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Research article

Chlorophycean algae in Khumbu Himalaya region of Nepal, including four new records.

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Abstract

A study was conducted to document the chlorophyceaen algae in the waterbodies of Sagarmatha National Park and Buffer zone, Solukhumbu, Nepal. A total 27 taxa of green algae including four new records were identified. The following algae *viz.*, *Euastrum oblongum*, *Penium cylindrus*, *Scenedesmus quadricauda* and *Spirogyra amplectens* were found new to Nepal. These species were collected from running water, stagnant water, rocky and sloppy moist habitats at Pheriche, luza khola, below 1st lake, in 1st lake, Namche and Larcha dovan between 2700-4600 m elevation. **Copyright © WJSTR, all rights reserved.**

Key words: Algae, Chlorophyceae, Sagarmatha National Park, Khumbu Himalaya, Nepal

Introduction

Information about taxonomy and diversity of algae in Nepal is inadequate, particularly from high lands of Nepal. Hutchinson (1937) observed algae in two high altitude lakes of Nepal. More than 176 taxa from high altitude Himalayan region of eastern and central Nepal were recorded by Hirano (1963, 1984), which is the major contribution in the Nepalese algal flora. Suxena *et al*. (1972), Hickel (1973), Shrestha and Manandhar (1983), Ishida (1986), Aizaki (1987), Habib (1997), Rothfritz *et al*. (1997) , Rai (2005) and Ghimire *et al* (2012a) and Ghimire *et al* (2012 b) have also made important contribution in high altitude algal flora of Nepal. Loffler (1960) studied the lakes in Khumbu valley and mentioned very poor phytoplankton assemblages. Ruggia *et al*. (1998) identified thirteen species were, most of them were not recorded previously in the Khumbu region. Kumar and Rai (2005) also recorded 13 taxa of chlorophyceae from Sikkim-Himalayas. These studies on chlorophyceae provide new information and the paper focuses on the enumeration of chlorophyceae in high altitude area in Sagarmatha National Park (SNP), Nepal.

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Materials and Methods

Study Area: SNP located in the southern slope of Sagarmatha (Mt. Everest), lies in the Solukhumbu district of the north eastern region of Nepal and covers 1148 sq. km (Fig. 1). It ranges between 27°30'19" and 27°06'45"N latitude to 86°30'53" to 86°99'08"E longitude. The park is characterized by rugged topography with altitude ranging from 2845 m at Jorsalle to 8848 m at the top of Mt. Everest. About 80% of the precipitation falls in the monsoon season from June to September. An average minimum temperature is in January where as maximum during August (-7.7 to 16.2°C). Four major rivers namely Dudh Koshi, Lobuche Khola, Imja Khola and Bhote Koshi drain from north to south. Dudh Koshi originates from Ngozumpa glacier and Gokyo lake system. Lobuche Khola originates in Khumbu Glacier, and Imja Khola from Imja Lake and Glaciers. The Lobuche and Imja Khola meet with each other below Dingboche and in Imja Khola. This Imja Khola meets Dudh Koshi below Phortse, and again called Dudh Koshi. Bhote Koshi originates in Tibet and it meets Dudh Koshi at Larja dobhan below the Namche Bazar. Several tributaries feed these major river systems. The major lake systems in the SNP are Imja and Gokyo.

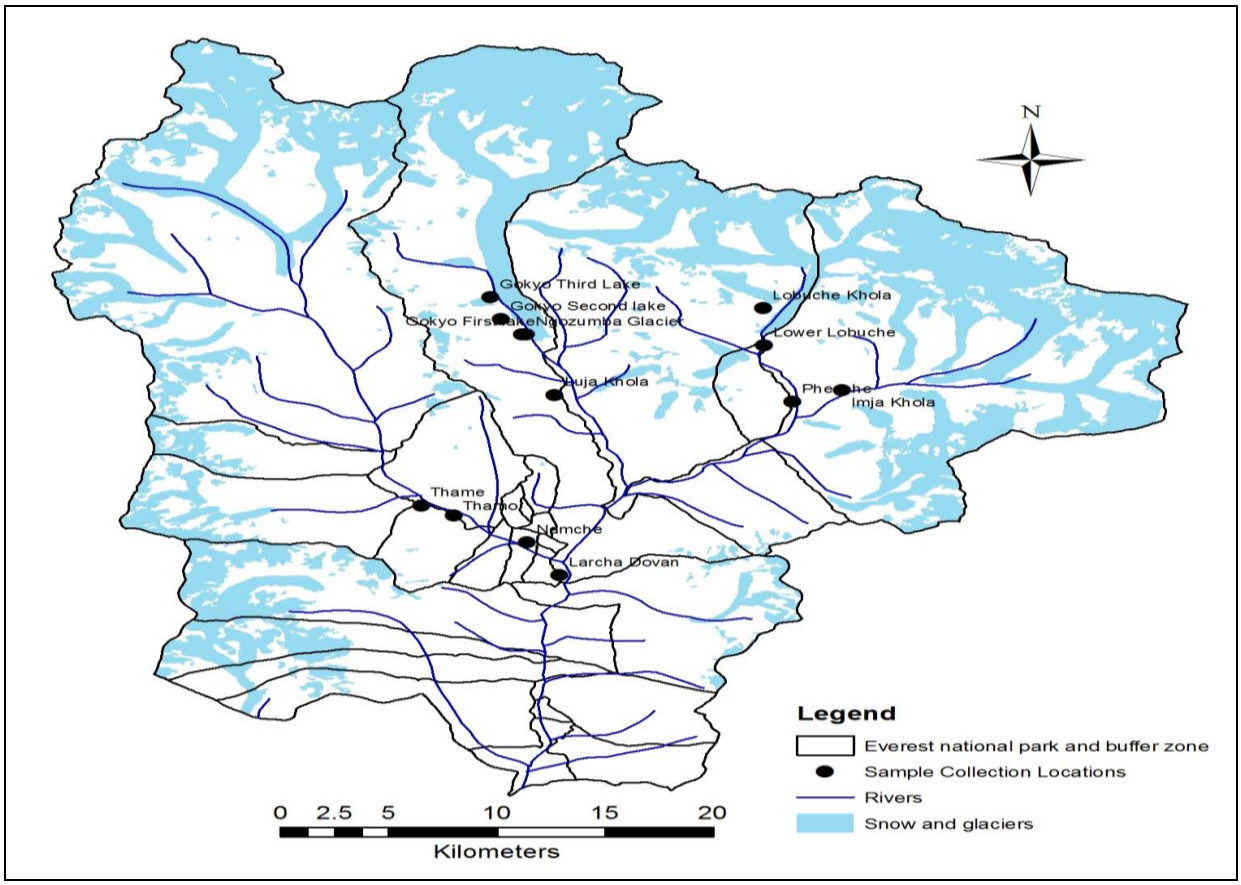

Figure 1: Map showing sampling points, Sagarmatha National Park.

Sample collection

Three visits to SNPBZ were made in October, 2007; May, 2008 and October, 2008 for exploration of algae. The sampling sites were mostly selected along the trekking routes from Lukla to Everest base camp, Gokyo, Imja Lake and Thame (Fig. 1). Samples of algae were collected from different corners of lakes, different sides of

rivers as well as moist rocks near water courses between 9:00 to 12:00 am. Samples were preserved in 4% un-buffered formalin and collected into plastic bottle. Identification of species was made by the use of a Leica binocular microscope and consulting relevant monographs. The classification of taxa was done according to Prescott (1951). Forty five samples (fifteen in each visit) were collected from three visits.

Results and Discussion

A total of twenty seven chlorophyceaean algae under 20 genera were recorded from SNP and its buffer zone area, a high altitude region, Nepal (Table 1). Out of these, 20 algae were identified up to species level where as seven were identified only up to genus level. Twenty genera were *Actinotaenium* (1 sp.), *Bulbochaete* (1sp.), *Chlorella* (1sp.), *Closterium* (1 sp.), *Cosmarium* (4 spp.), *Cylindrocapsa* (1sp.), *Cylindrocystis* (1 sp.), *Euastrum* (2 spp.), *Hyalotheca* (1sp.), *Mougeotia* (1 sp.), *Netrium* (1 sp.), *Oedogonium* (1 sp.), *Pediastum* (1sp.), *Penium* (1 sp.), *Phacus* (1 sp.), *Scenedesmus* (4 spp.), *Sphaerocystis* (1 sp.), *Spirogyra* (1sp.), *Staurastrum* (1sp.) and *Zygnema* (1 sp.). In the present study, four algal taxa *viz*., *Euastrum coralloides* Josh. var. *trigibberum* Lagerheim, *Euastrum oblongum* (Grev.) Ralfs ex Ralfs, *Penium cylindrus* (Ehr.) ex Bréb. and *Spirogyra amplectens* Skuja were reported for the first time from Nepal.

Generally unicellular, colonial algae and desmids were found to be dominant in stagnant waters where as filamentous green algae were common in both running and stagnant water bodies. Due to chilling temperature, chlorophycean algae were not as much dominant as in warm climate of Tarai of the country.

Green algae common to this area like *Closterium*, *Scenedesmus*, *Cosmerium*, *Spirogyra* genera have also been reported from Sikkim Himalaya range, 300-5,500 m elevations (Kumar and Rai, 2005). Yoshimura *et al.* (1997) also reported five species of algae from Yala glacier, central Nepal (Lantang region). Among them one species *Cylindrocystis brebissonii* is also found in Khumbu region. Takeuchi *et al.* (1998) also reported *Cylindrocystis brebissonii* from Himalayan glacier (Shorong region of East Nepal) altitude between 4950-5380 m.

Table 1: Chlorophycean algae from Sagarmatha National Park and Buffer Zone.

S.N.	species	Locality	Altitude (m)	Habitat
1	*Actinotaenium cf. subglobosum*	Larcha dovan	2700	Stagnant water at edge of Dudh kosi river
2	*Bulbochaete* sp.	1st Lake gokyo	4660	From outlet of 1st lake Gokyo
3	*Chlorella vulgaris*	Between 1st and 2nd lake	4650	Slow running water
4	*Closterium acerosum*	Between 1st and 2nd lake, Namche, Pheriche, Thamo, 2nd and 3rd lake	3400-4700	Running water
5	*Cosmarium subspeciosum*	Luza, Pheriche	4300	Stagnant as well as running
6	*Cosmarium awadhense*	Thame, 1st lake	3700-4660	Stagnant water
7	*Cosmarium cf. sublateriundatum*	Larcha dovan	2700	Stagnant water with rocky habitat

8	*Cosmarium nudum*	Just below to 1st lake	4600	Moist sloppy rocks
19	*Cylindrocapsa* sp.	Namche spring	3400	Running water
10	*Cylindrocystis brebissonii*	Luza khola	4300	Running water
11	*Euastrum coralloide* var. *trigibberum*	Luza khola	4300	Running water
12	*Euastrum oblongum*	Pheriche	4300	Stagnant water
13	*Hyalotheca dissiliens*	Pheriche	4300	Stagnant water
14	*Mougeotia* sp.	Below 1st lake, between 1st and 2nd lake, Luza, pheriche	4300-4700	Moist steep rocks, stagnant as well as running water
15	*Netrium digitus*	Luza	4300	Running water
16	*Oedogonium* sp.	Between pheriche and lobuche, 1st lake	4300-4660	Stagnant water
17	*Pediastum duplex*	Between pheriche and lobuche	4300	Stagnant water
18	*Penium cylindrus*	Pheriche	4300	Stagnant water
19	*Phacus* sp.	Namche	3400	Running water
20	*Scenedesmus bijugatus*	Pheriche, Namche	3400-4300	Running water
21	*S. quadricauda*	Just below to 1st lake, Pheriche	4300-4600	Sloppy moist rocky region and running water
22	*S. bijuga*	Below pheriche and lobuche	4300	Stagnant water
23	*S. obliquus*	Namche	3400	Running water
24	*Sphaerocystis schroeteri*	Between pheriche and lobuche	4300	Stagnant water
25	*Spirogyra amplectens*	Below 1st lake,1st lake, Namche, Larcha dovan	2700-4660	Rocky sloppy region, running water, stagnant water
26	*Staurastrum* sp.	Larcha dovan, Luza, Namche, between 1st and 2nd lake, between pheriche and lobuche	2700-4700	Running as well as stagnant water
27	*Zygnema* sp.	Lobuche khola, Just below to 1st lake, between 2nd and 3rd lake.	4700-4900	Moist rocky habitat as well as running water

(Source: field study, 2007-08)

Taxonomical descriptions of new algae are as follows:

1. ***Euastrum coralloides*** Josh. var. ***trigibberum*** Lagerheim (Fig. 2)
   Class- Zygnematophyceae
   Order- Desmidiales
   Family- Desmidiaceae
   Genus- *Euastrum*
   Species- *E. coralloides*

Cell 40 µm long, 30 µm broad; semicell has five facial swellings; isthmus 13 µm wide; thickness 19 µm.

2. ***Euastrum oblongum*** (Grev.) Ralfs ex Ralfs (Fig. 3)
   Class- Zygnematoophyceae
   Order- Desmidiales
   Family- Desmidiaceae

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Genus- *Euastrum*
Species- *E. oblongum*

Cell 148 µm long, 74 µm broad; a deep, closed median apical invagination, lateral invaginations many.

3. ***Penium cylindrus*** (Ehr.) ex Bréb.(Fig.4)
   Class- Zygnematoophyceae
   Order- Zygnematales
   Family- Peniaceae
   Genus- *Penium*
   Species- *P. cylindrus*

Cell 41 µm long, 11.5 µm broad, cylindrical with truncately rounded ends; cell wall dotted, bands present.

4. ***Spirogyra amplectens*** Skuja (Fig. 5)
   Class- Zygnematophyceae
   Order- Zygnematales
   Family- Zygnemataceae
   Genus- *Spirogyra*
   Species- *S. amplectens*

Vegetative cell 143 µm long, 18 µm broad; chloroplast single; conjugation lateral; zygospore 61 µm long, 36 µm broad, ellipsoid.

Figure 2: *E. coralloides var. trigibberum*

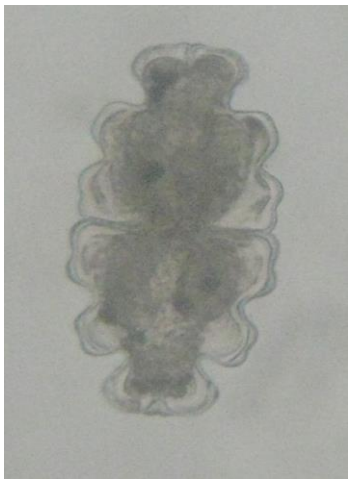

Figure 3: *Euastrum oblongum*

Figure 4: *Penium cylindrus*

Figure 5: *Spirogyra amplectens*

Plate 1: Photographs of new taxa of chlorophycean algae.

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