

Freshwater oyster *Bartlettia stefanensis* (Moricand 1856) reefs revealed by Amazon drought

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ABSTRACT

Calcrete platforms covered by tightly packed individuals of the Etheriidae freshwater oyster *Bartlettia stefanensis* (Moricand 1856) forming small reefs were exposed in several spots of the Muru river, Acre, Brazil, during the 2024 drought. Freshwater oysters were known to colonize submerged laterite outcrops growing inside cavities; but the reef-like formations recorded in Acre represent a previously undescribed aquatic habitat probably at risk as the frequency of extreme droughts increase due to climate change.

KEYWORDS: Acre, Calcrete, Etheriidae, Unionoida

Recifes da ostra de água doce *Bartlettia stefanensis* (Moricand 1856) revelados pela seca amazônica

RESUMO

Plataformas de calcário cobertas por densas agregações da ostra de água doce *Bartlettia stefanensis* (Moricand 1856, Etheriidae) formando pequenos recifes foram expostas em diversos trechos do rio Muru, Acre, Brasil, durante a seca de 2024. Ostras de água doce são conhecidas por colonizar afloramentos submersos de laterita, crescendo no interior das cavidades; as formações recifais observadas no Acre representam um habitat aquático não descrito e provavelmente sob risco devido ao aumento da frequência de secas extremas devido às mudanças climáticas.

PALAVRAS-CHAVE: Acre, Calcreta, Etheriidae, Unionoida

The Unionoida are a very diverse group of freshwater bivalves found all over the world except for Antarctica. Most are fish parasites in the larval stage and are considered good biological (Pereira *et al.* 2011) and paleoenvironmental (Wesselingh 2006) indicators, capable to withstand extreme situations, such as waterfalls, drought, and flood pulses (Pereira *et al.*, 2014). The majority burrows into soft sediments but a few are burrowers of compacted sediments (e.g., *Mycetopoda* d'Orbigny 1835 and *Mycetopodella* Marshall 1928) or wedgers in rocks and other hard substrates like the Etheriidae freshwater oysters (Myahira *et al.* 2017). The Etheriidae is a small family of sessile, oyster-like bivalves with irregular shells occurring almost entirely within the tropics. The family is composed of only four apparently monotypic genera, *Etheria* Lamarck, 1807, *Bartlettia* H. Adams, 1867, *Mulleria* A. Férussac, 1824, (*Acostaeta* A. d'Orbigny, 1851 is a synonym) and *Pseudomulleria* Anthony, 1907 distributed in Africa (*Etheria*), South America (*Bartlettia* and *Mulleria*) and India (*Pseudomulleria*) (Akélé *et al.* 2022, Molluscabase 2025).

Bartlettia stefanensis (Moricand 1856) is found in the western Amazon and upper Parana basins of South America

(Simone 2006; Pereira *et al.* 2014; Graff and Cummings, 2024). Studies in Peru found that *B. stefanensis*, alongside *Mycetopoda soleniformis* (Orbigny 1835) and *Mycetopodella falcata* (Higgins 1868), form a specialized digging bivalve community growing inside consolidated river deposits, especially laterite exposed on vertical riverbanks. In this habitat, densities can be around 60 individuals per square meter, but the only evidence of the mollusks are narrow vertical slits on the laterite's surface (Burmeister 1988; Anderson 2014). There are also records of individuals growing in cracks of solid rocks, including waterfalls, in Paraguay (Planeta Invertebrados 2020) but little is known about the ecology of the species in these settings or, as a matter of fact, in its Brazilian range. Here, we report the discovery of populations of *B. stefanensis* in the Muru river growing on exposed situations, unlike the ones reported in the literature and similar to reefs formed by marine oysters.

The Muru river has its headwaters in Peru but its main course cuts through central Acre, Brazil, before emptying into the Tarauacá river, one of the main tributaries of the Juruá river. It is a white-water river with a sediment load influenced

by widespread deforestation along its banks. Despite some oxbow lakes, upstream of the town of Tarauacá the Muru lacks a wide floodplain, being mostly constrained by steep banks. The banks of the Muru show several layers of calcium carbonate (calcrete) alternating with consolidated silt deposits belonging to the Solimões Formation originating from the Miocene deposits of Lake Pebas (Latrubesse *et al.* 2010; Adamy 2015). In some spots the calcrete forms thick horizontal platforms extending well into the riverbed or even across it, forming rapids or small waterfalls when water levels are low.

On 22 August 2024 the authors departed from the town of Tarauacá, at the confluence of the Muru and Tarauacá rivers, to carry preliminary surveys at Seringal Guajará (08°52'11"S, 71°12'24"W), some 175 km up the Muru river, where Perfin Climate manages a forest carbon project. The waters of the Muru were very low due to the pronounced drought affecting most of the Amazon that year (Nasa Earth Observatory 2024), showing steep banks with calcrete layers that became more exposed as we navigated upriver. We noticed several spots with exposed ledges of calcrete projecting into the riverbed that looked incrustated with shells. These were being explored by birds such as giant cowbirds *Molothrus oryzivorus* (Gmelin 1788) and wattled jacanas *Jacana jacana* (Linnaeus 1766) pecking at what looked like some food items.

Curious about by this finding, the following day we explored one spot where the calcrete ledges looked more extensive (08°34'6.6"S, 70°53'47"W, Figure 1). Upon closer examination we found them to be thickly packed with dead or dying individuals of the freshwater oyster *B. stephanensis*, their shells covering the calcrete surface similarly to marine oyster reefs (Dame *et al.* 1984; Figure 1). The hard, rock-like calcrete was surrounded by consolidated, albeit softer, sediments from where the shells of many dead (some recently so) *M. soleniformis* were protruding. Specimens of the exposed bivalves were collected and are housed at the Mollusk Collection of the *Museu de Zoologia da Universidade de São Paulo* (MZUSP, lot number 168639), while additional photographic documentation taken on site and also showing soft parts, is available at iNaturalist (2025).

Similar spots with exposed calcrete ledges covered by dead freshwater oysters and harder sediment with half-exposed dead *Mycetopoda* were found along our trip. Exposed calcrete ledges covered by oysters could reach over 20 m long and over 3 m wide, either exposed parallel to the riverbank or perpendicular to it and forming a shallow rapid. Interestingly, no oysters were found attached to the numerous submerged trees or to the steel hull and boiler of a long sunken rubber boom-era steamboat also exposed not far from the area we investigated, showing the mollusks rely on the calcrete ledges.

The Brazilian National Water Agency (ANA) drought monitor indicated that Acre entered an increasingly serious drought from April 2024 onwards, the situation becoming

especially dire in August–October, when most of the state was in “exceptional” drought (ANA 2024). Data provided to the authors by the Tarauacá Civil Defence on the river gauge at the Tarauacá river just downstream from the confluence of the Muru show water levels were at a peak of 10.8 m on 29 February 2024 (the river breaks its banks when over 9.5 m) but in July–August 2024 (the height of the dry season) it ranged between 2.1 and 2.4 m. Upriver the Muru this translated as several stretches where the water was ankle-deep and oyster reefs growing below the regular dry season water level were exposed to desiccation and killed in a mass mortality event.

Marine oyster reefs are important habitats for other invertebrates and fish (Coen *et al.* 1999; Tolley and Volety 2005) but we can only speculate about the biogenic structures found at the Muru river and that, very likely, can be expected to be present in other rivers cutting through the former Lake Pebas deposits. These seem to be a river micro-habitat that went unreported (or unrecognized) until exposed by the 2024 drought and worth exploring for its associated fauna.

The Afrotropical Etheriidae *Etheria elliptica* (Lamarck, 1807) is abundant enough to support fisheries that leave shell mounds both in the archaeological and modern contexts and, in the upper Volta river basin, forms reefs so big as to impede



Figure 1. A - *Bartlettia stephanensis* reef growing over calcrete ledges across the Muru river bed, B - the boat and person aboard give an idea of the reef's size, C - a calcrete ledge covered by *B. stephanensis*, D - a close-up of the surface of the oyster reef in A, E - detail of a live *B. stephanensis*.

navigation during the low-water season (Ampofo-Yebowa 2014 and references therein). It remains to be found if *B. stephanensis* can ever reach such abundance.

Bartlettia stephanensis was once considered as “Vulnerable” by the Brazilian Red List (dos Santos *et al.* 2013) but is currently treated as “Data Deficient” (dos Santos *et al.* 2025) while considered “Near-threatened” by the IUCN Red List (Pastorino and Darrigan 2011). The finding of dense populations in the Muru river increases the species’ range and area of occupation and informs its threat assessment, but extreme floods and droughts fed by climate change and deforestation are becoming more common across the Amazon (Staal *et al.* 2020; Maciel *et al.* 2024; Marengo *et al.* 2024) and in Acre (Silva *et al.* 2023). These changes in the local hydrology not only increase the frequency of mortality events like the one we recorded but, likely, the recolonization of affected habitat patches (see Miyahira *et al.* 2022). It is probable the conservation status of *B. strephanensis* and other freshwater fauna so far considered as little threatened by human activities will need to be reassessed.

ACKNOWLEDGEMENTS

Antonio Evangelista took us safely in our trip up the Muru. Rita C. R. Souza had the patience to clean the specimens before their delivery to the Museu de Zoologia da Universidade de São Paulo - MZUSP. Dickson Fabio de Souza connected with the *Tarauacá Civil Defense*; Lt. Gonzales shared the data from the Tarauacá river gauge.

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RECEIVED: 19/01/2025

ACCEPTED: 06/10/2025

ASSOCIATE EDITOR: Bruno Spacek Godoy 

DATA AVAILABILITY: The data that support the findings of this study are published in this article.

AUTHOR CONTRIBUTIONS: **Fábio Olmos** - investigation, visualization, writing - original draft, writing - review & editing; **Gabriel Serwy Caram** - investigation, visualization, writing - original draft, writing - review & editing; **Pedro Bueno Rocha Campos** - investigation, visualization, writing - original draft.



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