

First record of *Pseudosphaerocystis lacustris* (Lemmermann) Nováková (Chlamydomonadales, Palmellopsidaceae) in Nepal

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Abstract. Algal samples were collected from slow-running water from the paddy field of Pokhara, Kaski District, Nepal, on January 3, 2021, and stored in air-tight plastic bottles. The samples were brought to the Cryptogams section (Algae) of National Herbarium and Plant Laboratories, Godawari, Lalitpur. Microphotography was done by using a HumaScope LED microscope with attached 0.5X adapter. The Herbarium specimens, as well as the permanent slide of the samples, were also prepared. Morphological characters viz., the colony with the number of cells in the group, position of pyrenoids, and shape of chloroplast were used for the identification. The result, which includes morpho-taxonomic depiction, showed that the above-expressed taxon was recorded for the first time from Nepal. Dimensions and photographs are also provided. There is hardly any substantial research work on taxonomic studies of family Palmellopsidaceae in Nepal. So to fill this gap, the present work was designed which help to the diversity increment of the freshwater green alga of Nepal. This article describes the morphological characteristics of the freshwater green macro-algae *Pseudosphaerocystis lacustris* belonging to the family Palmellopsidaceae of the class Chlorophyceae.

Keywords: Green algae, Morpho-taxonomy, New record, Nepal, Palmellopsidaceae

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1. Introduction

The literature revealed that the largest division of the algae in Nepal is the Chlorophyta. Previously, the eminent explorations of Chlorophycean algal flora have been depicted by Japanese workers Hirano (1984), including 79 species of desmids. Similarly, Watanabe (1982) have reported 24 species of *Closterium* from Dudh pokhari and Dudh Koshi River in Eastern Nepal. The Eastern part of the country is more explored than other western and central parts of the country. In a recent period (after 2000), Takeuchi et al. (2009) have recorded 3 Chlorophyta from the AXO10 glacier. Likewise, in Nepal, the detailed investigation of algae has been carried out by Rai (2006, 2009), Rai and Misra (2008, 2010), and Rai et al. (2008) and reported 179 Chlorophyta species; Paudel (2007), Adhikari (2010), Udas (2010), Godar and Rai (2018), Rai and Poudel (2019). Paudel (2017) added nine new taxa on desmids from Ramwell-Rhino Lake, Chitwan from the total 21 taxa. The extensive exploration all through the country is still to be completed. Algal's exploration in Nepal carried out by Rai and Ghimire (2020) revealed that the total alga reported from Nepal is 986.

There are various genera of green algae (Chlorophyta) living in freshwater habitats. *Pseudosphaerocystis* Woronichin has a place with Chlorophyta, Chlorophyceae, Chlamydomonadales, Palmellopsidaceae. Cells spherical or ellipsoidal, often wider than long, and often in pairs with the anterior end facing; in groups of 2 to 32 embedded in a thick and ordinary mucilaginous, hyaline and structureless envelope forming small free-floating colonies, infrequently furnished with two long pseudocilia; chloroplast cup-

shaped, with a basal pyrenoid; eyespot present or absent; contractile vacuoles 2 in the cytoplasm; cells usually closely paired with anterior ends containing contractile vacuoles facing each other; asexual reproduction by autospores and biflagellate zoospores (John et al., 2002; Pentecost, 2011).

The genus *Pseudosphaerocystis* consists of 4 species [*P. indica* M.O.P.Iyengar, *P. lacustris* (Lemmermann) Nováková, *P. lundii* (Bourrelly) Bourrelly, *P. neglecta* (Teiling) Bourrelly] (Guiry and Guiry, 2021) including *Pseudosphaerocystis lacustris*, the type (holotype) of the genus. Species are distinguished based on details of chloroplast and pyrenoid morphology. *P. indica*, described by Madras regarded as an uncertain member of the genus by Ettl and Gartner (1988). *Pseudosphaerocystis* is distributed in Europe and India and frequent in the plankton of moderately nutrient-rich lakes and less common in nutrient-poor waters. *Pseudosphaerocystis* differs from other genera of the *Tetraspora* by the paired cells are often united into subgroups of 4 or 8, the opposing cell pairs, presence of contractile vacuoles, and unstratified mucilage. The *T. cylindrica* was reported in 1983 (Shrestha and Manandhar, 1983), since when there were no reports on freshwater *Tetraspora* species again in Nepal.

Previously, very few studies have been carried out on the algal flora of Pokhara valley (Rai, 2000; Maeda and Ichimura, 2007). In any case, the work that has been done in the documentation of algal flora in Nepal is not adequate. To date, the literature records suggest that *Pseudosphaerocystis lacustris* occurs on almost all continents indicates its possibly cosmopolitan character (Guiry and Guiry 2021). The record of this species in Nepal presented here is treated as preliminary and will be supplemented in the future by a more detailed study of the subject. Along these lines, in this, we give the first record of *P. lacustris* in Nepal.

2. Materials and methods

2.1. Study area

Pokhara is the second-largest city of Nepal, which is located 200 km west of Nepal, Kathmandu. It lies in Kaski District, Gandaki Province, Central Nepal, with latitude 28° 16' 0.80" N and 83° 58' 6.64" E longitude. The elevation ranges from 780 m in the southern part to 1350 m in the northern part of the Pokhara valley.

Pokhara valley has a humid subtropical type of climate; however, the elevation keeps the temperature moderate. The most extreme rainfall happens in July, amounting to 638.4 mm, while the least rainfall occurs in November, amounting to 17.4 mm; the hottest months of the year are July and August, with the monthly mean temperature of 25.9°C and 26.0°C respectively, while the coldest months of a year are December and January with the monthly mean temperature of 14.5 °C and 13.3 °C respectively (Gautam et al., 2020).

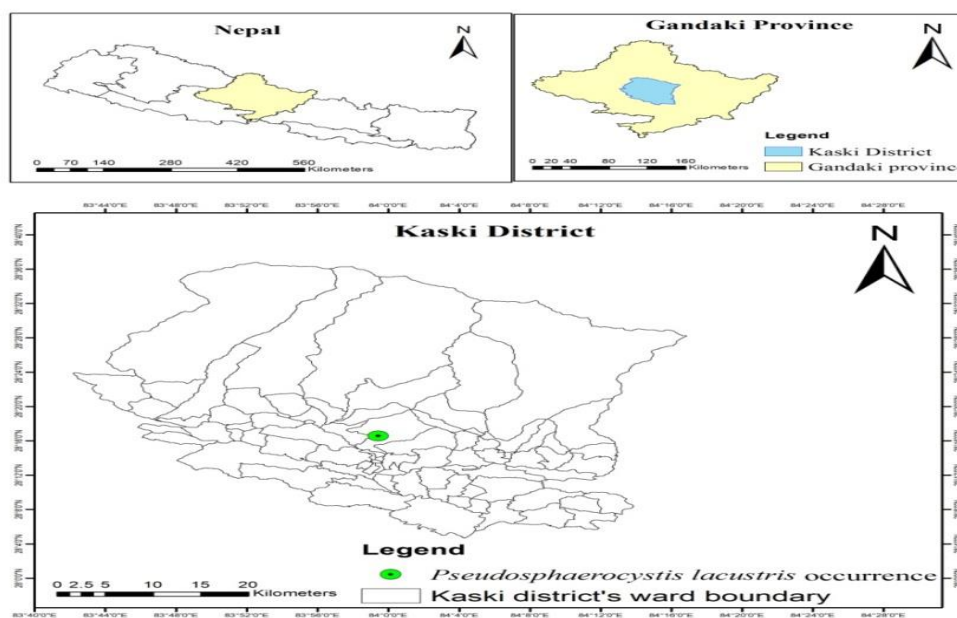


Figure 1. Location map of occurrence of *Pseudosphaerocystis lacustris*

2.2. Collection of material: *Pseudosphaerocystis lacustris* (Lemmermann) Nováková specimens have been collected in plastic bottles from the slow running canal of the paddy field being attached with stones and dried paddy leaves, aquatic grasses on January 3, 2021, from Lamachaur Pokhara of Kaski District of Gandaki Province of Central Nepal.

2.3. Identification of specimen: Detailed study was made by examining under Huma-Scope Premium LED magnifying lens with attached 0.5X adapter for recognizable proof of species. Identification of this taxon was accomplished with the help of authentic literature (Ettl and Gartner, 1988; John et al., 2002). Collected samples (preserved in 4% formalin), Herbarium specimens, and Permanent slide of this species were additionally stored in the Cryptogams section (Algae) in National Herbarium and Plant Laboratories, Godawari, Lalitpur District.

3. Results and discussion

New record: Paddy field, Lamachaur, near Lati Khola, Pokhara, Kaski District, 28.27641°N, 83.99010°E, altitude 940 m, 3 Jan 2021, Dhakal S., Paudel H.R., Magar, R. and Bhattarai, N. 202113003 (KATH); Permanent slide reference number 8.

Pseudosphaerocystis lacustris has been recorded in Europe (Baltic Sea, Britain, Czech Republic, France, Germany, Netherlands, Romania, Scandinavia, Slovakia, and Spain), North America (Mexico), South America (Argentina), Middle East (Turkey), and New Zealand (Guiry and Guiry, 2021). In Asia, the species has been observed in Bangladesh (Ahmed et al., 2008). Similarly, in Global Biodiversity Information Facility, there are 13 occurrence records of *Pseudosphaerocystis lacustris* (GBIF, 2019). The species recorded in GBIF are Netherlands, Estonia, Belgium, and United Kingdom of Great Britain and Northern Ireland. Despite its wide dispersion, the natural condition where it occurs appears to be specific.

Habitat: Growing attached with grasses, papers, stones, and other rough objects, some of them were free-floating, and certain specimens were also found growing at the bottom of the water. Occur here in mostly pristine water with macroalgae *Spirogyra* sp. and *Stigeoclonium* sp. with some associated diatoms are *Synedra* sp., *Cymbella* sp., *Diatoma* sp.

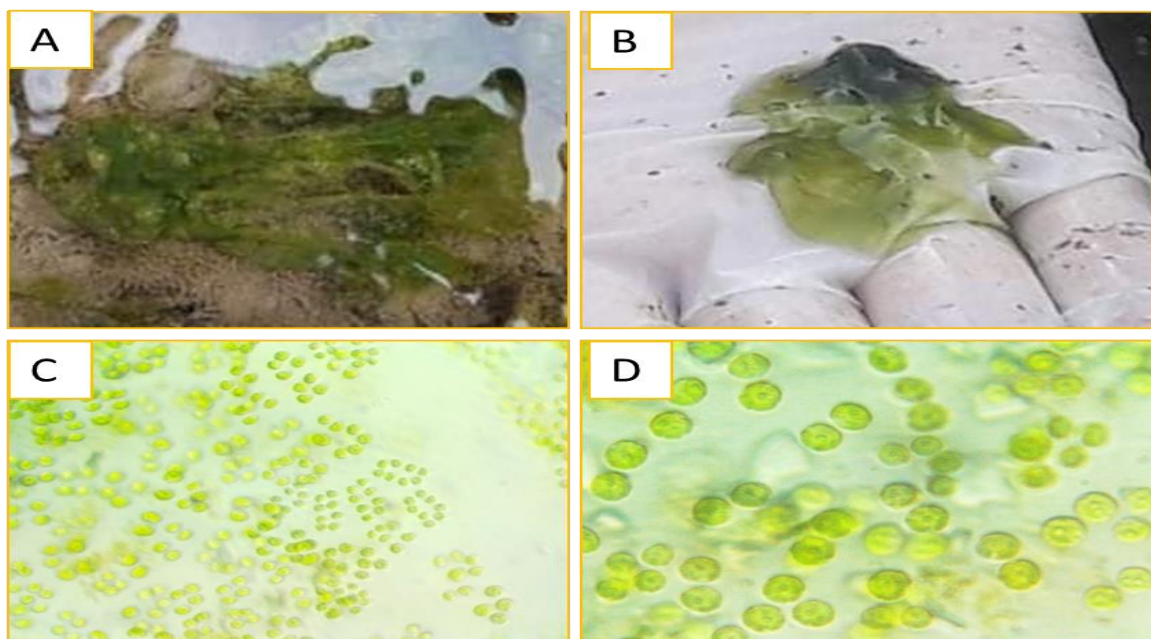


Figure 2. *Pseudosphaerocystis lacustris*. (A-B) Morphological structures of *Pseudosphaerocystis lacustris*, (C) Cells arranged in a group of 2, 4, 8, 16, or 32 within a mucilaginous investment (40X *0.5X); (D) Cells showing pyrenoids with cup-shaped chloroplast (100X *0.5X).

The genus *Pseudosphaerocystis* was previously regarded as *Tetraspora*. In *Tetraspora*, the cells lie within a mucilaginous matrix-forming macroscopic spherical colonies; cells arranged in two-by-two or four-by-four (Pentecost, 2011), but in *Pseudosphaerocystis*, the cells are arranged in groups of 2 to 32 embedded in a thick and common mucilage (Massjuk & Lilitka, 2011). The habitat of the proposed taxon in the present study is found in slow running and in the stagnant water of the paddy field, which is following the Islam and Irfanullah, (2000) recorded from Bangladesh. However, Celekli et al. (2007) reported this taxon from the Abant River of Turkey. Comparing the water quality where the taxon occurred, the water seems very clear in the paddy field of the collection site. Reynolds et al. (2002) also reported phytoplankton *Pseudosphaerocystis lacustris* found in clear epilimnia, tolerate low nutrients and high turbidity, and sensitivity to the carbon dioxide deficiency in review paper of the functional classification of the freshwater.

Morphology: *Pseudosphaerocystis lacustris* (Figure 2) is a planktonic alga, pale green spherical colonies; Thallus, macroscopic; colonies mucilaginous matrix. Colonies of 2,4,8,16 or 32 cells in a rounded, often flattened homogeneous mucilaginous investment; cells spherical to sub-spherical, without a papilla, 8-12 μm wide, 7-10 μm long, colonies 20-100 μm in diameter; eyespot anterior; pseudocilia absent.

The taxon morphological characteristics and the ecological conditions of the environment were recorded to confirm *Pseudosphaerocystis lacustris*. Thus, documentation of species as new records or their recollection from a specific territory has necessary for knowing its ecology and conservation of the environments and floristic investigation of algal flora (Halder, 2015). Such type of work will give baseline data and may provide information for future examinations on algal taxonomy. Future investigations should focus on the population relationships of this species to verify distribution patterns and potential localities where the species occurs and the risks for its conservation.

4. Conclusion

Heterogeneous climatic conditions and rich in lotic and lentic habitats make Nepal rich in algal biodiversity. In this contribution of algal flora, we have recorded *Pseudosphaerocystis lacustris* species for the first time in Nepal. This study added one species to the algal flora of Nepal, but this study alone is not sufficient without molecular data of the reported taxon. This type of study is also utilized for bioprospecting soon. Therefore, extensive explorations of algal species are necessary for Nepal.

Conflicts of interest. There are no conflicts of interest.

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