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*Short Communication*

# Preliminary Exploration of Cyanobacteria in Peat Waters, Palangka Raya, Central Kalimantan, Indonesia

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**Abstract.** Cyanobacteria were formerly known as blue-green algae and are currently considered algae-like Gram-negative bacteria belonging to the bacterial kingdom. Lack of scientific information on the presence and distribution of cyanobacteria species in peat water habitats, particularly in Central Kalimantan, Indonesia, which has extensive peat waters. This study aims to conduct a preliminary exploration as an initial action for further research on the diversity and distribution of cyanobacteria species in peat water ecosystems. The results of the study reported that 5 species of cyanobacteria were found to be present in the peat water habitat in Palangka Raya, Central Kalimantan, Indonesia, belonging to the orders Chroococcales, Oscillatoriales, and Synechococcales. The cyanobacteria species found in this study include *Microcystis* sp., *Chroococcus* sp., *Oscillatoria* sp., *Arthrospira* sp., and *Pseudanabaena* sp. These findings indicate that further research needs to be carried out to explore, identify and isolate cyanobacteria from peat waters to obtain more detailed and clear data as a basis for optimizing the potential and benefits of cyanobacteria for sustainable life.

**Keywords:** Blue-Green Algae, Cyanobacteria, Microalgae, Peat Waters, Phytoplankton



## 1. Introduction

Cyanobacteria were formerly known as blue-green algae and are currently considered algae-like Gram-negative bacteria belonging to the bacterial kingdom (Cymbaluk, 2013; R. E. Lee, 2008; Percival & Williams, 2014; Whitton & Potts, 2002). They are photosynthetic microorganisms and occur widely in various types of environments from aquatic to terrestrial habitats (Shukla et al., 2023; Vincent, 2009). In aquatic habitats, cyanobacteria can be found in form of unicellular, colonial, or filamentous and they act as phytoplankton like most aquatic microalgae (R. E. Lee, 2008; Whitton, 2012). In terrestrial habitats, cyanobacteria live as cyanobionts associated with lichens (Ranković & Kosanić, 2021). According to AlgaeBase (Guiry & Guiry, 2022), 5,316 cyanobacteria species are currently accepted taxonomically.

Although cyanobacteria are the main cause of Harmful Algal Bloom (HAB) and produce potent toxins that can harm the survival of other aquatic organisms (Catherine et al., 2013; Heisler et al., 2008), they have been widely cultivated because of their high nutritional content such as *Arthrospira platensis* that commercially known as *Spirulina*. *A. platensis* has a high protein content ranging from 50-77% (Khandual et al., 2021; Michalak et al., 2020; Seghiri et al., 2019), thus making the species a potential source of healthy food supplements.

Several studies related to phytoplankton diversity have been carried out in peat waters, but they only provide information on eukaryotic phytoplankton (Adam, 2022). To date, scientific information regarding the presence and distribution of cyanobacteria species in peat water habitats remains unclear, particularly in Central Kalimantan, Indonesia, which has extensive peat waters. The vast peat waters are thought to have high biological resources including the diversity of cyanobacteria and other beneficial organisms. Taking into account this urgency, a preliminary study needs to be carried out.

This study aims to conduct a preliminary exploration as an initial action for further research on the diversity and distribution of cyanobacteria species in peat water ecosystems.

## 2. Methods

*Study Site and Sample Collection*

This study is a preliminary study to explore the occurrence of cyanobacteria in peat water habitat, Palangka Raya, Central Kalimantan, Indonesia. Water samples were collected directly from the small peat water stream which is the sampling location for this study.

*Cyanobacteria Observation and Identification*

Microscopic observations were made on the samples using Olympus CX21 starting at low magnification (40× and 100×) which provides a wide viewing area for sample exploration. High magnification (400×) is used when specimens of suspected cyanobacteria are found, and then photographed for further identification. The morphotaxonomic approach was used in the identification of cyanobacteria based on the observed morphological characteristics. The following published works were used to guide the identification of cyanobacteria: R. E. Lee (2008), Nienaber & Steinitz-Kannan (2018), and Rosen & St. Amand (2015).

## 3. Results And Discussion

This study reported that 5 species of cyanobacteria were found to be present in the peat water habitat in Palangka Raya, Central Kalimantan, Indonesia, belonging to the orders Chroococcales, Oscillatoriales, and Synechococcales. The cyanobacteria species found in this study include *Microcystis* sp., *Chroococcus* sp., *Oscillatoria* sp., *Arthrospira* sp., and *Pseudanabaena* (Figure 1). They are found in spheroid colonial forms or filamentous and covered by a sheath on the outer part of the cells (Figure 2). There are generally two types of the sheath covering cyanobacteria cells, namely mucilaginous sheath (composed of cellulose fibrils) and gelatinous sheath (composed of collagen fibrils) (Gaysina et al., 2019; Leak, 1967; Nicoletti, 2022; Sand-Jensen, 2014).

The following presents the dichotomous keys to the main orders and genera of cyanobacteria found in this preliminary exploration.

Key to the main orders and genera of cyanobacteria from the peat waters

1. (a) Unicellular or spheroid colonies ........................ Chroococcales (2)
   (b) Filamentous ........................ (3)
2. (a) Small Colonies (4-32 cells) ........................ ***Chroococcus* (Fig. 2B)**
   (b) Large solid spherical colonies ........................ ***Microcystis* (Fig. 2A)**
3. (a) Elongated filaments ........................ Oscillatoriales (4)
   (b) Filaments with conspicuous constrictions at cross-walls consisting of cylindrical cells ........................ Synechococcales: ***Pseudanabaena* (Fig. 2E)**
4. (a) Elongated straight filaments ........................ ***Oscillatoria* (Fig. 2C)**
   (b) Elongated spiral filaments ........................ ***Arthrospira* (Fig. 2D)**

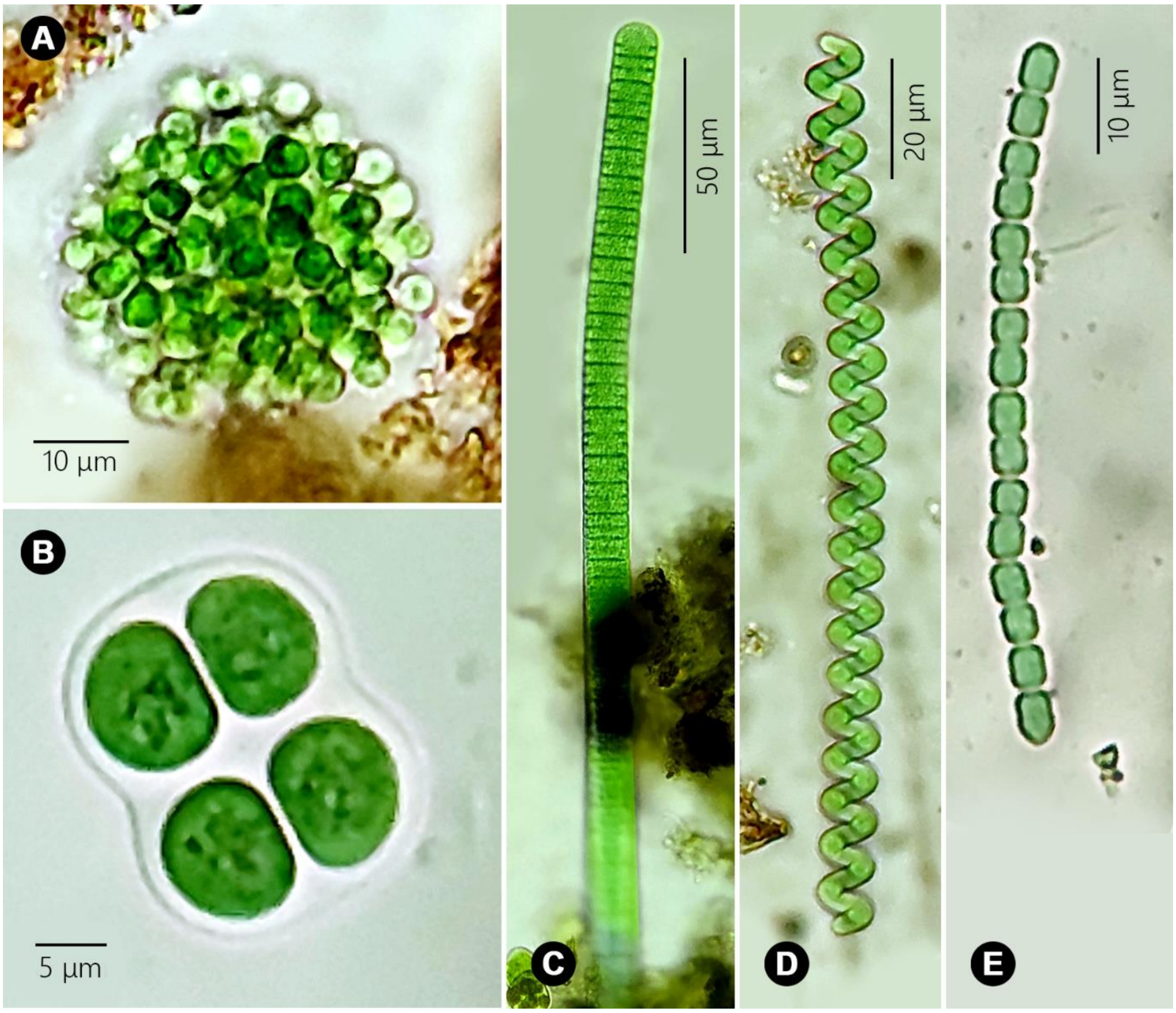


**Figure 1.** Cyanobacterial species found in this study: (A) *Microcystis* sp.; (B) *Chroococcus* sp.; (C) *Oscillatoria* sp.; (D) *Arthrospira* sp.; and (E) *Pseudanabaena* sp.

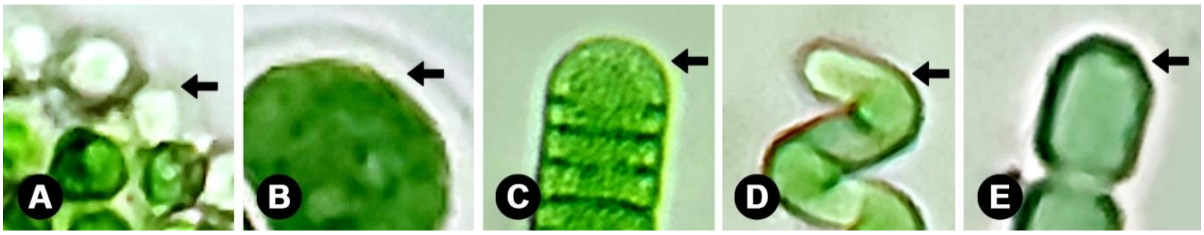


**Figure 2.** The sheath covering the cyanobacteria cells: (A) *Microcystis* sp.; (B) *Chroococcus* sp.; (C) *Oscillatoria* sp.; (D) *Arthrospira* sp.; and (E) *Pseudanabaena* sp.

Chroococcales

Chroococcales are the order of spheroid unicellular or colonies and typically lack specialized vegetative, resistant or reproductive cells (R. E. Lee, 2008). Currently, there are 664 species of cyanobacteria belonging to the order Chroococcales that are accepted taxonomically (Guiry & Guiry, 2022). Two species of Chroococcales found in this study include *Microcystis* sp. (Microcystaceae) and *Chroococcus* sp. (Chroococcaceae). ***Microcystis* sp.** were observed in colonial forms consisting of spherical cells (Figure 1A). They are found to form large spherical colonies and cover ered with gelatinous sheaths. The diameter of the *Microcystis* colonies ranges between 40 µm to 3 mm and Each cell ranges between 2-7 µm in diameter (H. Lee et al., 2021). *Microcystis* is a genus of cyanobacteria commonly known as the cause of Harmful Algal Bloom in freshwater ecosystems, i.e., *Microcystis aeruginosa* can grow excessively to cover the surface of the water under certain conditions (D'ors et al., 2013). *M. aeruginosa* can produce cyanotoxins that can cause acute to chronic hepatotoxicity and cellular damage (McLellan & Manderville, 2017; Qu et al., 2018; Vincent, 2009). ***Chroococcus* sp.** was observed in small colonies consisting of spherical cells (Figure 1B). Each cell in the colony is covered in a different sheath which can be regenerated after each cell division producing a multi-layered sheath. *Chroococcus* can occur in a group of 2-16 cells (Komárek & Johansen, 2015a; R. E. Lee, 2008) consisting of cells with a diameter of 2-58 m (R. E. Lee, 2008).

**Taxonomic Enumeration**

Phylum Cyanobacteria
  Class Cyanophyceae
    Order Chroococcales
      Family Microcystaceae
        Chroococcaceae
          Genus *Microcystis* **Lemmermann, 1907**
            *Chroococcus* **Nägeli, 1849**

Oscillatoriales

Oscillatoriales are the order of filamentous cyanobacteria with elongated straight or spiral filaments lacking heterocysts and akinetes (R. E. Lee, 2008). Currently, there are 1,045 species of cyanobacteria belonging to the order Oscillatoriales that are accepted taxonomically (Guiry & Guiry, 2022). Two species of Osciallatoriales found in this study include *Oscillatoria* sp. (Oscillatoriaceae) and *Arthrospira* sp. (Microcoleaceae). ***Oscillatoria* sp.** were observed in the form of unbranched elongated straight filaments (Figure 1C). The filaments of *Oscillatoria* sp. are consisted of coin-like or discoid cells with 2-8 µm in length and up to 25 µm in width (Komárek & Johansen, 2015b). *Oscillatoria* is also known to be a genus of cyanobacteria that can cause Harmful Algal Bloom (HAB) due to its ability to grow excessively and produce neurotoxins under certain conditions (Solter & Beasley, 2002). ***Arthrospira* sp.** were observed in form of unbranched elongated spiral filaments composed of individual cells (Figure 1D). The individual cell is about 8 µm in diameter (Masojídek & Torzillo, 2014). *Arthrospira* sp. is widely cultivated as a source of healthy dietary supplements due to its high nutritional content such as vitamin B12, minerals, proteins, lipids, carbohydrates, and carotenoids (Borowitzka, 2018; Ho et al., 2013; Sarkar et al., 2022). In addition, *Arthrospira* sp. is capable to reduce inflammation and also has an antioxidant effect (Ho et al., 2013; E. H. Lee et al., 2008).

*Oscillatoria* sp. and *Arthrospira* sp. both are motile cyanobacteria that have unique locomotion mechanisms. For instance, *Oscillatoria* sp. shows oscillating movement in which the filament can slide back and forth to direct the colony towards a light source (Dodd, 1960; Gupta & Agrawal, 2006; Halfen & Castenholz, 1971; Witty, 2009), whereas *Arthrospira* sp. shows helical gliding movement (Chaiyasitdhi et al., 2018).

**Taxonomic Enumeration**

Phylum Cyanobacteria

Class Cyanophyceae

Order Oscillatoriales

Family Oscillatoriaceae

Microcoleaceae

Genus *Oscillatoria* **Vaucher ex Gomont, 1892**

*Arthrospira* **Sitzenberger ex Gomont, 1892**

Synechococcales

Synechococcales are the order of cyanobacteria that includes coccoid and filamentous species. Currently, there are 1,003 species of cyanobacteria belonging to the order Synechococcales that are accepted taxonomically (Guiry & Guiry, 2022). *Pseudanabaena* sp. (Pseudanabaenaceae) is the only species of synechococcales found in this study. ***Pseudanabaena* sp.** were observed in the form of unbranched filaments with conspicuous constrictions at cross-walls consisting of cylindrical cells (Figure 1E). The cell size ranges from 1.6 to 2.0 µm in width and from 2.0 to 2.5 µm in length (Sorokovikova et al., 2008). *Pseudanabaena* sp. is also known as a common and harmful species in freshwater cyanobacteria blooms (Gao et al., 2018).

**Taxonomic Enumeration**

Phylum Cyanobacteria

Class Cyanophyceae

Order Synechococcales

Family Pseudanabaenaceae

Genus *Pseudanabaena* **Lauterborn, 1915**

## 4. Conclusion

The results of the study reported that 5 species of cyanobacteria were found to be present in the peat water habitat in Palangka Raya, Central Kalimantan, Indonesia, belonging to the orders Chroococcales, Oscillatoriales, and Synechococcales. The cyanobacteria species found in this study include *Microcystis* sp., *Chroococcus* sp., *Oscillatoria* sp., *Arthrospira* sp., and *Pseudanabaena* sp. These findings indicate that further research needs to be carried out to explore, identify and isolate cyanobacteria from peat waters to obtain more detailed and clear data as a basis for optimizing the potential and benefits of cyanobacteria for sustainable life.

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