

**Research Article**

## CYANOBACTERIAL DIVERSITY OF UNA, H.P, INDIA

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### ABSTRACT

The Cyanobacteria are the most morphologically and developmentally diverse groups of prokaryotic organisms. They range from simple unicellular forms to complex filamentous organisms capable of true branching and the production of a variety of highly differentiated cell types. The present study was aimed to explore the distribution of cyanobacterial diversity of Una district, Himachal Pradesh. The cyanobacterial samples were collected from different seasons i.e., summer, rainy and winter. The genera include the species of *Microcystis* (4), *Chroococcus* (2), *Gloeocapsa* (2), *Aphanocapsa* (1), *Aphanothece* (1), *Synechococcus* (1), *Merismopedia* (1), *Dermocarpa* (1), *Spirulina* (1), *Oscillatoria* (5), *Phormidium* (1), *Lyngbya* (1) and *Nostoc* (1). The number put in the parentheses represents the number of the species of a particular genus. Some of the species have the capability to assimilate both carbon as well as nitrogen from the atmosphere.

**Keywords:** Diversity, Cyanobacteria, Una, Himachal Pradesh

### INTRODUCTION

Cyanobacteria were the first gram negative photosynthetic bacteria that believed to have evolved on earth approximately 3.8 billion years ago. Cyanobacteria are commonly known as Cyanophyta, Myxophyta, Cyanochloronta, blue-green algae, blue-green bacteria and most recently as Cyanoprokaryotes. They constitute one of the major gram negative bacterial phyla and occupy the diverse range of habitats inhabiting most of the Earth's environment. They display considerable morphological diversity ranging from unicellular to colonial and filamentous forms.

Cyanobacteria are capable of photo-autotrophic growth; perform oxygenic photosynthesis similar to those of eukaryotic algae and plants. They also have the unique ability to fix atmospheric nitrogen (Faldu *et al.*, 2014). Some of the species known as nitrogen fixing cyanobacterial have the capability to assimilate both carbon as well as nitrogen from the atmosphere (Bhushan and Kumar, 2013). These nitrogen fixing bacteria contain special kind of thick walled cells called heterocysts which contain nitrogenase enzyme which help in the fixation of atmospheric nitrogen (Stewart *et al.*, 1987) into nitrites and nitrates. The orders Chroococcales and Dermocarpales mostly include the unicellular forms while order Nostocales includes only filamentous forms. They may be lithophytic, free-floating, epiphytic, terrestrial or epipellic. Various workers have studied the cyanobacterial flora of different parts of India. Some of them are Desikachary (1959), Khare and Kumar (2009), Mongra (2012), Bhushan and Kumar (2013), Sebastian and Joseph (2013), Maheshwari (2013), Ananya *et al.*, (2014), Sandyhyarani and Kumar (2014), Jain (2015), Mukhopadhyay and Naskar (2015), Singh and Singh (2017) and Sharma *et al.*, (2017).

### MATERIALS AND METHODS

#### *Study Area*

Una District is located at the South of Himachal Pradesh. It is situated at an altitude varying between 350-1200m. Una district is located between 75°58'-76°28' E Longitude and 31°17' - 31°52' N Latitude. The total area of the district is 1,549 km<sup>2</sup>. The closest nearby big destinations are Jalandhar and Hoshiarpur. It has borders with Kangra, Hamirpur and Bilaspur and then acts as a gateway to these regions. Hills of Una are basically with semi-tropical and semi-arctic conditions. Average temperature in summer is between 8° C to 45° C, though winter temperature rises between -3° C to 33° C. The hill ranges are covered by scanty vegetation comprising mostly of shrubs. The whole area is warm. Shivalik ranges experience heavy rainfall.

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**Collection, Identification, Maintenance and Preservation of Samples**

The samples were collected from the different habitats of the study area in different seasons i.e. summer, rainy and winter during 2016-2017. Cyanobacterial specimens growing on moist cemented walls, stones, bark of trees, soil, and sand, in temporary and permanent water bodies like ditches and ponds were collected for the study. The samples were stored in sterile plastic bottles, and assigned accession number and recorded in field note book. On return to the laboratory, they were washed thoroughly with water and preserved in 4% formalin.

Semi-permanent slides were prepared from each sample for the identification of various taxa and observed under trinocular research microscope. Camera-lucida diagrams were sketched to study the taxa up to the level of class, order, family, genus and species level following the monograph of Desikachary (1959). The taxonomy of Cyanobacteria was based mainly on their morphology.

**RESULTS AND DISCUSSION**

The cyanobacterial diversity of Una includes 22 species belonging to 13 genera, 4 families and 3 orders. The genera include the species of *Microcystis* (4), *Chroococcus* (2), *Gloeocapsa* (2), *Aphanocapsa* (1), *Aphanothece* (1), *Synechococcus* (1), *Merismopedia* (1), *Dermocarpa* (1), *Spirulina* (1), *Oscillatoria* (5), *Phormidium* (1), *Lyngbya* (1) and *Nostoc* (1). The number put in parentheses represents the number of species in each genus.

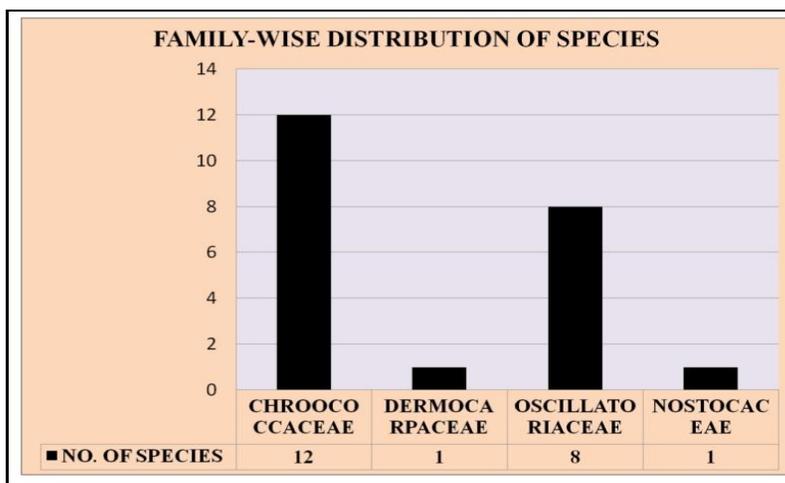


Figure 1: Family-Wise Distribution of the Species of Una District

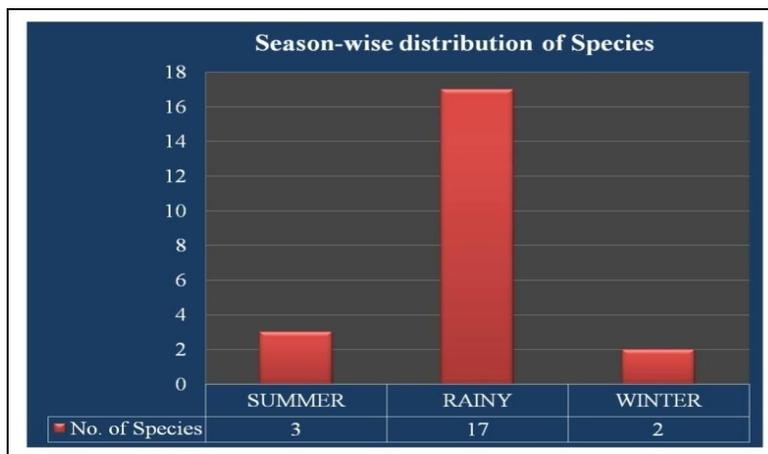


Figure 2: Seasonal Diversity of Cyanobacterial Taxa of Una District

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**Taxonomic Enumeration of Species**

S. No.	Species	Occurrence Season	Accession No. and Collection Time	Habit, Habitat and Collection Sites	Parameters
1.	<i>M. protocystis</i> Crow	Rainy	R-13; Aug. 2016	Free-floating- on water in a temporary ditch near Gurudwara, Una	Cell diameter: 3.0-4.2 $\mu$
2.	<i>M. ramosa</i> Bharadwaja	Rainy	R-13; Aug. 2016	Free-floating- on water in a temporary ditch near Gurudwara, Una	Cell diameter: 3.1-4.1 $\mu$
3.	<i>M. orissica</i> West, W.	Rainy	R-13; Aug. 2016	Free-floating- on water in a temporary ditch near Gurudwara, Una	Cell diameter: 1.8-2.1 $\mu$
4.	<i>M. elabens</i> (Breb.) Kütz	Rainy	R-09; Aug. 2016	Lithophytic- on the moist stone in a puddle near Gurudwara, Una	Cell length: 4.5-5.0 $\mu$ Cell breadth: 2.1-3.4 $\mu$
5.	<i>Chroococcus micrococcus</i> (Kütz) Rabenh.	Rainy	R-16; Aug. 2016	Epiphytic- on the moist bark of <i>Mangifera indica</i> near Hospital, Una.	Cell diameter with sheath: 58.6-61.2 $\mu$ Cell diameter without sheath: 44.2-47.6 $\mu$
6.	<i>Chr. tenax</i> (Kirchn.) Hieron	Summer	S-08; May 2016	Terrestrial- on the moist soil in the paddy field near Asha Ram Bapu Ashram, Una	Cell diameter with sheath: 23.0-17.2 $\mu$ Cell diameter without sheath: 16.2-17.1 $\mu$
7.	<i>Gloeocapsa gelatinosa</i> Kütz	Rainy	R-06; Aug. 2016	Epipellic- on the moist sand in a drain near Bus Stand, Una	Cell diameter with sheath: 3.1-4.4 $\mu$ Cell diameter without sheath: 1.5-1.9 $\mu$
8.	<i>Gl. livida</i> (Carm.) Kütz	Rainy	R-07; Aug. 2016	Terrestrial- on the moist soil near Bus Stand, Una	Cell diameter with sheath: 7.7-9.3 $\mu$ Cell diameter without sheath: 1.7-3.2 $\mu$
9.	<i>Aphanocapsa koordersi</i> Storm	Rainy	R-16; Aug. 2016	Epiphytic- on the moist bark of <i>Mangifera indica</i> near Hospital, Una	Cell diameter: 1.5-3.0 $\mu$
10.	<i>Aphanothece stagnina</i> (Spreng.) A. Br.	Rainy	R-13; Aug. 2016	Free- floating- on water in a temporary ditch near Gurudwara,	Cell Size (LxB): 10.3-11.9x5.1-6.8 $\mu$

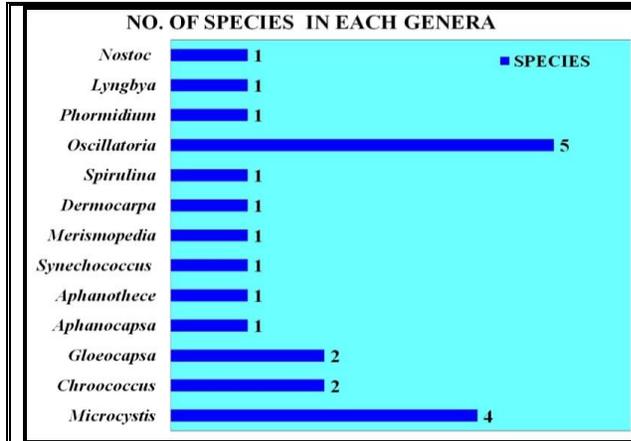
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11.	<i>Synechococcus aeruginosus</i> Nääg	Rainy	R-06; Aug. 2016	Una Epipellic- on the moist sand in a drain near Bus Stand, Una	Cell Size (LxB): 22.9-2.1x15.1-20.4 $\mu$
12.	<i>Merismopedia minima</i> Beck	Rainy	R-16; Aug. 2016	Epiphytic- on the moist bark of <i>Mangifera indica</i> near Hospital, Una.	Colony size (LxB): 3.1-3.3x2.6-3.0 $\mu$ Cell diameter: 0.3-0.5 $\mu$
13.	<i>Dermocarpa olivacea</i> var. <i>gigantea</i> Rao, CB	Winter	W-03; Jan 2017	Lithophytic- on the moist cemented wall of a drain near Bus Stand, Una	Sporangia length with pseudovagina: 87.2-100.2 $\mu$ Length without pseudovagina: 43.1-57.2 $\mu$
14.	<i>Spirulina subsalsa</i> Oerst. ex Gomont	Rainy	R-02; Aug. 2016	Lithophytic- on the moist cemented wall at Bus Stand, Una	Trichome breadth: 1.5-2.1 $\mu$ Spiral breadth: 3.4-4.9 $\mu$ Distance b/w spirals: 3.2-5.0 $\mu$
15.	<i>Oscillatoria obscura</i> Bruhl et Biswas	Winter	W-05; Jan 2017	Terrestrial- on the moist soil in the paddy field near Gurudwara, Una	Trichome breadth: 3.4-4.9 $\mu$ Cell length: 1.1-1.7 $\mu$
16.	<i>O. sancta</i> (Kütz.) Gomont.	Rainy	R-09; Aug. 2016	Lithophytic- on the moist stone in a puddle near Gurudwara, Una	Trichome breadth: 14.3-16.2 $\mu$ Cell length: 3.0-4.3 $\mu$
17.	<i>O. chilensis</i> Biswas	Summer	S-10; May 2016	Lithophytic- on the moist cemented wall of a drain near Gurudwara, Una.	Trichome breadth: 3.1-5.2 $\mu$ Cell length: 2.1-3.1 $\mu$
18.	<i>O. irrigua</i> (Kütz.) Gomont	Rainy	R-13; Aug. 2016	Free-floating- on water in a temporary ditch near Gurudwara, Una	Trichome breadth: 7.6-10.1 $\mu$ Cell Length: 7.6-10.7 $\mu$
19.	<i>O. agardhii</i> Gomont	Rainy	R-07; Aug. 2016	Terrestrial- on the moist soil near Bus Stand, Una.	Trichome breadth: 3.1-6.2 $\mu$ Cell length: 1.5-3.0 $\mu$
20.	<i>Phormidium corium</i> (Ag.) Gomont	Rainy	R-13; Aug. 2016	Free-floating- on water in a temporary ditch near Gurudwara, Una	Trichome breadth: 3.5-4.6 $\mu$ Cell length: 4.9-6.8 $\mu$
21.	<i>Lyngbya baculum</i> Gomont	Summer	S-08; May 2016	Terrestrial- on the moist soil in the paddy field near Asha Ram Bapu Ashram, Una.	Trichome breadth: 8.5-10.2 $\mu$ Cell length: 6.2-7.7 $\mu$
22.	<i>Nostoc commune</i> Vaucher ex Born. et Flah	Rainy	R-13; Aug. 2016	Free-floating- on water in a temporary ditch near Gurudwara, Una	Trichome breadth: 4.6-6.8 $\mu$ Cell length: 4.5-5.8 $\mu$

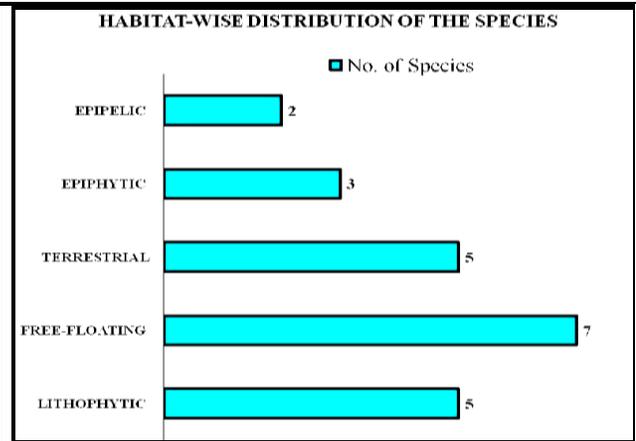
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The highest number of species has been reported from family Chroococcaceae (12) followed by Oscillatoriaceae (8), and Nostocaceae (1) and Dermocarpaceae (1) contains one species each {Figure 1}. Most of the species are free-floating (7), followed by lithophytic (5), terrestrial (5), epiphytic (3), and epipellic (2) {Figure 4}. They have ability to sustain in almost every habitat. Most of the species are found in rainy (17) season followed by summer (3) and winter (2){Figure 2}.

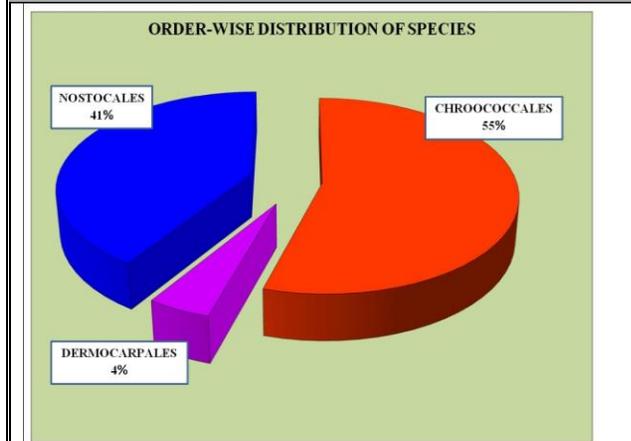
The order Chroococcales dominate with 12 species followed by Nostocales having 09 species and only one species has been reported from Order Dermocarpaceae.



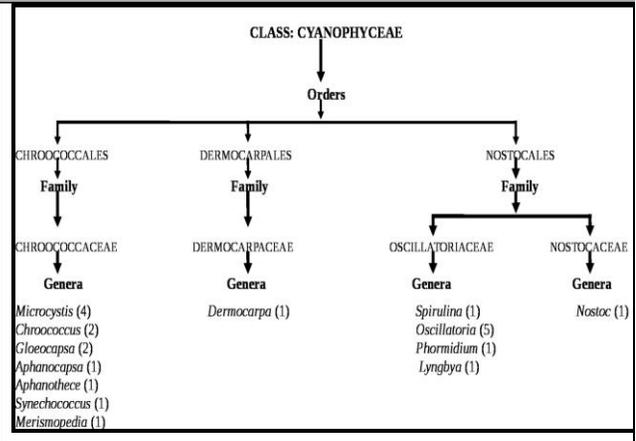
**Figure 3: Number of Cyanobacterial Species found in each Genus reported from Una**



**Figure 4: Habitat-wise distribution of the Cyanobacterial Species of Una District**



**Figure 5: Order-Wise distribution of Cyanobacterial species reported from Una**



**Figure 6: Systematic position of various taxa reported from the research sites of Una; the number put in parentheses represents the number of Speciesn**

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