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Morphological Study of *Coelastrum cambricum* from the Peat Water of Palangka Raya, Indonesia

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ABSTRACT

Coelastrum Nägeli 1849 is a genus of microalgae belonging to the scenedesmaceae family and currently has 31 taxonomically accepted species. *Coelastrum* can be found in the freshwater environment, e.g., in ditches, ponds, lakes, and swamps forming small colonies called coenobia. As no data records the description of this genus from the peat water environment, it is necessary to conduct a morphological study, especially the *Coelastrum cambricum* species which is commonly found in peat waters. Water samples were collected from peat waters in a ditch at the Bukit Keminting Road (Palangka Raya) near the Fisheries Department, University of Palangka Raya. Morphological examination of *Coelastrum cambricum* was carried out microscopically directly on the collected water samples and then photographed for further identification. *Coelastrum cambricum* was identified from the water samples collected from peat water at the sampling site. The peat water has a brownish color and looks fairly clear like brewed tea that allows enough sunlight to penetrate it. *C. cambricum* forming a spherical coenobium consisting of 4-32 cells and appear green in color and it is observed that coenobium groups form larger colonies consisting of 4 to 24 coenobia. The diameter of coenobia ranges from 40-62µm. In this study also observed the distinctive morphological characteristics of *C. cambricum* where 6 cells were observed in the center of the coenobium forming a pentagonal pattern that looked the same in all specimens observed. This characteristic has the potential to be studied further as a key feature of *Coelastrum* species identification.

Keywords: Chlorophyceae, Coelastrum cambricum, microalgae, peat water, phytoplankton

Introduction

Coelastrum Nägeli 1849 is a genus of microalgae belonging to the scenedesmaceae family and currently has 31 taxonomically accepted species based on data in AlgaeBase (Guiry & Guiry, 2013). This genus is widely distributed in the aquatic environment around the world including freshwater and marine (Guiry & Guiry, 2013; Shubert, 2003; Lukavský, 2006). *Coelastrum* is a non-motile green microalgae and lives in small colonies called coenobia which usually each coenobium consists of an even number of cells ranging from 4-32 cells or even more (Guiry & Guiry, 2013; Yu & Wong, 1975; Morris et al., 1973; Hindak, 1987). Many research results reveal descriptions of microalgae species from the genus *Coelastrum*, such as descriptions of morphological ultrastructure (Yu & Wong, 1975; Comas & Krienitz, 1997), nutritional properties (Lynch et al., 1967; Figler et al., 2021), and its potential role in human life and the ecosystems, in addition to its role as a producer in the ecosystem because of its autotrophic nature, such as biofuel production (Liu et al., 2013; Valdez-Ojeda et al., 2021; Mousavi et al., 2018; Das et al., 2021), wastewater treatments (Adeyinka et al., 2020; Mousavi et al., 2018), and bioremediation (Das et al., 2021;

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Sutherland & Ralph, 2019). Until now, there is no scientific data related to the specific description of *Coelastrum* from peat waters, not even preliminary data regarding the description of its morphological characteristics, although many research results have revealed the diversity of microalgae from peat waters, especially in Central Kalimantan, Indonesia.

Morphological characteristics are important in the identification of microalgae species because each species has its distinctive characteristics in terms of morphology including the group of microalgae that live to form coenobia (Kruk et al., 2010; Adam, 2022). Each species of microalgae that make up coenobia has differences in cell shape, arrangement pattern, and the number of constituent cells, especially *Coelastrum* Nägeli 1849, and this is one of the important morphological parameters in their identification (Lukavský, 2006; Chan, 1976; Richter & Schiller, 2012). *Coelastrum pascheri* is similar to *Coelastrum morus* but differs in significantly smaller cell size and the number of cells in a coenobium (Lukavský, 2006). *C. pascheri* only has 4-8 cells in a coebium similar to *C. microporum* which is a much less cell count range than other *Coelastrum* species like *C. morus*, *C. sphaericum,* and *C. cambricum* which have 4-32 cells (Lukavský, 2006; Kim, 2013). As there is no data that records the description of this genus from the peat water environment and by considering its potential, it is necessary to conduct a morphological study, especially the *Coelastrum cambricum* species which is commonly found in peat waters.

Material and Methods

Study site and sample collection

This study was conducted in Palangka Raya, Central Kalimantan, Indonesia, from December 2021 to January 2022. Water samples were collected from peat waters in a ditch at the Bukit Keminting Road (Palangka Raya) near the Fisheries Department, University of Palangka Raya (Figure 1), using plastic sample bottles.

Physico-chemical parameter measurement

Physico-chemical parameters measured in this study are Temperature (T), Potential Hydrogen (pH), and Total Dissolved Solids (TDS). The following Table 1 shows the physicochemical parameter measurement methods in detail.

Table 1. Physico-chemical Parameter Measurement Methods

No.	Physico-chemical Parameters	Methods/Instruments
1	Temperature (T)	Water Thermometer
2	Potential of Hydrogen (pH)	NESCO® pH Test Paper
3	Total Dissolved Solids (TDS)	TDS Meter

Morphological examination

Morphological examination of *Coelastrum cambricum* was carried out microscopically using an Olympus CX21 binocular microscope directly on the collected water samples. The magnification used in this observation is 100× (10× Ocular; 10× Objective) and 400× (10× Ocular; 40× Objective) magnifications where the morphology of *C. cambricum* cells is visible and then photographed for further identification. Parameters observed were cell arrangement in coenobium as the distinctive characteristics and cell dimensions. Estimation of the dimensions of *C. cambricum* cells was carried out by calculating the ratio of the object to the diameter of the field of view at a certain magnification (Adam, 2022).

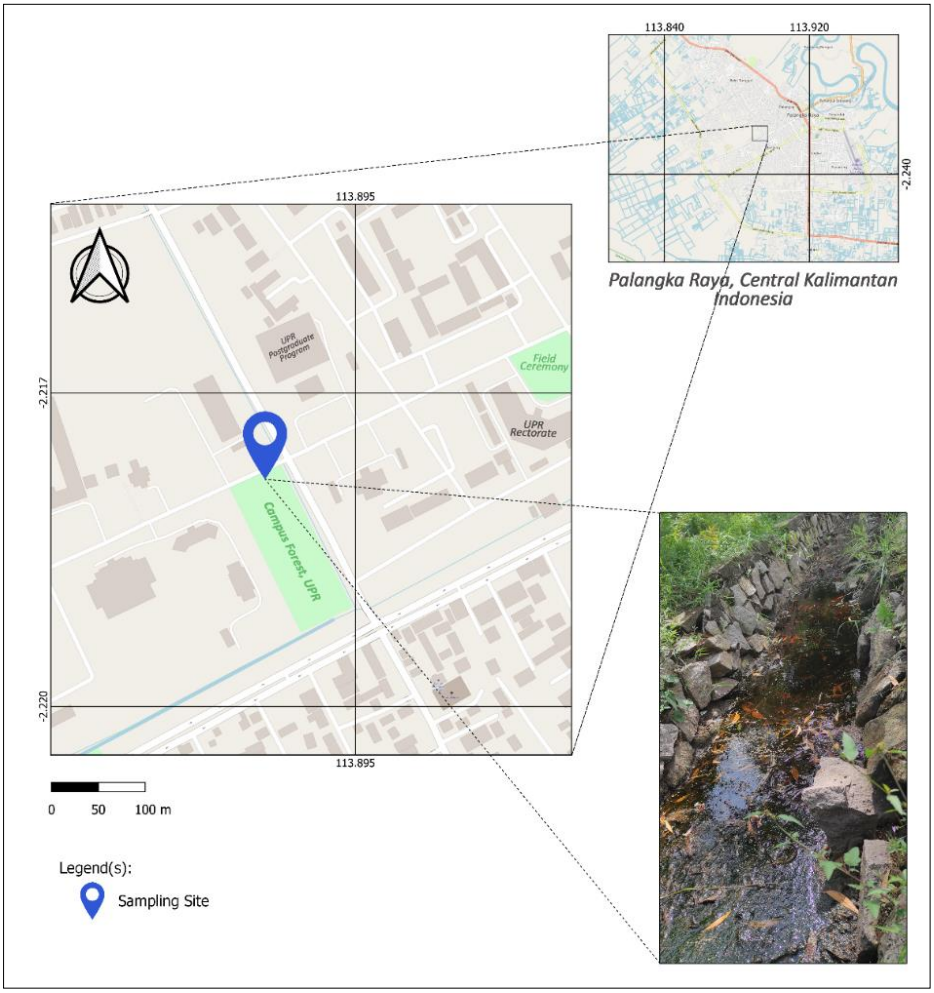

Figure 1. Research map

Results and Discussion

Habitat characteristics

Coelastrum cambricum was identified from the water samples collected from peat water at the sampling site. The peat water has a brownish color and looks fairly clear like brewed tea that allows enough sunlight to penetrate it. The depth ranges from 30-50 cm and there is a lot of leaf litter on the surface because on the sides of the trench there are lots of *Acacia* trees that are shedding their leaves. Measurements of physicochemical parameters show that peat water has a temperature (T) of 31.4˚C, a potential of Hydrogen (pH) 5, and total dissolved solids (TDS) of 13ppm (Figure 2).

The characteristics of peat water from the research location are following the characteristics of peat water that have been described in several previously published works. The color of peat water usually appears in blackish brown color, has an acidity range between pH 3-5 and the organic matter content is relatively high (Suhendra, 2008; Syafalni et al., 2013). The high levels of acidity and organic material of peat water depend on its region and vegetation types (Huling et al., 2001). The vegetation along the peat water ditch in this study consisted of *Acacia* trees shedding their leaves and grass growing into the peat water. This state of vegetation probably contributes to most of the organic matter in the peat water at the study site to support the growth of microalgae in it including *C. cambricum*.

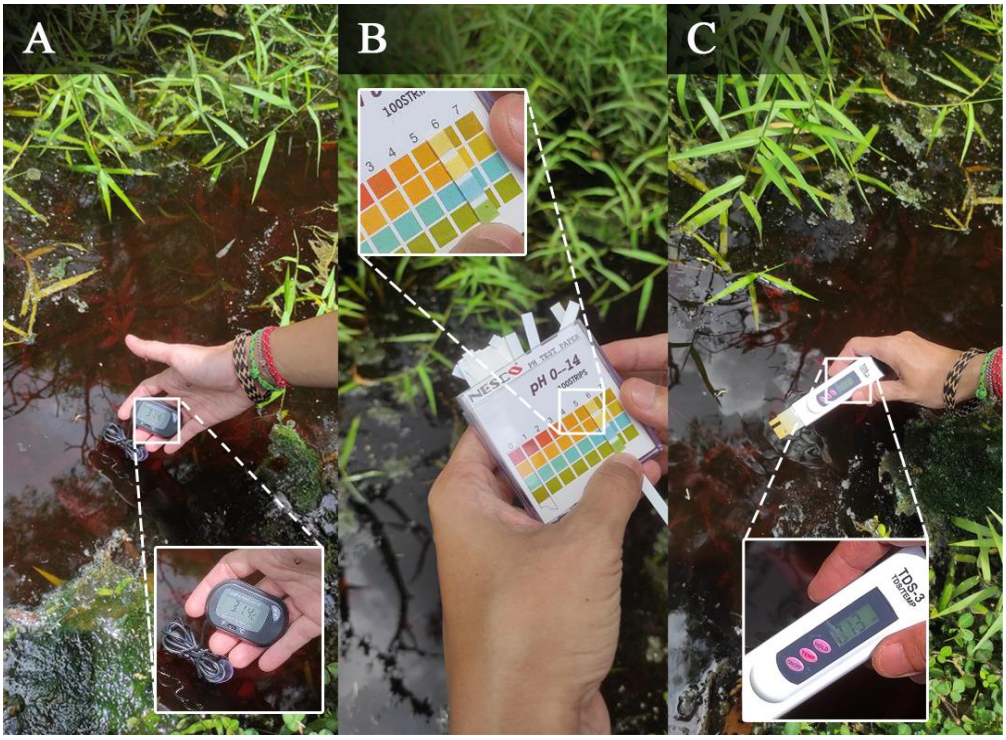

Figure 2. Physico-chemical parameters of peat water measurement: (A) Temperature; (B) pH; and (C) Total dissolved solids

Morphological features

Coelastrum cambricum forms a spherical coenobium consisting of 4-32 cells and appear green in color and it is observed that coenobium groups form larger colonies consisting of 4 to 24 coenobia (Figure 3A-B). The diameter of coenobia ranges from 40-62µm.

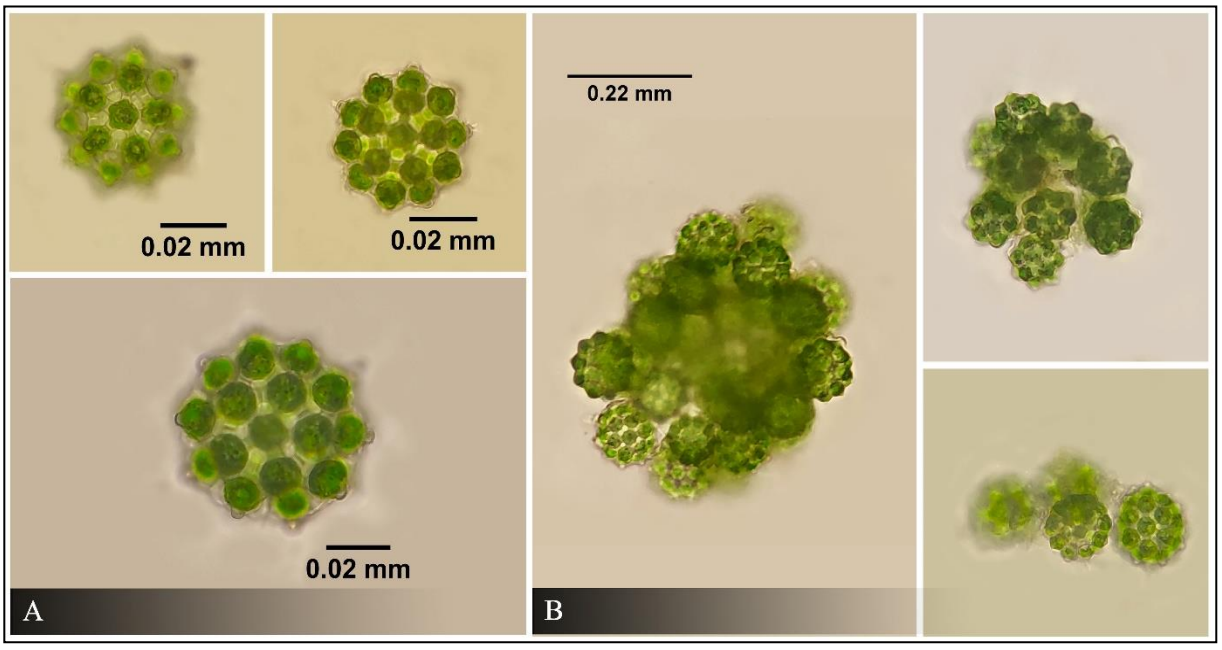

Figure 3. *Coelastrum cambricum*: (A) Coenobia; and (B) Larger colonies consisting of 4-24 coenobia

C. cambricum cells are joined together forming a coenobium by a certain gelatinous substance (Figure 4). A gelatinous substance that binds the cells of a coenobium appears colorless but visible at 400× magnification. The gelatinous substance is composed of collagen in the form of protein-type cellulose fibrils and has various roles in the survival of microalgae. The main function of a gelatinous substance is to regulate the locomotion of cells, retain colonies, and plays an intermediate role in symbiotic association for cell-cell communication (Watanabe et al., 2006). Lange (1976) stated that the level of substance thickness in the cell sheath is associated with the content of essential nutrients in the environment surrounding the microalgae. The gelatinous sheath will remain thick if organic matter as an important nutrient is available because it is not attacked by bacteria associated with algae. These bacteria tend to attack the gelatinous layer on the microalgae cell envelope if there is no other organic material that can be assimilated.

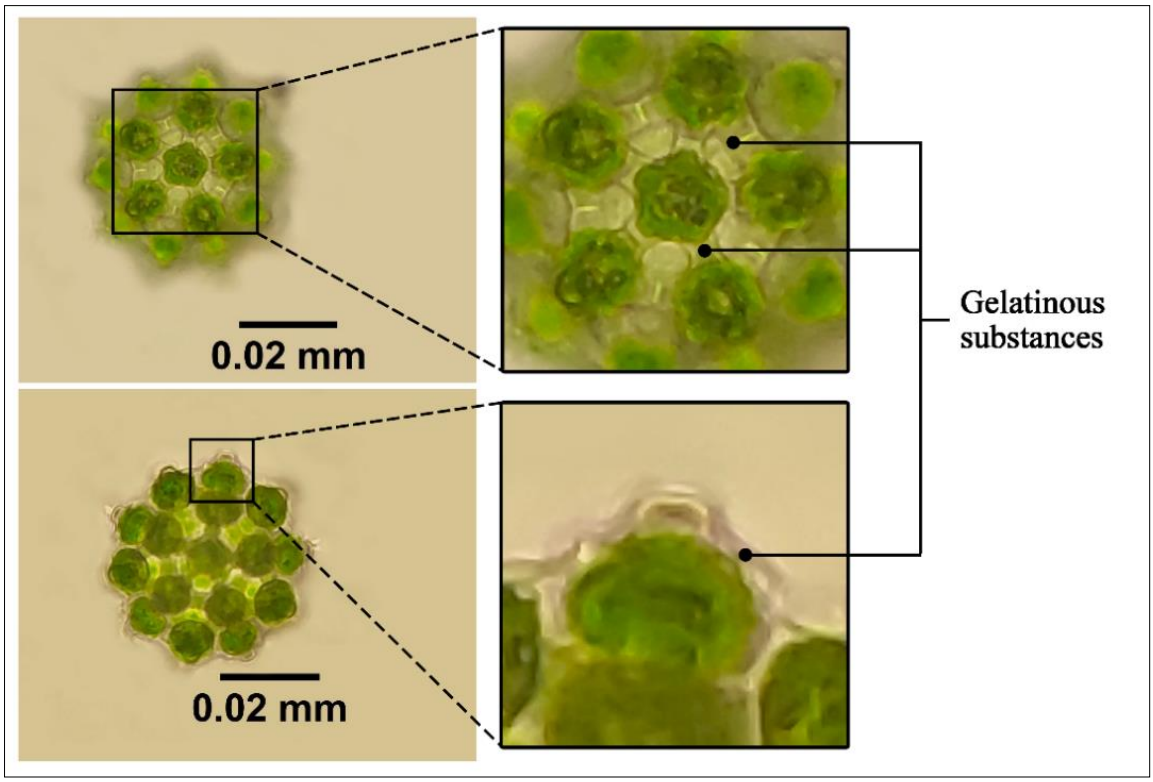

Figure 4. A certain gelatinous substance that binds the cells of the coenobium together

Cells are spherical ranging between 6-21µm in diameter with large blunt rounded processes toward the outer face of the external cells and covered with a delicate gelatinous sheath. The intercellular space formed in the coenobium is triangular and it is also observed that some are slightly narrow. Figure 5 shows a close-up view of each cell in a different position with the shape of the intercellular space.

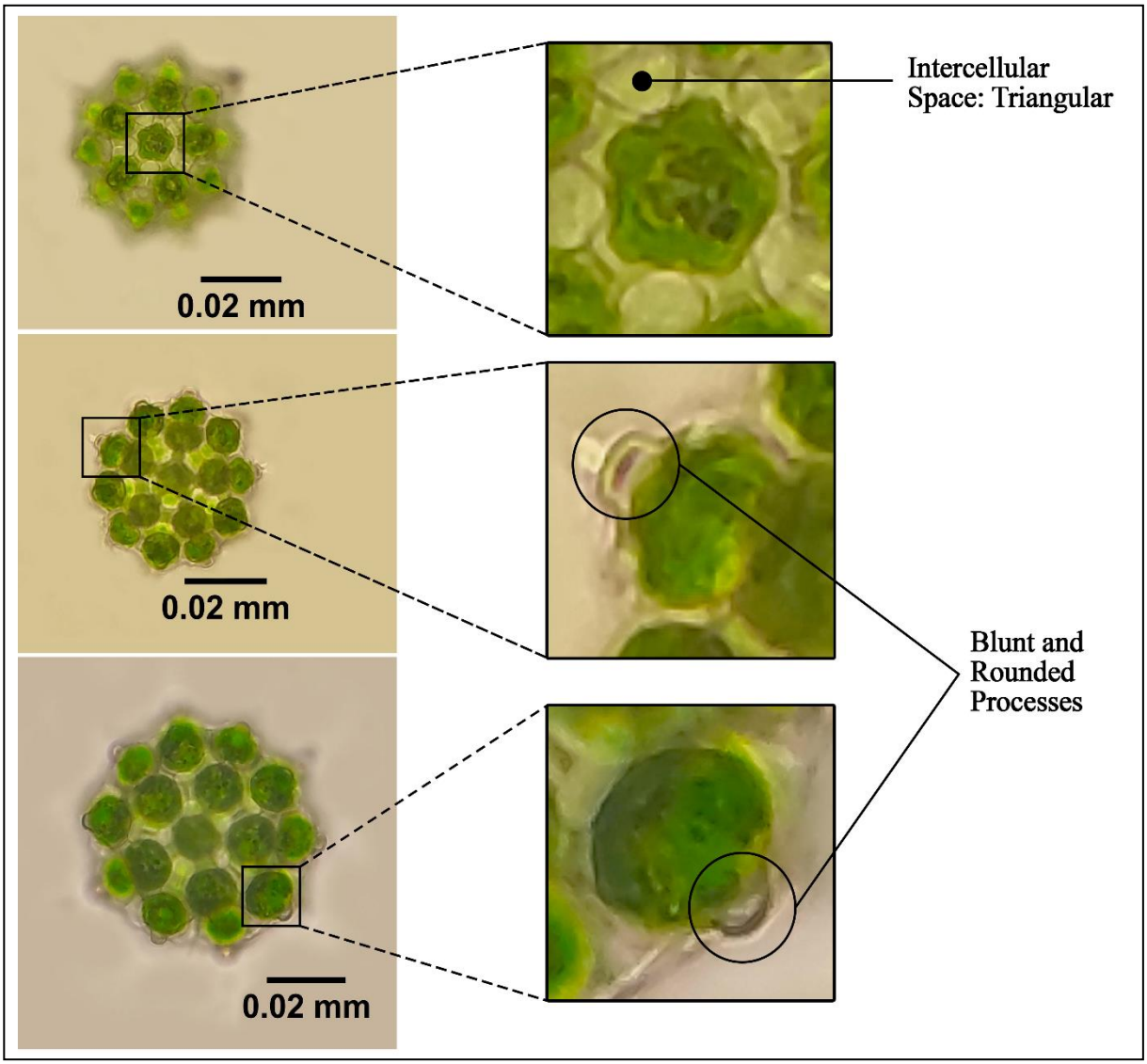

Figure 5. Cell morphology of *C. cambricum* at different positions in a coenobium

This study also observed the distinctive morphological characteristics of *C. cambricum* where 6 cells were observed in the center of the coenobium forming a pentagonal pattern that looked the same in all specimens observed (Figure 6). This characteristic has the potential to be studied further as a key feature of *Coelastrum* species identification.

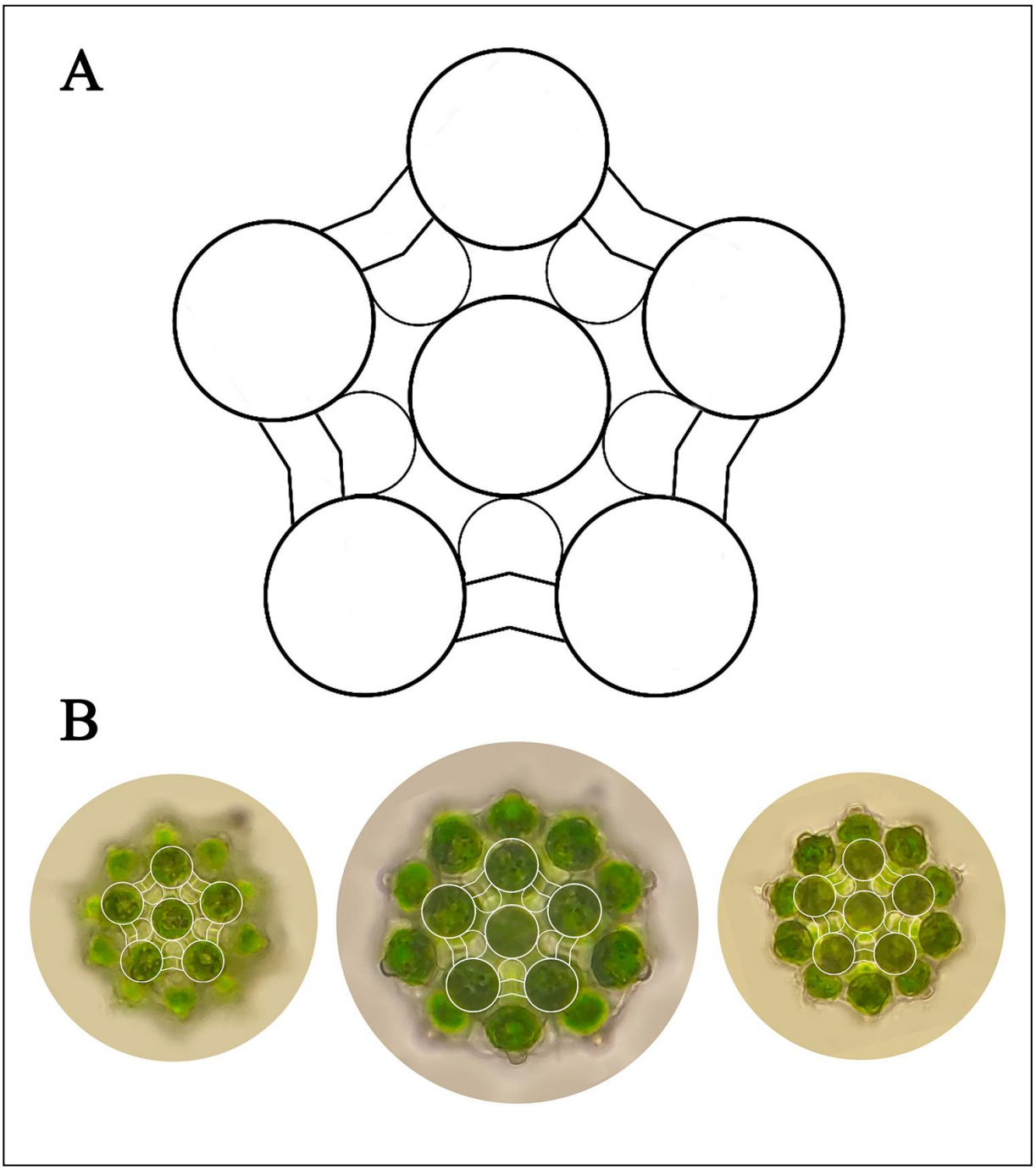

Figure 6. The pentagonal pattern: Distinctive morphological characteristic of *C. cambricum*: (A) Redrawn pentagonal pattern; and (B) The pattern matches the coenobia

Conclusion

This study revealed a preliminary report regarding the descriptions of *Coelastrum cambricum* from the pear water of Palangka Raya, Indonesia. *C. cambricum* forming a spherical coenobium consisting of 4-32 cells and appear green in color and it is observed that coenobium groups form larger colonies consisting of 4 to 24 coenobia. The diameter of coenobia ranges from 40-62µm. This study also observed the distinctive morphological characteristics of *C. cambricum* where 6 cells were observed in the center of the coenobium forming a pentagonal pattern that looked the

same in all specimens observed. This characteristic has the potential to be studied further as a key feature of *Coelastrum* species identification.

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