

## *Caloglossa fluviatilis* (Delesseriaceae, Rhodophyta) from Bataan province, Luzon Island, Philippines, a new country record

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### Abstract

*Caloglossa fluviatilis* Kravesky, Fredericq & J.N.Norris is one of the least known freshwater algal species of its genus. It has been reported thus far from its type locality in Pedro Miguel, Republic of Panama, and Chalakkudy and Periyar Rivers in the State of Kerala, India. This study presents a new locality record of the species from Bataan province on the island of Luzon, Philippines. *Caloglossa fluviatilis* is characterised by having (1) a blade-like internodal region that is <1.0 mm, (2) moderate development of adventitious secondary branches at the node, and (3) fewer than eight rhizoidal filaments arising from pericentral cells at the node. Indeed, this Philippine population of *C. fluviatilis* has helped fill the gaps and extended the distribution of the species to the western Pacific region. Further studies and reassessment of freshwater *Caloglossa* specimens will contribute to further understanding of species of this little-known genus.

### Introduction

The Ceramiales is one of the eight orders in the class Florideophyceae of the phylum Rhodophyta with a handful of freshwater species (Vis and Necchi, 2021). One of its members, the genus *Caloglossa* (Harvey) G.Martens (Delesseriaceae, Ceramiales), is widespread in tropical to temperate mangrove, estuarine, and freshwater habitats. The genus comprises 22 currently accepted species (Guiry, 2022), and about six species have been documented in permanent freshwater streams. However, despite its widespread distribution, few morphological variations have been reported among its species, and some are occasionally difficult to distinguish morphologically. Recent phylogenetic analyses within *Caloglossa* re-examined its infraspecific classifications using molecular data and revealed some paraphyletic members (Kamiya et al., 2003; Kamiya and West, 2014; Kamiya et al., 2016; Freshwater et al., 2021). These studies successfully established the differences among *Caloglossa beccarii* (Zanardini) De Toni, *C. fluviatilis* Kravesky, Fredericq & J.N.Norris, *C. ogasawaraensis* Okamura and *C. stipitata* Post using various morphological characteristics and molecular data and led to the recognition of three new species, *C. fonticola* Fang, Nan, Feng, Liu, Liu & Xie; *C. kamiyana*

Freshwater, Cath.E.Miller & Frankovich, and *C. manaticola* Freshwater, Cath.E.Miller & Frankovich (Fang et al., 2021; Freshwater et al., 2021).

About six taxa of the genus *Caloglossa* have been described and documented in countries in Southeast Asia (Kamiya et al., 2003; Johnston et al., 2014; Kamiya and West, 2014; Kamiya et al., 2016; Chankaew et al., 2019). There have only been two reported *Caloglossa* in the Philippines, *C. ogasawaraensis* and *C. stipitata* (Kamiya and West, 2014; Kamiya et al., 2016). The former is generally a brackish water species but was reported in Taal Lake, a freshwater lake on the island of Luzon, purportedly a marine area previously connected to the nearby Balayan Bay until in 1754 when a series of volcanic eruptions constricted its connection to the sea and diverted Pansipit River, its only outlet to the sea, hence increasing the lake surface level to its current elevation which is 3 m above sea level (Hargrove, 1991; Willette et al., 2014). For both species, however, no voucher specimens were deposited in local herbaria, nor was any information or description available in the country. The insufficient knowledge of freshwater red algae in the Philippines is likely a product of several factors, including insufficient sampling efforts caused by inadequate interest and the lack of suitable habitats. Alteration of waterways, such as regime shifts, construction of dams, dredging, and environmental pollution, such as sewage disposal in natural freshwater bodies, can further reduce the occurrence of these algae.

A population of the freshwater red algae, *Caloglossa*, was collected from a forested stream in the Bataan province of Luzon Island, Philippines. The identity of the species is presented in this paper using its morphological characteristics as evidence.

## Materials and Methods

The specimens were collected on 06 June 2022 from the upper section of Mauban Creek, at 14°39'01.49"N, 120°19'05.06"E, near a waterfall in Barangay Nagbalayong, Municipality of Morong, Province of Bataan, on the island of Luzon, Philippines. The site is within a deep ravine at 67 m asl, surrounded by disturbed tropical lowland rainforest with a heavy litter layer on the forest floor. Portions of the specimens collected were preserved in 70% ethanol for identification and morphological characterisation. The remaining portions were dried for herbarium specimens as vouchers deposited in the herbaria of the University of the Philippines Los Baños (CAHUP) and the National Museum of the Philippines (PNH).

Samples of the collected materials were washed in tap water for a few minutes and mounted with 50% sugar syrup in distilled water with 10% formalin to highlight cytoplasmic content. These materials were examined under Amscope 20–80× Compact Multi-Lens Stereo Microscope and Harman XSZ-107BN Binocular Microscope and photographed using Amscope MU500 5MP USB Microscope Camera. Species identification was based on two collections. Species were determined using diagnostic morphological characters consulted from references (Krayesky et al., 2012; Kamiya et al., 2016).

## Results

Specimens were identified as *Caloglossa fluviatilis* Krayesky, Fredericq & J.N.Norris (Delesseriaceae, Rhodophyta), which is new to the freshwater algal flora of the Philippines and represents the first report of the species in Southeast Asia. Worth mentioning is that this new record represents an expansion of its current geographical range, which was previously known only from its type locality in Pedro Miguel, Republic of Panama, and in Kerala state, India.

***Caloglossa fluviatilis*** Krayesky, Fredericq & J.N.Norris, *Phycologia* 51(5): 523–525, figs 14–15 (2012).

Type: REPUBLIC OF PANAMA: Pedro Miguel, Pedro Miguel Lock, [08°59'46.42"N, 79°35'30.49"W], on the cement of western wall of upper western lock (freshwater), 5 May 1999, B.S. Wyszor 421 (holo: U.S. Alg. Type Coll. 217746; iso: LAF).

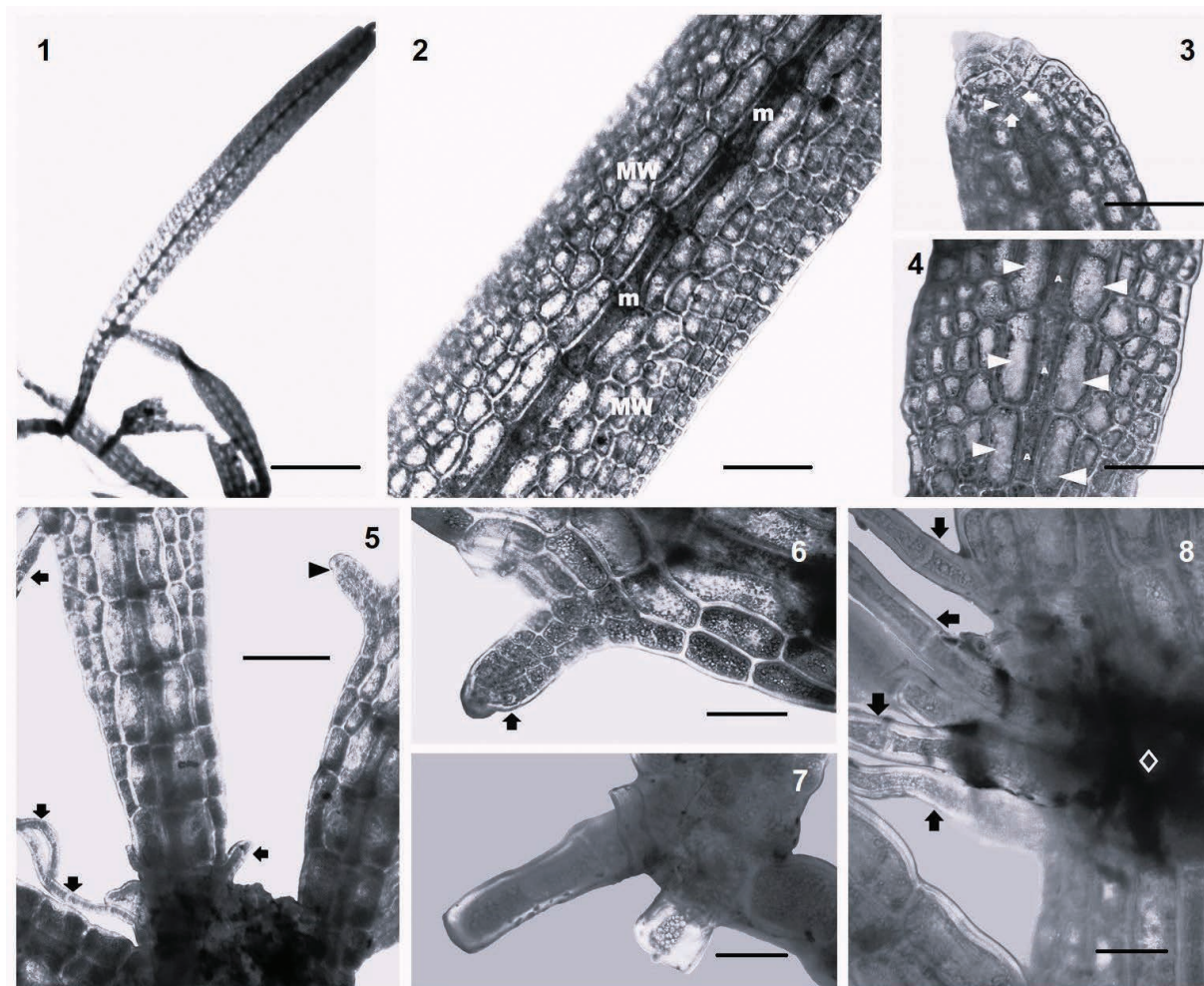
Thalli densely tufted, laminate, reddish to pale violet red, subdichotomously branching up to (0.5–)0.6–1.4 cm long, consisting of a midrib region with monostromatic wings on either side. The midrib region comprises two transverse and two lateral periaxial cells and one axial cell series. Blades narrowly lanceolate up to 2.0–6.0(–10.0) mm long and 0.7–1.2 mm wide at the median node region, becoming strongly constricted at nodes. Endogenous branching is absent. Adventitious branching is present. Both rhizoids and adjacent marginal wing cells are formed from the nodal periaxial cells. Basal rhizoidal cells are not tightly adherent to develop into a stipe-like cortical pad. Adaxial cell row derived from the first axial cell of the lateral axis is present. One cell row is derived from the nodal axial cell opposite the lateral branch, whereas two to four cell

rows are derived from the first axial cell of the main axis opposite the lateral branch. Reproductive structures not seen. (Figs 1–8)

**Specimens examined:** PHILIPPINES: Mauban Creek, Barangay Nagbalayong, Municipality of Morong, Province of Bataan, Luzon Island, freshwater stream, heavy shade, complex mixed rocky and muddy bottom, disturbed tropical lowland rain forest, 67 m asl, 14°39'01.49"N, 120°19'05.06"E, 06 June 2022, V.C. Linis & L.V. Vitug 5731-22 (CAHUP; PNH); *loc. cit.*, 06 June. 2022, V.C. Linis & L.V. Vitug 5732-22 (CAHUP; PNH).

**Habitat:** This population of *C. fluviatilis* was found in a single locality in Mauban Creek, Municipality of Morong, on the island of Luzon, Philippines, submerged in a forest stream with cool, clear flowing water, heavily shaded by the forest canopy above. The plant grew on rocks and cobbles on the stream bottom mixed with muddy sediments. The stream is in a shallow ravine surrounded by disturbed tropical lowland rainforest with several fallen tree trunks scattered along its banks.

**Distribution:** The species was only known from the type locality – Pedro Miguel, Republic of Panama; and Chalakkudy and Periyar Rivers in the State of Kerala, India; and now in Mauban Creek, Bataan Province, Luzon Island in the Philippines (a new record for Southeast Asia).



**Figs. 1–8.** Vegetative thalli of *Caloglossa fluviatilis* Krayesky, Fredericq & J.N.Norris. 1. Habit. 2. Internodal blade showing the midrib (m) and the monostromatic regions (MW). 3. Apex and distal node of the thallus. The vertical arrow points to the nodal axial cell. The horizontal arrow points to the first axial cell of the developing lateral axis. The arrowhead points to the first cell of the main axis. 4. Mature internodal blade showing the nodal axial cell (A). Six arrowheads point to the periaxial cells. 5. Thallus blade showing strong constriction at the node. Four arrows pointing to rhizoidal filaments. The arrowhead points to a juvenile adventitious branch. 6. Higher magnification of the thallus internodal blade margin. A vertical arrow points to a juvenile adventitious branch. 7. Rhizoidal nodes displaying the type F arrangement of Kamiya et al. (2003). Mound of cortical cells at the bases of rhizoidal filaments is absent. 8. Rhizoidal filaments (arrows) produced at the node. The nodal cell (diamond) is visible. All from V.C. Linis & L.V. Vitug 5731-22 (CAHUP). Scale bars: 1 = 2 mm; 2–4 = 100  $\mu$ m; 5–8 = 50  $\mu$ m.



**Etymology:** The species epithet *fluviatilis* (from the Latin ‘of the stream’) refers to the freshwater habitats where this species was initially collected.

**Taxonomic notes:** The genus *Caloglossa* is recognised by possessing (1) flat-dichotomously branched reddish blades with constrictions, (2) monostromatic blades at least at the outer portion composed of oblique series of hexagonal cells, (3) a prominent midrib composed of a broad axial row of cells surrounded by a cortex of elongated cells, and (4) rhizoids arising at constrictions, either from the midrib area or from the peripheral layer of cells (Sheath, 2003). This algal sample collected from Luzon Island, Philippines, also fits most closely the description of *Caloglossa fluviatilis*. Apart from being exclusively distributed in freshwater habitats, *C. fluviatilis* is distinctive in having (1) a thallus width at the internode region narrower than 1.0 mm, (2) moderate development of adventitious secondary branches at the node, and (3) fewer than eight rhizoidal filaments deriving from pericentral cells at the node (Kamiya et al., 2016).

*Caloglossa fluviatilis* can also easily be distinguished from *C. ogasawaraensis* in that the latter possesses “type E” rhizoid arrangements, which are produced on the ventral side of nodes with a single rhizoid originating from ventral and lateral pericentral cells of the node and those immediately above and below it, whereas *C. fluviatilis* has “type F” rhizoids, which are produced on the ventral side of nodes with mostly single, but sometimes multiple, rhizoids originating from nodal periaxial and adjacent marginal wing cells (Kamiya et al. 2003). In addition, *C. fluviatilis* has a median thallus blade up to 0.1–0.5 mm wide, a smaller range that does not overlap with that of *C. fluviatilis* (0.8–1.1 mm). Unlike *C. fluviatilis*, *C. ogasawaraensis* is not strongly constricted at the nodes.

Recently, a new *Caloglossa* species, *C. fonticola* Fang, Nan, Feng, Liu, Liu & Xie, has been documented from an underground spring in Bama County, Guangxi, China (Fang et al., 2021). *C. fonticola*, however, is morphologically distinguishable from *C. fluviatilis* and other *Caloglossa* species by a unique combination of character states, including (1) the possession of linear thallus internodal blades which are hardly or only slightly constricted at nodes, (2) absence of adventitious branches and endogenous branches, and (3) formation of unicellular rhizoids from clusters of wing cells arising from the first three axial cells of the main axis and lateral axis.

**Proposed IUCN Conservation Assessment:** Due to scant information regarding its geographic range, habitat, or habitat range, being known only in several localities globally, the algal collections presented herein satisfy criteria B2 and D of the IUCN Red List (IUCN Standards and Petitions Committee, 2019). Therefore, we propose considering *C. fluviatilis* as Critically Endangered (C.R.) in terms of its conservation status following Fernando et al. (2008).

In the Philippines, *C. fluviatilis* has a small population size (<50 mature individuals), and it is restricted to a single, small area on Luzon Island, relatively close to a human settlement. The population can be severely reduced or driven to extinction if not managed well due to habitat destruction or modification.

## Discussion

The specimens collected from the Philippines have extended the distributional range of *C. fluviatilis*, previously recorded from its type locality – Pedro Miguel, Republic of Panama, and in Chalakkudy and Periyar Rivers in the State of Kerala, India. Interestingly, the collection locality of the Philippine specimens is about 16,600 km away from the species’ type locality and about 4,950 km away from the State of Kerala in India, filling a gap in records and extending the distribution of *C. fluviatilis* to the western Pacific region.

These Philippine collections represent only the third report of *C. fluviatilis* worldwide. Its discovery in the Philippines has reinforced our suspicion that this species could be more widely distributed in freshwater habitats. Careful reassessment is needed for freshwater *Caloglossa* specimens like those we have presented in this study. A dichotomous key is provided here to highlight the diagnostic features amongst all species of *Caloglossa* documented in the Philippines.

### Key to the species of *Caloglossa* reported in the Philippines

1. Thallus width at the internode more than 1.0 mm in width; eight or more rhizoidal filaments derived from pericentral and wing cells at the node ..... ***C. stipitata***
- 1: Thallus width at the internode region less than 1.0 mm in width; usually fewer than eight rhizoidal filaments derived from pericentral cells at the node..... 2

2. Thallus blades strap-like and thallus nodes slightly constricted; more significant development of adventitious secondary branches at the node, giving an appearance of pinnate branching..... **C. ogasawaraensis**
- 2: Thallus blades lanceolate and thallus nodes strongly constricted; moderate development of adventitious secondary branches at the node ..... **C. fluviatilis**

### Acknowledgements

We want to thank CAHUP and PNH for providing materials for curating the specimens. We are indebted to Eugene Logatoc for providing us with short-term use of his private facilities and supplies for this project. In addition, we also like to thank Dr Carmen C. Tan and Jasmine Ting of De La Salle University Manila, and two reviewers for their helpful remarks on this manuscript.

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