

New record of mayflies (Ephemeroptera, Insecta) from Maranhão State, Northeast Brazil.

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Abstract

The State of Maranhão, located in northeastern Brazil, has a great biodiversity due to the complex of biomes that constitutes its territory. Due to the paucity of research in the area, there are gaps in knowledge of the local fauna. This work aims to contribute to the knowledge of the order Ephemeroptera. Two species of Baetidae, *Callibaetis nigracyclus* Cruz, Salles & Hamada, 2014 and *Cloeodes auwe* Salles et al., 2004, and one species of Leptophlebiidae, *Hermanella mazama* (Nascimento, Mariano and Salles, 2012) are here registered from the State. It is noteworthy that the genus *Cloeodes* Traver 1938 and *Hermanella* Needham & Murphy, 1924, still do not have records from the State and it is also worth mentioning that all new records represent an important geographic extension.

Introduction

Currently, several regions of Brazil, from a faunal point of view, are well characterized, while others remain almost unexplored, with no adequate representation (Hughes et al. 2021). Among the Brazilian states with the least amount of research on mayflies (Insecta, Ephemeroptera), Maranhão, located in the Northeastern region of the country, can be mentioned as one of the less documented (CTFB 2023; Salles 2022).

The order Ephemeroptera, in this state, probably presents a big biodiversity due to the encounter of three biomes in this area, namely: Amazon Forest, which contains the most diverse records of species known in Brazil; the Cerrado, which contains most of the country's hydrographic regions; and the caatinga, considered an exclusively Brazilian biome, also presenting a high biological diversity (Araújo et al. 2016).

The objective of this work is to present new records of three species of mayflies from the state of Maranhão, in the Cerrado biome located in the eastern region of the state.

Material and Methods

The examined material was collected in the municipality of Chapadinha, in the eastern portion of the state of Maranhão, northeastern of Brazil, in an area of the Cerrado biome (Fig. 1). In this area, tree watercourses were investigated. The Itamacaoca Stream (3°44'51.4"S 43°19'33.7"W) with mostly lentic environment with little water flow and 0.5 to 1.5 m wide and 0.30 to 1.0 depth. The stream is preserved and shows few impacts by human action and characterized by a sandy bed, gravel, pebbles and large stones covered by fine sediments, substrate with the presence of sticks and trunks, with aquatic and marginal vegetation. Munim River (3°42'22.6"S 43°31'45.4"W), lotic environment with 4.0 to 5.0 m wide and 0.30 to 2.0 depth. The river is with medium currents and characterized by a sandy bed, with gravel, pebbles, large and small stones covered by fine sediments, space between the stones provides habitat diversity. The environment is well preserved, but human action resulting from fishing and recreational activity significantly impacts the place where the specimens were collected. Riacho Feio stream (3°50'47.2"S 43°18'32.4"W) a lotic environment with moderate water flow with 3.0 to 6.0 m wide and 2.0

to 4.0 depth. The stream is characterized by a muddy bed, substrate with the presence of branches and trunks, it also contains aquatic and marginal vegetation, with high depth (2 meters on the margins). The environment is? used for fishing and recreational activities.

Samples were collected with the aid of a D-type net with a 250 microns mesh. Organisms were screened in the field with the aid of 3ml Pasteur pipettes. Some specimens were fixed in 75% ethyl alcohol, while others were carried alive in the laboratory to be reared. In the laboratory, the material was sorted in the family level and successively identified by mounting permanent slides, and identified using specialized bibliography (e.g., Dominguez et al. 2006; Hamada et al. 2014; Cruz et al. 2014, Lima et al. 2012; Salles et al. 2018).

The specimens are deposited at the Coleção de Invertebrados do Centro de Ciências Agrárias e Ambientais (CINCAA), Chapadinha, Universidade Federal do Maranhão.

Figure 1: Map of Maranhão state with biomes and location of the sampling area. In green, Amazon Forest; in yellow, the Cerrado; in red, the Caatinga. The black dot represents the location of the municipality where the samples were collected.

Results and Discussion

Callibaetis (Cunhaporanga) nigracyclus Cruz, Salles & Hamada, 2014

Sampling site: Itamacaca Stream

Collection number: CINCAA 145, 146, 147

Comments: Nymphs were sampled in the Itamacaca Stream and reared in the laboratory until the emergence of male and female imagos. They were identified based on the nymphal description (Cruz et al. 2014) and the key to identify nymphs of *Callibaetis* from South America (Cruz et al. 2017) using the following characters: female fore wing with single marginal intercalary vein, with area around bulla and some spaces on outer margin pigmented (Fig. 2B); hind wing venation hyaline (Fig. 2C); turbinate eye of male basally constricted (Fig. 2D); distal margin of the labrum with medial emargination (Fig. 3A), glossa subequal in length to the paraglossa (Fig. 3B), labial palp with spine-like setae (Fig. 3B), hind claw without tiny spines on the surface (Fig. 3C).

In the present work, the species is reported for the first time from the State of Maranhão. The new record also represents a geographic extension, as the species was recorded only in northern Brazil, in the states of Pará and Amazon (Cruz et al. 2014).

Figure 2. *C. nigracyclus*: A – Dorsal view of nymph, scale bar 500 µm; B- lateral view of female imago, scale bar 500 µm; C - male hind wing, scale bar 500 µm; D - partial view of thorax and head of male imago, scale bar 200 µm.

Figure 3. *C. nigracyclus*. Selected nymphal structures: A, labrum, scale bar 100 µm; B, labium, scale bar 100 µm; C, hind tarsal claw, scale bar 10 µm.

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

Sampling site: Riacho Feio Stream

Collection number: CINCAA 136

Comments: *Cloeodes auwe* was described by Salles et al. (2004) and the description was based only on nymphs from Mato Grosso, the adults of the species were only described eight years later by Massariol et al. (2013), who described the female and male of the species. Later, Kluge (2017) reported its presence in Peru. The species was identified based on the following characters: characteristic spot on the nymph's first abdominal terga (Fig. 4A); hind wing pads absent (Fig. 4A); femora with two spatulate spines apically (Fig. 4B); tarsal claws 0.5 times length of tarsi; and maxillary palp longer than galea-lacinia (Fig. 4C). The species and genus are reported for the first time from the State of Maranhão, also presenting a geographic extension of northeast Brazil.

Figure 4. Nymph of *C. auwe*: A - dorsal view, scale bar 1 mm; B - partial view of middle leg with arc of long setae (arrow), scale bar 50 µm; C – maxilla, scale bar 50 µm.

***Hermanella mazama* (Nascimento, Mariano & Salles, 2012)**

Sampling site: Munin River

Collection number: CINCAA 134

Comments: The species *H. mazama*, described by Nascimento, Mariano and Salles (2012) was first allocated in the genus *Needhamella* Domínguez & Flowers, 1989 and later transferred to the current genus by Lima et al. (2012).

The species was identified by the following characters: clypeus without medial projection; gills translucent, with a basal and median grayish band; terga yellowish brown (Fig. 5A); galea-lacinia with prominent tusk on inner apical margin (nearly half the length of galea-lacinia) (Fig. 5B); tarsal claw devoid of accessory denticles (Fig. 5C).

The species is being registered for the first time from the State of Maranhão, which also consists an important geographic extension. The species was previously reported only from the states of Espírito Santo and Bahia, with an extension area (*sensu* IUCN) of less than 20.000km² (ICMBio 2023).

Figure 5. Nymph of *H. mazama*: A - dorsal view, scale bar 1 mm. Selected mouth parts of the nymph: B – maxilla, scale bar 20 µm; C- tarsal claw, scale bar 20 µm.

Among the three species considered herein *C. nigracyclus* represent a new record in the State, while *C. auwe* and *H. mazama* represent new records at the species and generic level. All these records represent a geographic extension for northeastern Brazil (Fig. 6).

Figure 6. Distribution map of *C. nigracyclus*, *C. auwe* and *H. mazama*. Triangles represent distribution of *C. nigracyclus*, circle represent distribution of *C. auwe* and square represent *H. mazama*. Club represent the new records of three species. Colors in map represent biomes.

Conclusion

The order Ephemeroptera in Brazil is represented by 10 families, 83 genera, and 426 described species (Cardoso et al. 2023). Northeast is represented by 10 families, 48 genera and 125 species (Salles 2022). In the Maranhão State the research on the Ephemeroptera is scarce and heterogeneously distributed throughout the territory, with no checklist or identification keys, and the growing number of recently published articles (e.g., Hughes et al. 2021; Nessimian et al. 2019) highlights the need for increased efforts in research on this group.

Declarations

Acknowledgment

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Figures

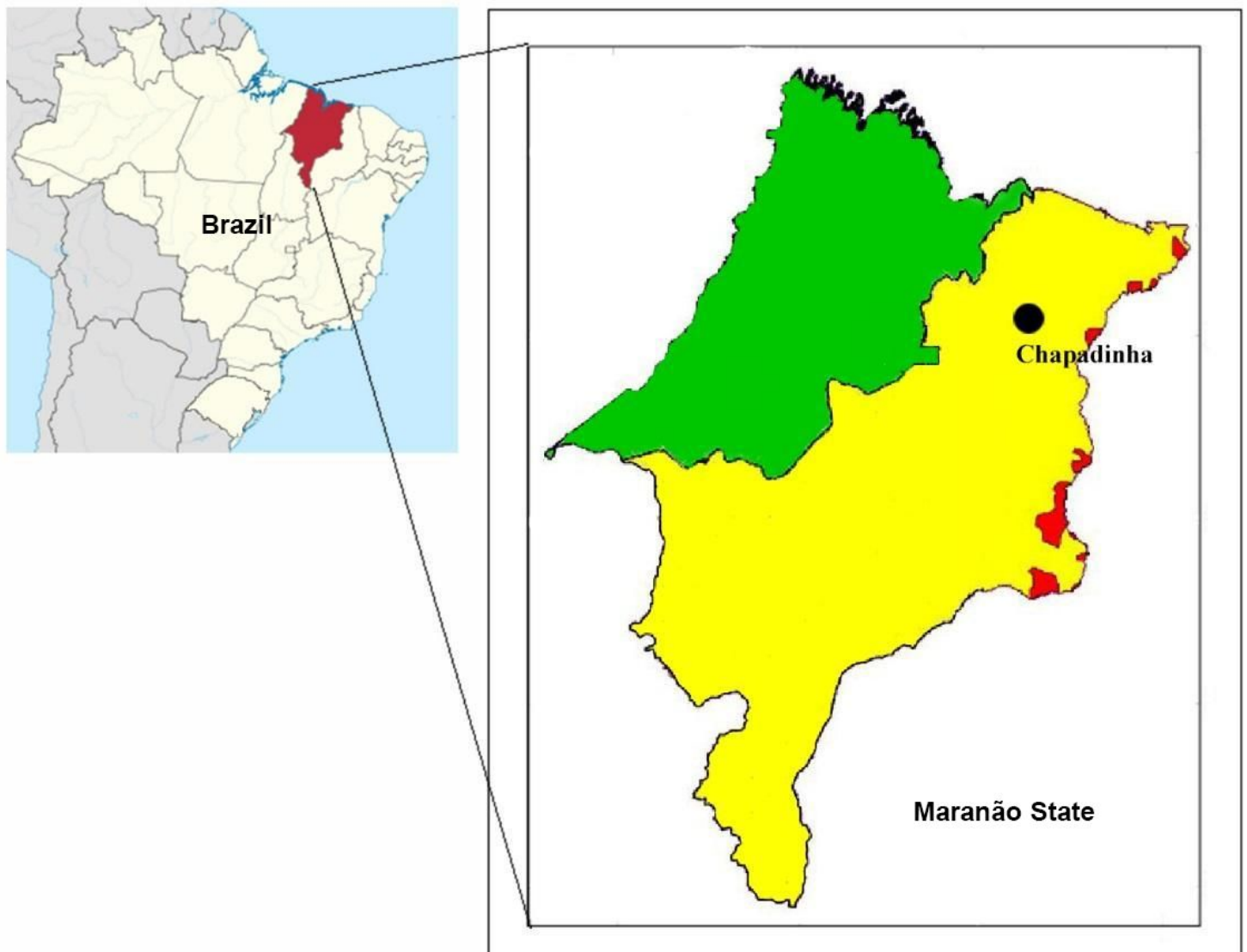


Figure 1

Map of Maranhão state with biomes and location of the sampling area. In green, Amazon Forest; in yellow, the Cerrado; in red, the Caatinga. The black dot represents the location of the municipality where the samples were collected.

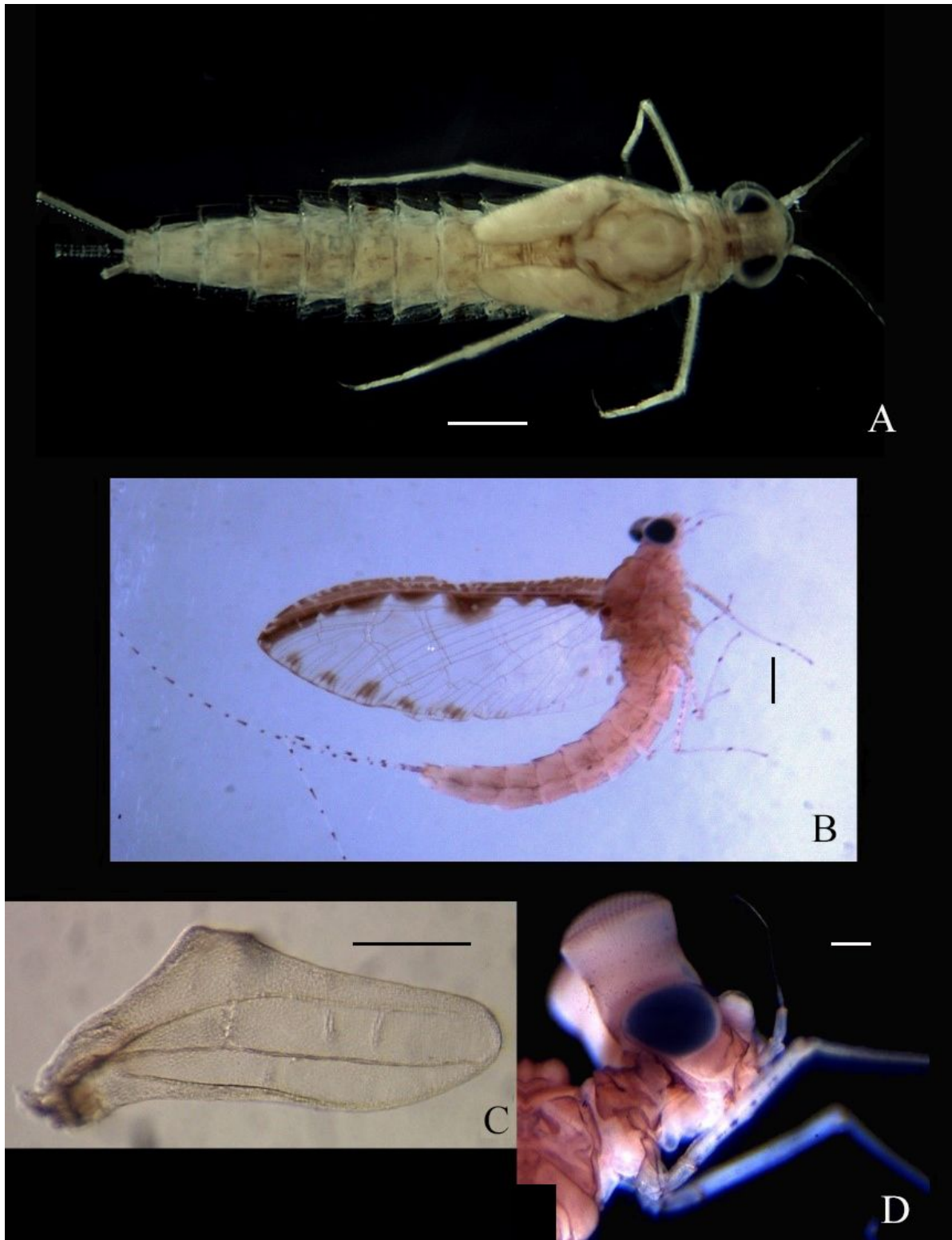


Figure 2

C. nigracyclus: A – Dorsal view of nymph, scale bar 500 μm ; B- lateral view of female imago, scale bar 500 μm ; C - male hind wing, scale bar 500 μm ; D - partial view of thorax and head of male imago, scale bar 200 μm .

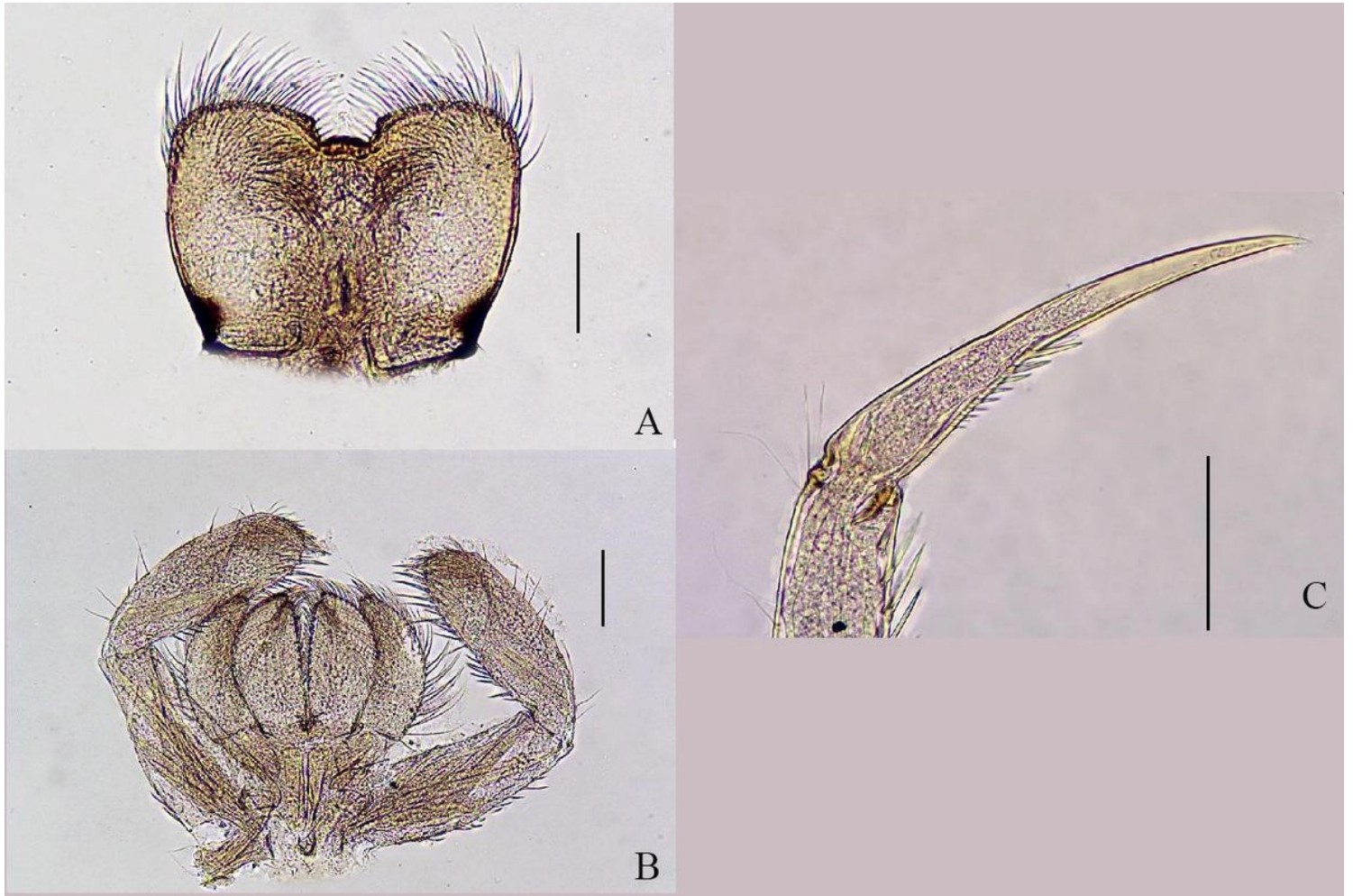


Figure 3

C. nigracyclus. Selected nymphal structures: A, labrum, scale bar 100 μm ; B, labium, scale bar 100 μm ; C, hind tarsal claw, scale bar 10 μm .

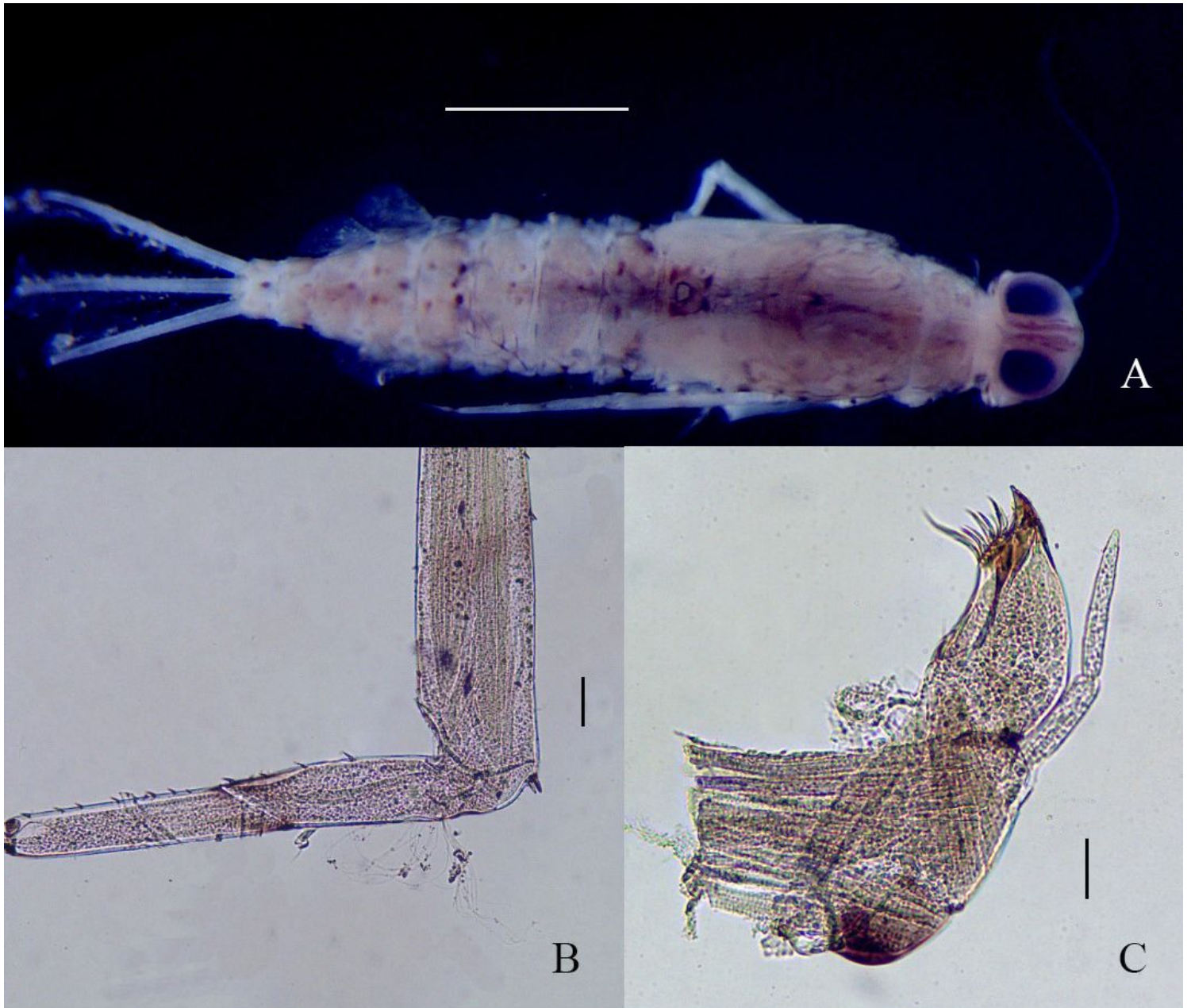


Figure 4

Nymph of *C. auwe*. A - dorsal view, scale bar 1 mm; B - partial view of middle leg with arc of long setae (arrow), scale bar 50 μm ; C – maxilla, scale bar 50 μm .



Figure 5

Nymph of *H. mazama*: A - dorsal view, scale bar 1 mm. Selected mouth parts of the nymph: B – maxilla, scale bar 20 μ m; C- tarsal claw, scale bar 20 μ m.

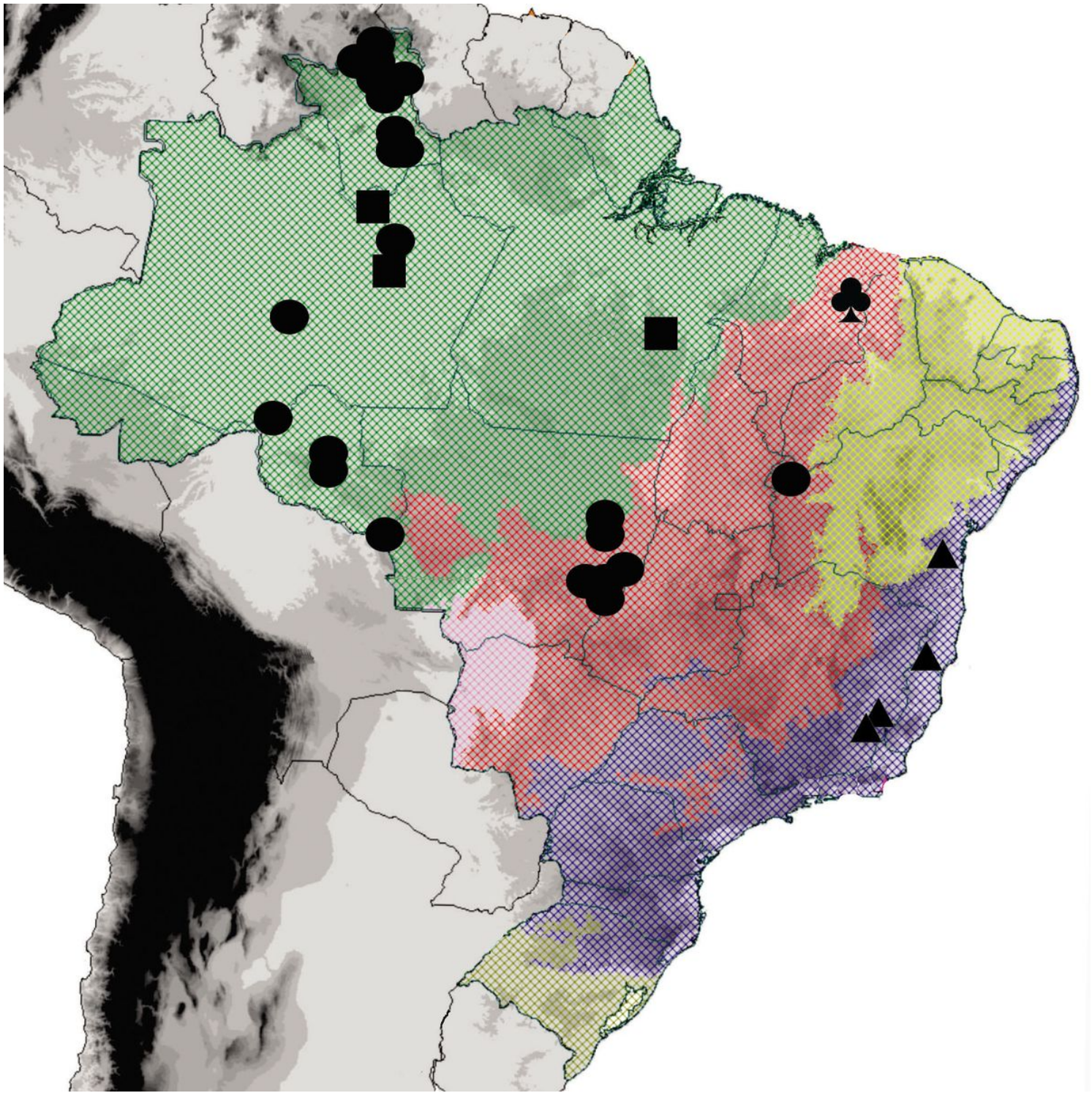


Figure 6

Distribution map of *C. nigracyclus*, *C. auweand* *H. mazama*. Triangles represent distribution of *C. nigracyclus*, circle represent distribution of *C. auweand* and square represent *H. mazama*. Club represent the new records of three species. Colors in map represent biomes.