Ouro Preto.

Material examined: P34: (29N) 18.X.2023, (1N) 04.V.2024.

Comments: This morphospecies is considered a new species.

***Cloeon smaeleni* Lastage, 1924**

Distribution: (information by Cardoso et al., 2023) Côte d'Ivoire, Democratic Republic of the Congo, Gambia, Ghana, Kenya, Madagascar, Malawi, Nigeria, South Africa, Tanzania, Uganda, Brazil: Espírito Santo, Maranhão, Minas Gerais, Pará, Rio de Janeiro.

Municipalities in Minas Gerais: Governador Valadares, Viçosa.

Material examined: P45: (1A) 07.V.2024.

Comments: It is the only alien species in the study, and represents a new occurrence to the state of Minas Gerais, in Viçosa.

***Cryptonympha dasilvai* Salles & Francischetti, 2004**

Distribution: Argentina, Brazil: Bahia, Espírito Santo, Goiás, Minas Gerais, Pernambuco, Rio de Janeiro, São Paulo.

Municipalities in Minas Gerais: Aimorés, Guaraciaba, Ponte Nova, Santo Antônio.

***Cryptonympha* sp. 1**

Distribution: Brazil: Minas Gerais

Municipalities in Minas Gerais: Jaboticatubas, Santa Bárbara.

Material examined: P26: (1N) 05.X.2022; P36: (3N) 01.IX.2024; P38: (1N) 01.IX.2024; P41: (3N) 29-30.VIII.2024.

Comments: This morphospecies is considered a new species.

Paracloeodes carolinae

Distribution: Uruguai, Brazil: Bahia, Minas Gerais.

Municipalities in Minas Gerais: Conceição do Ibitipoca, Santa Bárbara.

Material examined: P16: (4N) 26.X.2022; P17: (13N) 26.X.2022; P18: (46N) 26-27.X.2022; P19: (5N) 26.X.2022; P20: (26N) 25.X.2022; P21: (1N) 30.XI.2020; P36: (7N) 01.IX.2024; P37: (53N) 20.XII.2024, (6N) 31.VIII.2024; P38: (7N) 01.IX.2024; P39: (2A) 01.IX.2024; P40: (264N) (33A) 30.VIII.2024, (22N) 19.XII.2024; P41: (1N) 20.XII.2024; P43: (5N) 31.VIII.2024, (10N) 19.XII.2024; P44: (5N) (1A) [02.IX.2024](#).

Comments: New record to the State.

***Paracloeodes charrua* Emmerich & Nieto, 2009**

Distribution: Uruguai, Brazil: Minas Gerais, Pernambuco.

Municipalities in Minas Gerais: Araponga, Timóteo.

Material examined: P1: (6N) [05.IX.2018](#), (1N) [24.IX.2018](#); P5: (1N) 21.X.2022; P6: (1N) [09.IX.2023](#); P15: (1N) [03.XI.2022](#).

***Paracloeodes eurybranchus* Lugo-Ortiz & McCafferty, 1996**

Distribution: Argentina, Brazil: Bahia, Espírito Santo, Maranhão, Minas Gerais, Rio de Janeiro, Rio Grande do Sul, São Paulo.

Municipalities in Minas Gerais: Ouro Preto, Timóteo.

Material examined: P31: (2N) 15.VIII.2024; P34: (29N) 18.X.2023, (2N) 02.IV.2024; P35: (1N) 14.VIII.2024.

***Paracloeodes ibicui* Lugo-Ortiz & McCafferty, 1996**

Distribution: Argentina, Paraguai, Brazil: Minas Gerais, Paraná, Rio Grande do Sul, Santa Catarina.

Municipalities in Minas Gerais: Araponga, Mathias Lobato, Santo Antônio.

***Paracloeodes leptobranchus* Lugo-Ortiz & McCafferty, 1996**

Distribution: Brazil: Minas Gerais, Goiás, Paraná, Pernambuco, Rio Grande do Sul, Roraima, Santa Catarina.

Municipalities in Minas Gerais: Periquito.

***Paracloeodes peri* Nieto & Salles, 2006**

Distribution: Brazil: Minas Gerais, Rio de Janeiro.

Municipalities in Minas Gerais: Itamonte

***Paracloeodes poranga* (Salles & Lugo-Ortiz, 2003)**

Distribution: Brazil: Minas Gerais, Rio de Janeiro.

Municipalities in Minas Gerais: Itamonte

Material examined: P22: (2N) 17.III.2022; P23: (2N) 17.III.2022.

***Paracloeodes prismatobranchus* Cruz, Salles & Hamada, 2018**

Distribution: Brazil: Bahia, Ceará, Espírito Santo, Maranhão, Mato Grosso do Sul, Minas Gerais, Paraná, Piauí, Rio de Janeiro, Roraima, Rondônia, Santa Catarina.

Municipalities in Minas Gerais: Araponga, Baependi, Itamonte, Periquito, Ouro Preto.

Material examined: P6: (5N) [09.IX.2023](#); P9: (1N) [10.IX.2023](#); P10: (3N) [10.IX.2023](#); P11: (1N) 28.VII.2022; P15: (1A) [03.XI.2022](#).

***Paracloeodes waimiri* Nieto & Salles, 2006**

Distribution: Brazil: Bahia, Ceará, Espírito Santo, Manaus, Mato Grosso, Maranhão, Minas Gerais, Rio Grande do Norte, Rondônia, Roraima.

Municipalities in Minas Gerais: Aimorés, Barra do Cuieté, Bom Jesus do Galho, Conselheiro Pena, Córrego Novo, Dionísio, Ferros, Governador Valadares, Guaraciaba, Jaguarapu, Marliéria, Mathias Lobato, Periquito, Ponte Nova, Raul Soares, Santo Antônio.

***Paracloeodes* sp. 1**

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Santa Bárbara.

Material examined: P37: (8N) 31.VIII.2024; P39: (1A) 02.IX.2024; P40: (78N) (1A) 19.XII.2024.

Comments: This morphospecies were considered as a new species of *Paracloeodes* and is in process of publication.

***Rivudiva watu* Lima, Massariol, Cruz & Hamada, 2022**

Distribution: Brazil: Minas Gerais

Municipalities in Minas Gerais: Resplendor

***Tupiara ibirapitanga* Salles, Lugo-Ortiz, Da-Silva, Francischetti, 2003**

Distribution: Brazil: Espírito Santo, Minas Gerais, Rio de Janeiro

Municipalities in Minas Gerais: Alto Caparaó, Araponga Bocaina de Minas, Conceição do Ibitipoca, Espera Feliz, Itamonte, Lima Duarte.

Material examined: P1: (1N) [20.XI.2020](#); P3: (3N) 28.X.2021; P4: (5N) [17.XI.2021](#); P5: (10N) 22-23.X.2022; P6: (11N) [09.IX.2023](#); P12: (2N) 07.XII.2022; P15: (2N) 19.X.2022; P17: (31N) 26.X.2022; P18: (12N) 25.X.2022, (46N) 26-27.X.2022; P19: (4N) 26.X.2022; P20: (4N) 26.X.2022.

***Waltzoyphius fasciatus* Lugo-Ortiz & McCafferty, 1995**

Distribution: Brazil: Bahia, Espírito Santo, Goiás, Manaus, Mato Grosso, Minas Gerais, Pará, Pernambuco, Rio de Janeiro, São Paulo.

Municipalities in Minas Gerais: Araponga, Bom Jesus do Galho, Caratinga, Dionísio, Governador Valadares, Ipaba, Jaboticatubas, Jaguarapu, Jequeri, Mariana, Marliéria, Ouro Preto, Periquito, Rio Doce, Santa Bárbara, Timóteo.

Material examined: P10: (3N) [10.IX.2023](#); P26: (3N) 5.X.2022; P27: (1N) 3.X.2022; P30: (6N) 16.VIII.2024; P33: (1N) 04.V.2024; P34: (4N) (1A) 04.V.2024; P35: (2N) 14.VIII.2024; P40: (4N) 30.VIII.2024; P43: (2N) 31.VIII.2024, (9N) 18-19.XII.2024.

***Zelusia deceptiva* Angeli & Salles, 2016**

Distribution: Brazil: Bahia, Espírito Santo, Goiás, Manaus, Mato Grosso, Minas Gerais, Rio de Janeiro, Rondônia, Roraima.

Municipalities in Minas Gerais: Araçuaia, Alto Caparaó, Conceição do Ibitipoca, Conceição do Mato Dentro, Espera Feliz, Guaraciaba, Mariana, Ouro Preto, Periquito, Prados, Santa Bárbara, Santos Dumont.

Material examined: P1: (1N) 24.IX.2024; P6: (5N) 09.IX.2023; P10: (1N) 10.IX.2023; P15: (1N) 10.IX.2023; P16: (3N) 26.X.2022; P17: (1N) 26.X.2022; P18: (1N) 26-27.X.2022; P20: (2N) 26.X.2022; P21: (1N) 30.XI.2022; P30: (6N) 16.VIII.2024; P31: (2N) 17.X.2023; P34: (2N) 14.VIII.2024; P37: (2N) 20.XII.2024; P43: (1N) 18.XII.2024; P44: (1N) [02.IX.2024](#).

New Genus and new species

Distribution: Brazil: Minas Gerais.

Municipalities in Minas Gerais: Araçuaia.

Material examined: P14: (1N) 11.III.2025.

Comments: The specimen collected could not be identified as neither genera known. Therefore, it is considered a new genus

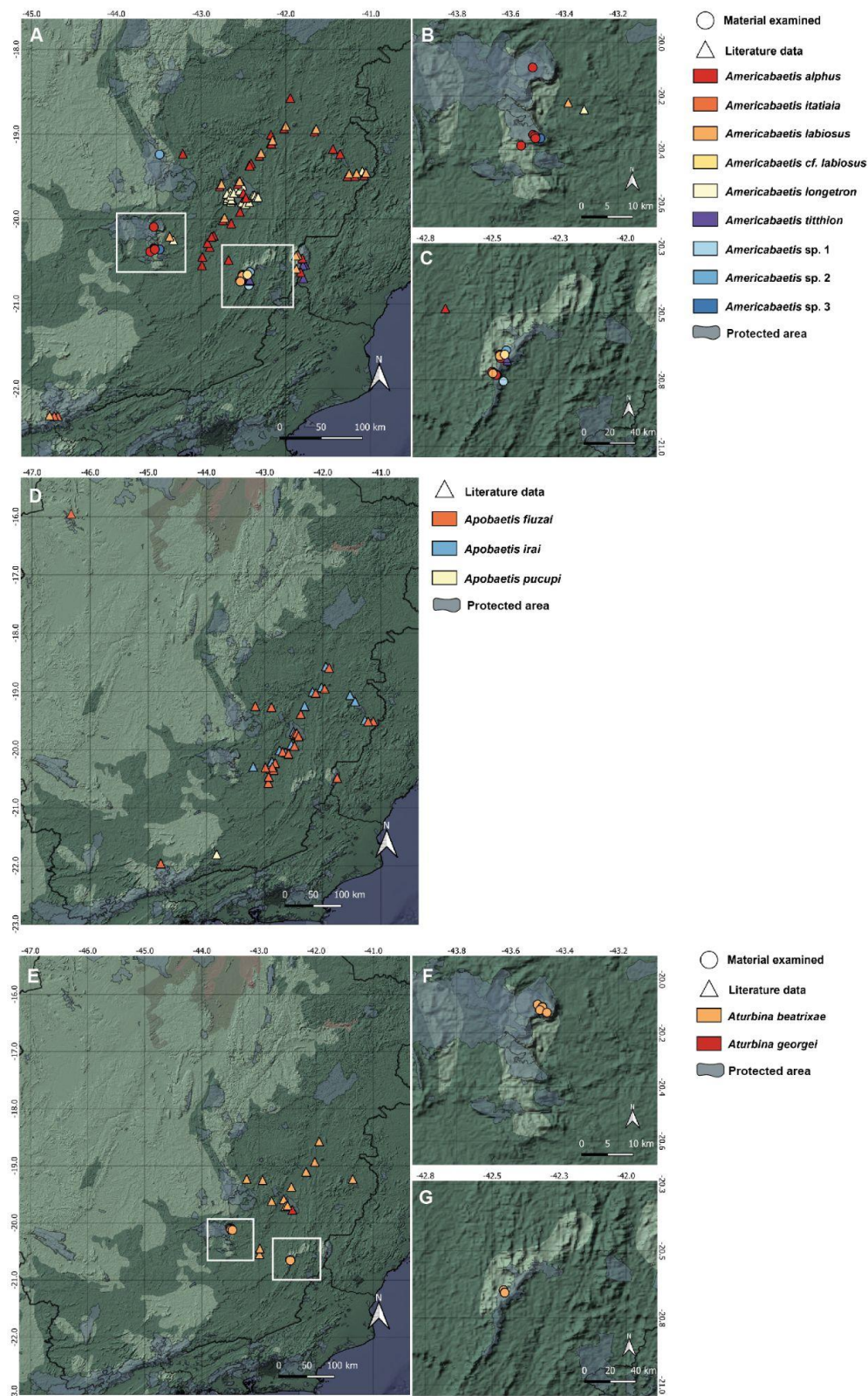


Figure 2. Partial view of the map of southeastern Brazil and protected areas. **A.** Distribution of *Americabaetis* species. White rectangle highlighting the location of Andorinhas Municipal Park and Santuário do Caraça Private Natural Heritage Reserve (**B**), and Serra do Brigadeiro State Park and adjacent areas (**C**). **D.** Distribution of *Apobaetis* species; **E.** Distribution of

Aturbina species. White rectangle highlighting the location of Andorinhas Municipal Park and Santuário do Caraça Private Natural Heritage Reserve (F), and Serra do Brigadeiro State Park and adjacent areas (G).

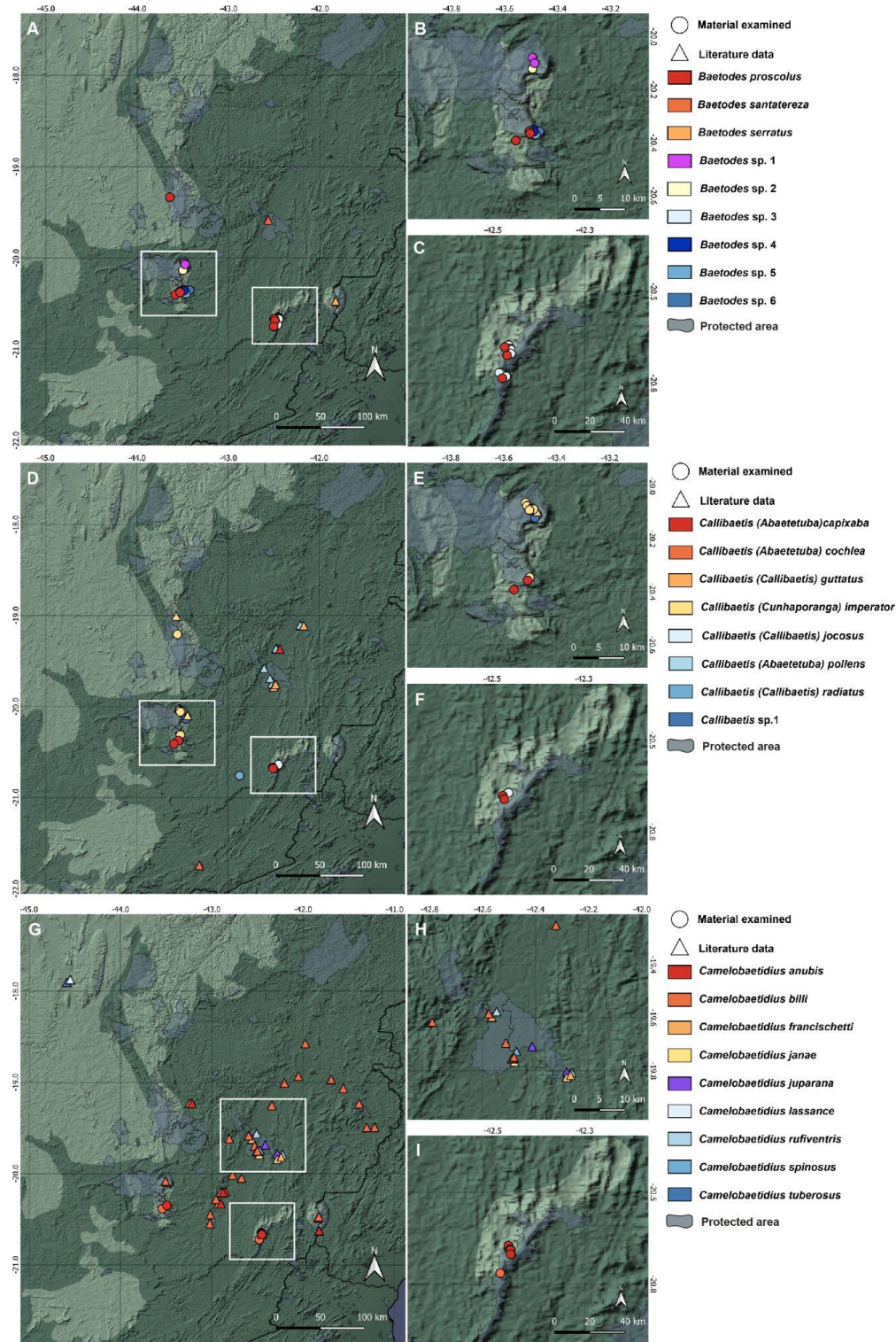


Figure 3. Partial view of the map of southeastern Brazil and protected areas. **A.** Distribution of *Baetodes* species. White rectangle highlighting the location of Andorinhas Municipal Park and Santuário do Caraça Private Natural Heritage Reserve (**B**), and Serra do Brigadeiro State Park and adjacent areas (**G**).

Park and adjacent areas (C). D. Distribution of *Callibaetis* species. White rectangle highlighting the location of Andorinhas Municipal Park and Santuário do Caraça Private Natural Heritage Reserve (E), and Serra do Brigadeiro State Park and adjacent areas (F). G. Distribution of *Camelobaetidius* species. White rectangle highlighting the location of Rio Doce State Park (H), and Serra do Brigadeiro State Park and adjacent areas (I).

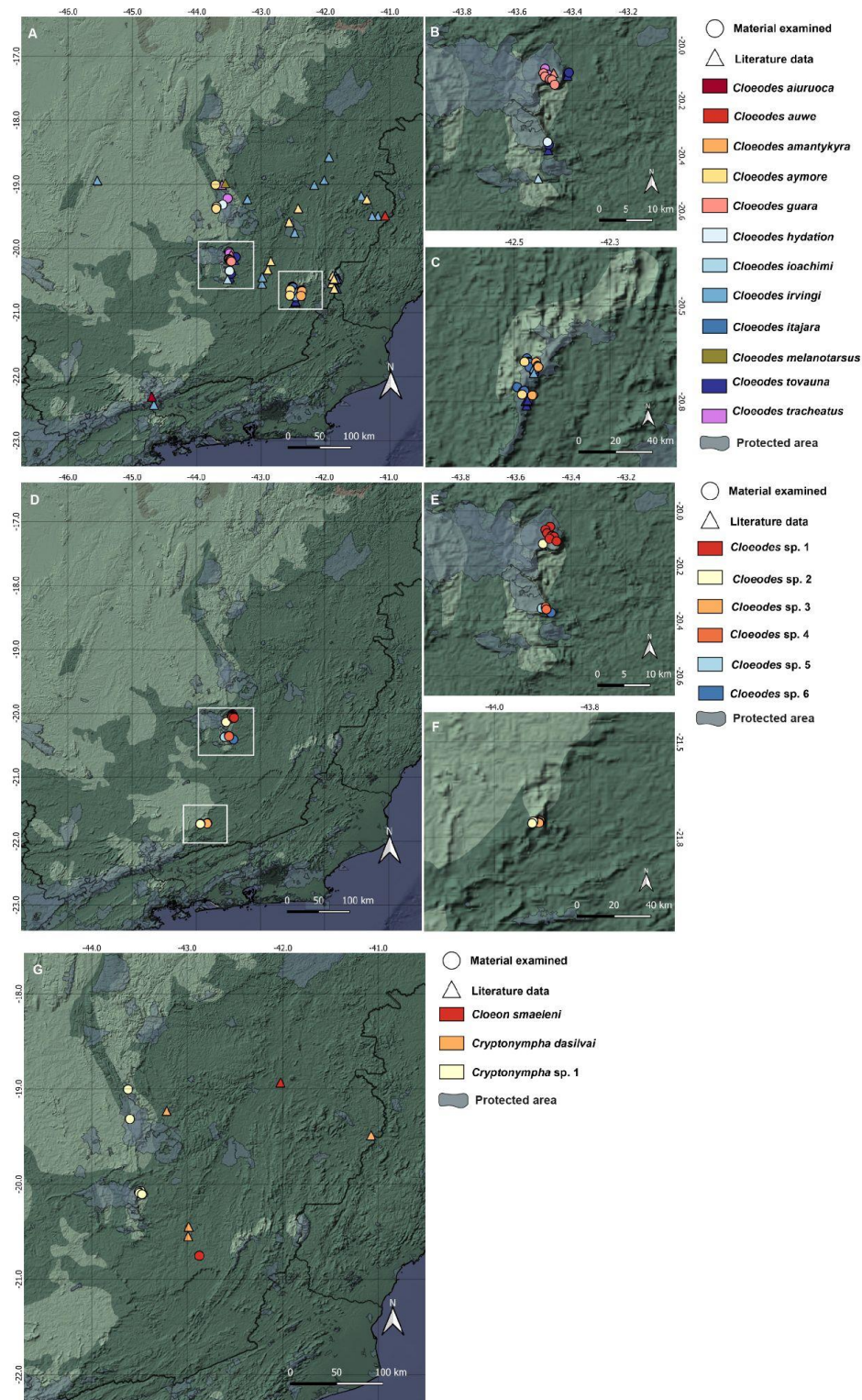


Figure 4. Partial view of the map of southeastern Brazil and protected areas. A. Distribution of *Cloeodes* species. White rectangle highlighting the location of Andorinhas Municipal Park and Santuário do Caraça Private Natural Heritage Reserve (E), and Serra do Brigadeiro State Park and adjacent areas (F). G. Distribution of *Camelobaetidius* species. White rectangle highlighting the location of Rio Doce State Park (H), and Serra do Brigadeiro State Park and adjacent areas (I).

and Santuário do Caraça Private Natural Heritage Reserve (**B**), and Serra do Brigadeiro State Park and adjacent areas (**C**). **D.** Distribution of *Cloeodes* morphospecies. White rectangle highlighting the location of Andorinhas Municipal Park and Santuário do Caraça Private Natural Heritage Reserve (**E**), and Ibitipoca State Park and adjacent areas (**F**). **G.** Distribution of *Cloeon smaeleni* and *Cryptonympha* species.

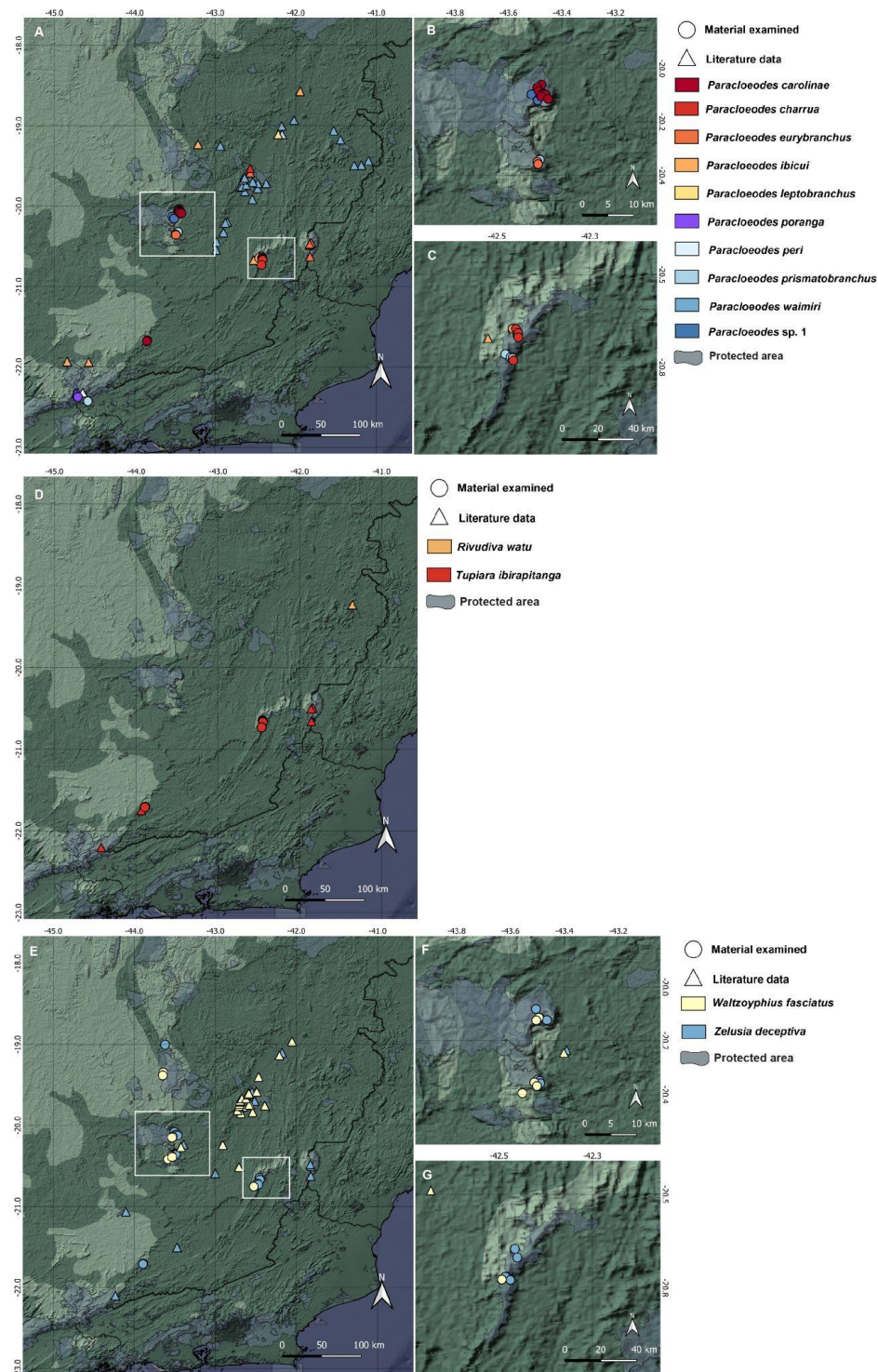


Figure 5. Partial view of the map of southeastern Brazil and protected areas. **A.** Distribution of *Paracloeodes* species. White rectangle highlighting the location of Andorinhas Municipal Park and Santuário do Caraça Private Natural Heritage Reserve (**B**), and Serra do Brigadeiro

State Park and adjacent areas (C). **D.** Distribution of *Rivudiva watu* and *Tupiara ibirapitanga* species; **E.** Distribution of *Waltzoyphius fasciatus* and *Zelusia deceptiva* species. White rectangle highlighting the location of Andorinhas Municipal Park and Santuário do Caraça Private Natural Heritage Reserve.

Discussion

Species richness and records

Until this study, research efforts on Baetidae in Minas Gerais had been largely concentrated in the southeastern region of the state, where 53 species and 332 records had been reported. Most of these records are from Atlantic Forest areas, particularly within the Rio Doce basin. In the present study, we reported 45 species and 218 new records, distributed across the Atlantic Forest, Cerrado, and transitional zones between their ecoregions. Considering both newly species and new registered from the material examined, the total Baetidae diversity in Minas Gerais now comprises 76 species and 550 records. With these additions, Minas Gerais becomes not only the southeastern state with the highest number of Baetidae records, but also the state with the greatest number of records in the entire country, followed by Espírito Santo, Roraima, and Rondônia (Salles et al., 2023; Salles et al., 2025a).

Regarding species distribution among genera, *Cloeodes* was the most species-rich genus (18 species), followed by *Paracloeodes* (10), *Americabaetis*, *Baetodes*, and *Camelobaetidius* (9 each), *Callibaetis* (8), *Apobaetis* (3), *Aturbina* and *Cryptonympha* (2 each), and *Cloeon*, *Rivudiva*, *Waltzoyphius*, *Zelusia*, and the new genus (1 each). A total of 18 new species were found in our samples, distributed among *Cloeodes* (6), *Baetodes* (6), *Americabaetis* (3), and *Callibaetis*, *Cryptonympha*, *Paracloeodes* and the new genus (1 each). Considering that most samples were collected in southern Minas Gerais—an area already relatively well studied—this number likely represents only a fraction of the state's potential to harbor a rich Baetidae diversity.

At least 37 species were recorded outside protected areas, representing approximately 48% of the total species registered for the state. These include species belonging to the genera *Cloeodes* (7 species), *Callibaetis* (6), *Americabaetis* (5), *Camelobaetidius* (4), *Paracloeodes* (4), *Apobaetis* (3), *Baetodes* (2), and *Cryptonympha* (2), as well as *Aturbina beatrixae*, *Waltzoyphius fasciatus*, *Zelusia deceptiva*, and *Cloeon smaeleni*. Although this represents a substantial proportion of the recorded diversity, most occurrences are concentrated in the Rio Doce basin. In contrast, other basins have records exclusively from protected areas, underscoring a major sampling gap across the state. Furthermore, many protected areas still lack faunistic surveys, which also contributes to the knowledge deficit.

The fact that *Cloeodes* presents the greatest richness here is not surprising, as it is one of the most species-rich genera in the Neotropical region (Salles et al., 2016). Most of the species found did not show variation regarding the biome in which they were collected; however, three species stand out: *Cloeodes amantkyra*, recorded for the first time outside its type locality; *Cloeodes hydation*, reported for the first time in the state; and *Cloeodes* sp. 2, which is the only new species found in two different localities (Fig. 4A–F).

Baetodes is another genus with high diversity, distributed from Arizona and Texas to Argentina (Nieto, 2016). Although few previously described species were found, six putatively new species were collected, showing notable diversity in ecotonal zones (Fig. 3A–C). Following that, *Americabaetis* appears with three new species; this genus currently includes 14 described species in South America (Salles et al., 2025b). The overlapping occurrences shown on the map (Fig. 2A–C) highlight the fact that multiple species may inhabit the same environment.

Since the taxonomy of the genus *Callibaetis* is primarily based on the adult stage, the new species could not be identified, but it differs markedly from those previously recorded in the study area. Two species are noteworthy: *Callibaetis (Cunhaporanga) imperator*, apparently

restricted to the Cerrado biome, and *Callibaetis (Abaetetuba) capixaba*, which occurs in both the Atlantic Forest and Cerrado. Surprisingly, a new species of *Cryptonympha* was also identified and showed a wide distribution across the Cerrado and adjacent ecotonal zones.

Paracloeodes stands out as the second most species-rich genus. It is widely distributed throughout the Americas, with 16 species reported from South America. In this study, we report 10 species from Minas Gerais, including one new species. *Paracloeodes carolinae* was found for the first time outside its type locality, occurring in both the Cerrado and ecotone zones.

It is notable the occurrence of *Cloeon smaeleni*, an alien species, in the study. Although it had already been recorded in the state, this finding represents an important new record for the species. As predicted by Cardoso et al. (2024), this evidence suggests that the species is establishing itself in the interior of the continent—specifically, in the case of Minas Gerais and Espírito Santo, within the Rio Doce Basin. Notably, the specimens were collected in urban areas, and our study found no evidence of habitat overlap with other species.

The current status of Baetidae diversity in Minas Gerais

In Minas Gerais, the Rio Doce basin stands out as the most intensively sampled area, with 40 species previously reported. With our study, this number increased to 67 species, if we sum the new species. This concentration of records can be attributed to multiple factors, foremost among them the presence of taxonomists working in the region. Salles and colleagues (2004) documented many of the earliest Baetidae species in the municipality of Araponga, which remains the locality with the highest number of records in our study (25), followed by Ouro Preto (20), Santa Bárbara (16), Jaboticatubas (9), Conceição do Ibitipoca (5), Conceição do Mato Dentro (5), Itamonte (2), and Viçosa (1). Except for Viçosa (where no targeted collections were conducted, despite the record of *Cloeon smaeleni*) most sampled sites are located near institutions to which researchers are affiliated. This pattern reflects a well-documented bias in

biodiversity surveys: areas in close proximity to research centers are more likely to be systematically studied (Fernandes, 2021).

Another significant factor was the environmental catastrophe that occurred on November 5th, 2015, when the collapse of the Fundão dam released approximately 60 million cubic meters of mining tailings into the basin (Marta-Almeida et al., 2016). As one of the most severe ecological disasters in Brazilian history, it prompted numerous studies aimed at assessing its impacts on local ecosystems and monitoring the recovery of aquatic fauna (De Lima et al., 2022; Viana et al., 2024; Alvim et al., unpublished data).

The conservation areas sampled in our study are located not only within the Atlantic Forest, but also in the Cerrado biome and in transitional zones between these two biomes. After analyzing the databases, only 6 species [*Apobaetis fiuzai*, *Callibaetis (Cunhaporanga) imperator*, *Camelobaetidius tuberosus*, *Cloeodes guara*, *Cloeodes tracheatus* and *Cloeodes tovauna*] were registered to this biome. If we consider that the municipalities of Conceição do Ibitipoca, Conceição do Mato Dentro, Jaboticatubas, Ouro Preto and Santa Bárbara are located in Cerrado biome, then we have 35 new records to Cerrado and 41 species recorded to this biome. However most of these sample sites are located at transition zones between the biomes, which makes it difficult to assume these numbers of records.

The Cerrado is recognized as a biodiversity hotspot, encompassing approximately 30% of Brazil's biodiversity and representing the largest and most species-rich Neotropical savanna (Myers et al., 2000; Françoso et al., 2015). Furthermore, transitional areas—or ecotones—are often associated with elevated species richness and play a key role in sustaining evolutionary and ecological processes (Kark and Rensburg, 2006). The species diversity observed in our results can be attributed to the effort to sample different biomes and ecological contexts.

However, the current numbers clearly do not reflect the true potential of this biome. Given that only a small portion of the Cerrado has been surveyed, Baetidae biodiversity in the

region remains largely unexplored. This gap is even more pronounced in the Caatinga biome within the state, which still lacks any species records, despite known occurrences of Baetidae in this biome in other Brazilian states (Salles et al., 2023; Salles et al., 2025a). A similar pattern has been observed for Plecoptera, with no records from either biome in Minas Gerais. In both cases, the conclusion is the same: much greater sampling effort is still needed in these regions (Castillo-Velásquez et al., 2024).

Conclusion

This study significantly advances the knowledge of Baetidae diversity in Minas Gerais, increasing the number of recorded species from 53 to 76 and the total records to 550, making it the state with the highest number of Baetidae records in Brazil. Among the findings, 18 new species and one new genus were discovered, with *Cloeodes*, *Baetodes*, and *Americabaetis* showing the highest richness.

Although previous efforts were concentrated in the Rio Doce basin, our results reveal important new records from conservation units and ecotonal regions, underscoring the value of exploring environmentally diverse and previously neglected areas. These findings reflect the high potential of other regions in the state to contribute to Baetidae diversity.

Despite this progress, vast areas of the Cerrado remain underexplored, and no Baetidae records have yet been documented from the Caatinga within Minas Gerais. This highlights persistent gaps in sampling and reinforces the need for broader geographic and ecological coverage. Expanding research into these areas is essential to uncover the full extent of the state's mayfly fauna and to guide future taxonomic and conservation efforts.

Acknowledgements

The authors sincerely thank the managers of Parque Estadual Serra do Brigadeiro, Parque Estadual do Ibitipoca, Parque Nacional da Serra do Cipó, Parque Nacional do Itatiaia, Parque Municipal Cachoeira das Andorinhas, Estação Ecológica do Tripuí, RPPN Santuário do Caraça. We also thank the managers of Pousada Fazenda Remanso, for permitting us to collect. We are grateful to all collectors involved in the samples, Ana Viana, Erika Cifuentes-Vargas, Felipe Sarmiento, Gabriel Pantoja, Iâmara Santos, Isabel Cortes, Jhon Marulanda, Juliana Alvim, Maisa Gonçalves, Mellis Rippel, Pedro Bonfá, Rodrigo Gastaldo and Tales Orlando. A special thanks to our colleagues Pedro Bonfá and Rodrigo Gastaldo for their help with map preparation. Finally, we acknowledge and appreciate the financial support provided by the funding agencies Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), Conselho Nacional de Desenvolvimento Científico e Tecnológico do Brasil (CNPq, processes 408346/2023-0, 309666/2019-8, 310205/2021-2, and 316547/2021-2) and Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG, processes APQ 05461-18 and APQ-01591-23), which were essential for making this study possible. Fieldwork was conducted under authorization from the Sistema de Autorização e Informação em Biodiversidade (SISBIO/ICMBio, proc. 79695-1; proc. 92744-1), and we also thank the Instituto Estadual de Florestas (IEF, proc. 058/2021) for the permission to collect specimens.

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4. CONCLUSÃO

Os estudos desenvolvidos ao longo desta dissertação contribuíram significativamente para o reconhecimento da biodiversidade e da distribuição da família Baetidae em Minas Gerais, ao mesmo tempo em que evidenciaram importantes lacunas de conhecimento ainda existentes no estado. Como resultado, Minas Gerais passa a ser o estado com o maior número de registros e espécies conhecidas de Baetidae, não apenas na região Sudeste, mas em todo o Brasil.

Além de ampliar o conhecimento sobre a fauna do estado, os trabalhos trouxeram avanços relevantes para a taxonomia da família. A descrição de semaforontes, como no caso de *Americabaetis titthion*, representa um passo importante para reduzir o déficit haeckeliano, considerando que ainda são poucos os adultos conhecidos para diversas espécies do gênero. A disponibilização de semaforontes favorece análises filogenéticas futuras e aprimora a identificação em estudos ecológicos. Também foi proposta uma chave interativa para as ninfas de *Americabaetis* na América do Sul, que auxiliará nas identificações do grupo. Ao todo, foram descritas quatro novas espécies, duas delas para Minas Gerais.

Foram encontradas 18 espécies possivelmente novas e um gênero novo, além do registro inédito de cinco espécies para o estado. As amostragens no Cerrado e em zonas de transição com a Mata Atlântica ampliaram o número de espécies conhecidas nessas áreas. No entanto, ainda são necessários maiores esforços para que a fauna de Baetidae de Minas Gerais seja plenamente conhecida. Apesar da ampliação das áreas amostradas, a maioria das coletas ainda se concentra na porção sudeste do estado, enquanto outras regiões permanecem subamostradas ou sequer exploradas. O bioma da Mata Atlântica segue como o mais investigado, em contraste com o Cerrado e, sobretudo, com a Caatinga, que ainda permanece sem registros.

Dessa forma, a análise do conhecimento atual sobre a fauna de Baetidae em Minas Gerais permite destacar três pontos centrais: (1) embora o estado ainda represente uma lacuna no conhecimento, ele possui alto potencial para descobertas taxonômicas; (2) é urgente intensificar os esforços de coleta no Cerrado, nas zonas de ecótono e, especialmente, na Caatinga; (3) os ecótonos demonstram ser áreas de elevada diversidade e devem ser priorizados em estudos futuros. Assim, os próximos passos devem se concentrar na amostragem das demais regiões e biomas de Minas Gerais, a fim de revelar de forma mais abrangente a diversidade da família Baetidae no estado.