ABSTRACT

The Similipal biosphere is located in the Mayurbhanj district of Odisha, India, and is 2,750 km² (1,060 sq mi) in size. The purpose of this research is to document the cyanobacteria collected from tree bark and rock surfaces at various collection sites of Similipal Biosphere Reserve. In the present study, a total of 25 cyanobacterial species under 15 genera, 12 families and 05 orders under division Cyanophyta was reported from different sites of Similipal biosphere reserve, Odisha. Out of 25 cyanobacterial species, 21 are first time recorded from the Similipal biosphere reserve such as Anabaena subcylindrical, Aphanothece microscopica, Calothrix clavatoides, Chroococcus minor, Chroococcus minutus, Chroococcidiopsiska shayi, Gloeocapsa punctata, Gloeothece palea, Hapalosiphon hibernicus, Nostoc piscinale, Oscillatoria subbrevis, Phormidium ambiguum, Phormidium aerugineo-caeruleum, Phormidium bulgaricum, Phormidium kolkwitzii, Phormidium retzii, Planktothrix clathrata, Planktothrix isothrix, Scytonema javanicum, Scytonema stuposum, Tolypothrix rechingeri.

Key words: Cyanobacteria, Similipal biosphere reserve, Subaerial

Introduction

The majority of photosynthetic microorganisms found in terrestrial and subaerial habitats is Cyanobacteria. Land-based algae are commonly found on stable, exposed surfaces above the soil. In India, subaerial cyanobacteria grow, giving most tree barks, structures, and rocks a golden or reddish orange tint (Neustupa and Škaloud, 2010). Terrestrial cyanobacteria have evolved to thrive in a wide range of microhabitats, including wet soil and all exposed places above the soil surface. Soil and subaerial cyanobacteria are two types of non-aquatic cyanobacterial species that have emerged on land as a result (aerophytic cyanobacteria) (Neustupa and Škaloud, 2010). The cyanobacterial substrates in these habitats include trees, massive rocks, unpainted compound walls, old wood works, metals, exposed pieces of old buildings, tree bark and leaves, stone monuments, and other man-made structures (Lopez-Bautista et al., 2007). They can be epiphytic (living on plants), epiphyllous (living on leaves), corticolous (living on tree bark, stems, or trunks), epizoic (living on animals), lithophilous (living on stones, brick, or cement), epixylous (living on dead wood such as poles, posts, or doors), or epimetallous (living on metal) (inhabiting on metals) (Lopez-Bautista et al., 2007). Cyanobacteria (blue-green algae) are photosynthetic prokaryotic microorganisms that may live on exposed rock surfaces,
scorching deserts, dry locations, and tree bark, among other places (Adhikary and Sahu, 2000; Büdel, 2002; Pattanaik and Adhikary, 2005). On exposed surfaces such as rocks, leaves, and tree bark, sub-aerial cyanobacteria have been shown to grow (Neustupa and Škaloud, 2008).

Cyanobacteria are among the oldest fossils known, and they played an important role in the creation of life on Earth as some of the first invaders (Schopf, 2012). Unfortunately, they are also among the least well-studied and catalogued creatures, owing in part to a common misconception among traditional monographers (Desikachary, 1959). Despite being some of the most extensively spread and pervasive creatures on the planet, cyanobacteria have been historically understudied. They are the species that have the best chance of surviving in a variety of subaerial settings. Cyanobacteria are one of the most common and numerous algae lineages with subaerial members, and they play a significant role in community succession (Gerrath et al., 2000). Researchers have been researching subaerial cyanobacteria in various situations since the 19th century. They are the most frequent algal group, but also the least well-known and ignored. Our knowledge of the variety and distribution of algae in subaerial environments is scant and far behind that of freshwater and marine algae (Adhikary and Sahu, 2000; Büdel, 2002; Pattanaik and Adhikary, 2005). Several workers have reported seeing a huge number of cyanobacteria with morphometric records in various locations of Odisha (Dey and Bastia, 2008; Dey et al., 2010). However, several researchers have reported on the taxonomy of some corticolous cyanobacteria on tree bark (Bhakta et al., 2014; Neustupa and Škaloud, 2010), also reported some algae from soil crust (Bhakta et al., 2015), from rock surface (Barkatullah et al., 2013). Subaerial cyanobacteria have been studied by a small number of people. A review of the literature finds that, with the exception of a few studies, no major attempt has been made to research the subaerial cyanobacterial variety of the Similipal Biosphere Reserve (Bhakta et al., 2015; Bhakta et al., 2014). On study exposed surfaces such as rocks, leaves, and tree bark, sub-aerial cyanobacteria have been shown to grow (Singh et al., 2017). Corticolous cyanobacteria from the genera Gloecapsa, Aphanocapsa, Phormidiun, Stigonema, Tolypothrix, Fischerella, Lyngbya, Nostoc, Porphyritoaphan, Hapalosiphon, Luptolyngbya, and others have been found on tree bark by several studies (Bhakta et al., 2015; Bhakta et al., 2014; Neustupa and Škaloud, 2010). However, because to problems in using morphological features to identify species and a lack of specialists exploring new settings, cyanobacterial diversity is still underreported. As a result, subaerial habitats represent a cyanobacterial biodiversity treasure trove that has yet to be discovered.

Apart from this, cyanobacterium have the ability to produce both primary and secondary metabolites. They are cosmopolitan in nature, occurring in both filamentous and coccoid forms, and prefer tropical climates to temperate climates. These autotrophic organisms can grow on exposed walls of building facades, temples, and monuments because they can endure tough and extreme conditions such as excessive temperature, drought, UV radiation, and so on.

In this context, the Similipal Biosphere Reserve in Odisha is a new ecosystem that has to be explored for subaerial habitat like dirt, rock, and tree bark. As the drainage systems cut across its area in which anthropogenic activities are less, so the diversity of cyanobacterial forms may be unique in the region. The fluctuating ecosystem of Similipal in various seasons may favor the growth and evolution of many cyanobacterial species. So, the study of diversity of cyanobacteria is indispensable. Keeping all these in view, this investigation aims to document the cyanobacterial flora of Similipal Biosphere Reserve, Odisha is the unique region.

Materials and Methods

The study sites: The Similipal Biosphere Reserve (SBR), an unique ecosystem, is situated in the heart of Mayurbhanj district of Odisha. The Biosphere Reserve being an assemblage of number of ecosystems is rich in floristic and faunal accounts, has the potential to serve as an untapped reservoir of natural resources like freshwater, trees rock surfaces. The Similipal Biosphere Reserve, an unexplored storehouse of various algal resources, is located in the centre region of Odisha’s Mayurbhanj district, between 21° 28” and 22° 08” north latitude and 86° 04” and 86° 37” east longitude (Bhakta et al., 2014; Jena et al., 2006). The name Similipal comes from the ‘Simul’ (silk cotton) tree. In 1956, it was formally declared as a tiger reserve, and in 1973, it was placed under Project Tiger. In June of 1994, the Indian government designated it as a biosphere reserve. Since 2009, it has been a member of the
UNESCO World Network of Biosphere Reserves. It is part of the Mayurbhanj Elephant Reserve, which contains three protected areas: Similipal Tiger Reserve, Hadagarh Wildlife Sanctuary, and Kudliha Wildlife Sanctuary. It is located in the Mayurbhanj district of Odisha, in the northwestern region of the state. It is situated at the eastern end of the eastern ghat (Ray, 2014). The biosphere covers 4,374 square kilometres and includes 845 square kilometres of core forest (tiger reserve), 2,129 square kilometres of buffer land, and 1,400 square kilometres of transition space. Similipal is home to 1,076 blooming plants including 96 orchid species. Tropical semi-evergreen woods, tropical moist deciduous forests, dry deciduous hill forests, high level sal forests, and expansive meadows are all found there. The ErengaKharias and the Mankirdias are two tribes who live in the reserve’s forests and engage in traditional agricultural pursuits (the collection of seeds and timber) (Upadhyay et al., 2012). Similipal is home to a diverse assortment of wild creatures, including tigers and elephants, as well as 304 bird species, 20 amphibian species, and 62 reptile species (Dash and Behera, 2012).

Sampling: A total of 55 samples were collected in sterile tarsot centrifuge tubes/plastic jars. The visual prevalence of cyanobacteria in the Similipal biosphere reserve, such as epilithic, and epiphytic cyanobacteria, was gathered using forceps, needles, polythene bags, brush, petri dishes, scalpel, and brushes. Sample preservation: The samples were dried and kept in a cool, dark location. Each sample was assigned a unique voucher number and placed in the Maharaja Sriram Chandra Bhanja Deo University’s Department of Botany in Baripada.

Sample processing: Due to the crust or dense connection with the tree bark, samples are particularly difficult to identify in their natural state. As a result, these were inundated in distilled water in petri plates and cultured for 24 hours under white light before being examined under a microscope.

Microscopy and microphotography: After each filament, colony, or consortium had grown, it was microphotographed. A phase contrast microscope was used to analyse two to three slides from each sample, with the features enumerated. The gathered samples were examined using a phase-contrast mi-

Fig. 1. Map showing the sample collection sites of Similipal biosphere reserve, Odisha. S1: Bhajam, S2: Joranda, S3: Barehipani, S4: Chahala, S5: Devkund, and S6: Machhakandana.
Morphological identification: By the following existing literature, the morphological traits of specimens of cyanobacterial species were identified and enumerated (Behera et al., 2020; Behera et al., 2021; Bhakta et al., 2015; Bhakta et al., 2014; Das and Adhikary, 2014; Dash et al., 2020; Dash et al., 2021; Desikachary, 1959; Hanna et al., 2022; Hindák, 1977; Jena et al., 2006; Khaybullina et al., 2010; Kim and Lee, 2014; Komárek, 2005; Komárek and Anagnostidis, 1999; Komárek et al., 1983; Komárek and Johansen, 2015; Komárek et al., 2011; Komárek et al., 2013; Komárková et al., 2010; Lopez-Bautista et al., 2007; Loza et al., 2013; Maharana et al., 2019; Mahendra Perumal and Anand, 2009; Nakano and Isagi, 1987; Neustupa and Škaloud, 2008, 2010; Pradhan et al., 2021a; Pradhan et al., 2021b; Stace et al. 2005; Vijayan and Ray, 2015; West et al., 1912).

Systematic accounts and taxonomic enumeration of algal species

Cyanophyta

Order: Nostocales; Family: Nostocaceae; Genus: Anabaena

1. Anabaena subcylindrical Borge, 1921 (Plate 1, Fig. 1)

Kim and Lee, 2014; Komárek, 2005; Komárek and Anagnostidis, 1999; Komárek et al., 2011; Komárek et al., 2013; Komárková et al., 2010; Lopez-Bautista et al., 2007; Loza et al., 2013; Maharana et al., 2019; Mahendra Perumal and Anand, 2009; Nakano and Isagi, 1987; Neustupa and Škaloud, 2008, 2010; Pradhan et al., 2021a; Pradhan et al., 2021b; Stace et al. 2005; Vijayan and Ray, 2015; West et al., 1912).

Results

A total of 25 cyanobacterial species under divisions such as Cyanoprokaryota were recorded from Similipal biosphere reserve, Odisha. These species belonged to 5 orders and 12 families. Further, these cyanobacterial species belonged to 15 genera such as Anabaena, Aphanocapsa, Aphanothece, Calothrix, Chroococcus, Chroococcidiopsis, Gloeocapsa, Gloeothecae, Hapalosiphon, Nostoc, Oscillatoria, Phormidium, Planktothrix, Scytonema and Tolypothrix. The microphotographs identified algal species were shown Figs. 2 & 3. The details of the systematic accounts and all the algal species were described below.

Systematic accounts and taxonomic enumeration of algal species

Cyanophyta

Order: Nostocales; Family: Nostocaceae; Genus: Anabaena

1. Anabaena subcylindrical Borge, 1921 (Plate 1, Fig. 1)

Habitat: on tree bark; Voucher number: 861, Place of collection: Devkund, Date: 30th April 2021.

Order: Synechococcales; Family: Chroococcales; Genus: Chroococcus

2. Aphanocapsa testacea (A.Braun ex Kützing) Nägeli 1849 (Plate 1, Fig. 2)

[Habitat: on tree bark surface; Voucher number: 912, Place of collection: Barehipani, Similipal; Date of collection: 30th April 2021.

Order: Synechococcales; Family: Chroococcales; Genus: Chroococcus

3. Aphanothece microscopica Nägeli, 1849 (Plate 1, Fig. 3)

Habitat: black patches on soil crust; Voucher number: 021; Place of collection: Barehipani, Similipal; Date: 11th December 2021.

Order: Nostocales; Family: Calothricaceae; Genus: Calothrix

4. Calothrix clavatoides Ghose 1927 (Plate 1, Fig. 4)

Habitat: soil crust, brown patches; Voucher number: 024; Place of collection: Barehipani, Date: 11th December 2021.

Order: Chroococcales; Family: Chroococccaceae; Genus: Chroococcus

5. Chroococcus minor (Kützing) Nägeli 1849 (Plate 1, Fig. 5)

Habitat: on tree bark surface; Voucher number: 854; Place of collection: Devkund, Similipal; Date of collection: 30th April 2021.

Order: Chroococcales; Family: Chroococccaceae; Genus: Chroococcus minutus (Kützing) Nägeli 1849 (Plate 1, Fig. 6)
[Basionym- *Protococcus minutus* Kutzing]
[Synonym- *Protococcus minutus* Kutzing, *Gloeocapsaminuta* (Kutzing) Hollerbach]

Komárek and Anagnostidis, 1998, p. 296, Fig. 391

Four celled colonies, cells embedded in homogenous gelatinous mass, cells spherical or oval, pale blue green in color, 4 – 6 µm in diameter.

Habitat: black patches on rock surface; voucher no: 589; Place of collection: Machhakandana; Date: 30th April 2021.

**Order:** Chroococcidiopsidales; **Family:** Chroococcidiopsidaceae; **Genus:** Chroococcidiopsis

7. *Chroococcidiopsiskashayi* Friedmann 1961 (plate 1, Fig. 7)

Komárek and Anagnostidis, 1998, p. 423, Fig. 553

Cells in a group, more or less spherical, colony spherical, enveloped by sheath, cells 3 µm broad, 4 µm long, colony 21 µm in diameter.

Habitat: black patches on rock surface, Voucher no. 589, place: Machhakandana, date-30th April 2021

**Order:** Chroococcales; **Family:** Microcystaceae; **Genus:** Gloeocapsa

8. *Gloeocapsa punctata* Nägeli 1849 (Plate 1, Fig. 8)

Komárek and Anagnostidis, 1998, p. 239, Fig. 309

Thallus bluish green, colonial, colony four celled, mucilaginous, mucilage hyaline, stratified, cell content homogenous with individual sheath, cells 6-8 µm in diameter, colony 20 - 22 µm diameter.

Habitat: black patches on soil crust; Voucher no:025; Place of collection: Barehipani, Date: 11th December 2021

**Order:** Chroococcales; **Family:** Aphanothecaceae; **Genus:** Gloeothece

9. *Gloeoethece palea* (Kützing) Nägeli, 1849 (Plate 1, Fig. 9)

Komárek and Anagnostidis, 1998, p. 96, Fig. 93

Four celled colony, cells cylindrical, pale blue green in colour, with homogenous content, 7.2-8.5 µm long and 3 - 4 µm broad, envelopes around the cells distinct, with 1-2 layers.

Habitat: black patches on soil crust; Voucher no:021; Place of collection: Barehipani, Similipal, Date: 11th December 2021

**Order:** Nostocales; **Family:** Nostocaceae; **Genus:** Nostoc

11. *Nostoc piscinale* Kützing ex Bornet & Flahault 1886 (plate 1, Fig. 11)

Desikachary, 1959, p. 377, pl. 69, Fig.3

Thallus with a firm mucilaginous layer, trichomes densely coiled, clearly visible, trichome 2-5 µm broad, cells barrel shaped, homogenous.

Habitat: on tree bark; Voucher no: 870; Place of collection: Devkund; Date: 30th April 2021

**Order:** Oscillatoriales; **Family:** Oscillatoriaceae; **Genus:** Oscillatoria

12. *Oscillatoria subbrevis* Schmidle 1901 (Plate 1, Fig. 12)

Komárek and Anagnostidis, 2005, p. 587, Fig. 877

Trichome usually solitary, blue green, straight with oscillating movement of the apex, cell content slightly granulated at cross walls, sheath absent, cell wall not constricted, cells slightly broader than long, 1.6 µm long, 3.5 µm broad.

Habitat: Black patches on soil crust; Voucher no:025; Place of collection: Chahala, Similipal; Date: 11th December 2021

**Order:** Oscillatoriales; **Family:** Oscillatoriaceae; **Genus:** Phormidium

13. *Phormidiumambiguum* Gomont 1892 (Plate 1, Fig. 13)

[Hanna et al., 2022, p. 05, Fig-c, d]

Filaments usually in expanded thallus, form clusters, without any branching, long filament with thin sheath, tip slightly rounded, cells are bead like, 1.86 µm long and 1.86 µm broad, trichome not narrow, slightly rounded tip, non-heterocystous, blue-green in color.
Habitat: Black patches on rock surface; Voucher no: 019; Place of collection: Chahala, Similipal; Date: 11th December 2021

14. *Phormidium aerugineo-caeruleum* (Gomont) Anagnostidis and Komárek, 1988 (Plate 1, Fig. 14)

[Basionym: *Lyngbya aerugineo-coerulea* Gomont 1892, *Potamolinea aerugineocaerulea* (Gomont, 1892) Martins and Branco, 2016]

Filaments flexuous, single or forming dark blue green aggregates, sheath thin, trichomes pale blue green, 3.6-6.8 µm broad, not constricted at the cross walls, end cell slightly rounded.

Habitat: Black patches on rock surface, Voucher no: 019, Place of collection: Barehipani, Similipal,

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15. *Phormidium bulgaricum* (Komárek) Anagnostidis and Komárek 1988 (Plate 1, Fig. 15)

Komárek, 2005, p. 442, Fig. 642.

Filaments usually without sheaths, bluish green; trichomes among other cyanobacteria in mats, straight or slightly curved, very slightly constricted at cross-walls; cells cylindrical, 1-5 μm long, with pale blue-green, homogenous content, usually granulated, no granulation at cross walls, apical cells widely-rounded.

Habitat: Black patches on soil crust; Voucher no. 021; Place of collection: Barehipani, Similipal, Date: 11th December 2021

16. *Phormidium kolkwitzii* Komárek 2001 (Plate 1, Fig. 16)

Komárek, 2005, p. 409, Fig. 576.

Thallus membranous, blue green, or solitary trichomes, 5-6 μm broad, not constricted and not granulated at cross walls, attenuated towards ends, generally curved, sheaths not found or very fine cells are wider than long, apical cell without calyptra and rounded in shape.

Habitat: on tree bark; Voucher no: 864; Place of collection: Devkund, Similipal; Date: 30th April 2021.

17. *Phormidium retzii* Kützing ex Gomont, 1892 (Plate 2, Fig. 1)

[Synonyms: *Oscillatoria retzi, Phormidium retzii* (C. Agardh) Gomont]

Behera *et al.*, 2021, p. 113, Plate 2, Fig. m

Thallus bluish-green color, slightly curve, without constriction at cell-cell junction, 4.62 μm broad, granules present along septum, tip and bottom oval in shape.

Habitat: on tree bark; Voucher no: 915; Place of collection: Bhajam, Similipal; Date: 30th April 2021.

Order: Oscillatoriales; Family: Microcoleaceae; Genus: *Planktothrix*

18. *Planktothrix clathrata* (Skuja) Anagnostidis and Komárek 1988 (Plate 2, Fig. 2)

[Basionym: *Oscillatoria mougeotii* var. clathrata Skuja]

[Synonym: *Oscillatoria mougeotii* var. clathrata Skuja, *Oscillatoria mougeotii* f. clathrata Skuja ex Starmach]

Komárek 2005, p. 358, Fig. 457

Filaments free floating, slightly constricted at the cross walls, gradually attenuated towards the apex, cells 4.5 – 5 μm broad and 1.6 – 2 μm long, with aerotopes, apical cell widely rounded.

Habitat: Brown patches on soil crust; Voucher no: 017; Place of collection: Chahala, Similipal; Date: 11th December 2021

19. *Planktothrix isothrix* (Skuja) Komárek and Komárová 2004 (Plate 2, Fig. 3)

[Basionym: *Oscillatoria agardhii* var. isothrix Skuja]

[Synonym: *Oscillatoria agardhii* var. isothrix Skuja]

Komárek, 2005, p. 356, Fig. 495

Trichomes usually straight, blue green or grey green, not or very slightly constricted at the usually inconspicuous cross walls, 4.5-6 μm broad, cylindrical and not attenuated ends, cells slightly shorter than broad, 1.8-2.5 μm long, with plenty of irregular aerotopes causing the characteristic brown color, apical cells cylindrical and widely rounded or flat rounded, without calyptra or thickened outer cell wall.

Habitat: on tree bark; Voucher no: 912; Place of collection: Bhajam, Similipal; Date: 30th April 2021.

20. *Scytonema burmanicum* Skuja 1949 (plate 2, Fig. 4)

Desikachary 1959, p. 460, Plate 97, Figs. 1-9

Thallus brownish, sheathed, sheath lamellated, brownish to clear, thick 4.3 μm, broad, filament pseudo branched, trichome slightly constricted at cross walls, heterocyst intercalary, rectangular to compressed, cells barrel shaped to compressed, broader than long, 8.6 μm long, 7.2 μm to 10 μm broad, cell content granular.

Habitat: on bark surface; Voucher no: 861; Place of collection: Devkund, Similipal; Date: 30th April 2021.

21. *Scytonema javanicum* (Kütz.) Bornet 1887 (Plate 2, Fig. 5)

Komárek *et al.*, 2013, Plate 178, Fig. 3 (d)

Filaments 12–15, trichomes 6–10 (14) μm broad, sheaths colorless to yellow, bases of branches usually shortly parallel, trichomes usually compact, hormogonia separate, solitary, cells mostly isodiametric, sheath mostly smooth from the outsides.

Habitat: on rock surface; Voucher no: 011; Place of collection: Joranda, Similipal; Date: 11th December 2021.

22. *Scytonema schmidtii* Gomont 1901 (Plate 2, Fig. 6)

Komárek *et al.*, 2013, Plate. 186, Fig. 10 (a-k)

Filaments cylindrical, binary branches, filaments and branches straight, slightly curved or rarely slightly flexuous, intercalary Heterocyst, usually barrel-shaped, 7.5 μm in long, 10 μm in broad.

Habitat: black patches on rock surface; Voucher
no: 019; Place of collection: Barehipani, Similipal; Date: 11th December 2021.

23. *Scytonemastusporus* f. *nanyohense* C.-C. Jao 1939 (plate 2, Fig. 7)
   Behera et al., 2020, Plate 211, Fig. 2 (j)
   Thallus blackish violet to reddish, false branched, thick sheath, gelatinous, 3.33 μm broad, cell 12-15 μm broad and 3-5 μm long, cell sub quadrate, heterocyst 14-16 μm broad and 6-6.6 μm long, filament 18-21 μm broad.
   Habitat: on soil crust; Voucher no: 017; Place of collection: Barehipani, Similipal; Date: 11th December 2021.

Order: Nostocales; Family: Tolypothrichaceae; Genus: *Tolypothrix*

24. *Tolypothrix rechingeri* (Wille) Geitler 1925 (Plate 2, Fig. 8)
   Keshari and Adhikary, 2014, Plate 47, Fig-2 (x)
   Long filaments bearing spherical, heterocyst arises at which false branching arises, heterocyst is intercalary, 4 μm long, 12 μm broad, sheath is thin and not constant, cell cylindrical.
   Habitat: black patches on rock surface; Voucher no: 019; Place of collection: Barehipani, Similipal; Date: 11th December 2021.

25. *Tolypothrix sytonematoides* (N.L.Gardner) Geitler 1932 (Plate 2, Fig. 9)
   Keshari and Adhikary, 2014, Fig. 2 (c), pg-47
   Habitat: Black patches on soil crust; Voucher no: 021; Place of collection: Barehipani, Similipal; Date: 11th December 2021.

Discussion

The finding of our present study represented those 25 subaerial cyanobacteria reported. It is important to note that out of these 25 cyanobacteria species 21 subaerial cyanobacterial species were first time recorded from Similipal biosphere reserve, Odisha such as *Anabaena subcylindrical* Borge, *Aphanthece microscopica* Naegeli, *Calothrix clavatooides* S.L. Ghose, *Chroococcus minor* (Kützing) Nägeli, *Chroococcus minutus* (Kützing) Nägeli, *Chroococcidiopsis kashayi* Friedman, *Gloeocapsa punctata* Nägeli, *Gloeocethra palea* (Kützing) Nägeli, *Hapalosiphon hibernicus* Nägeli ex Bornet and Flahault, *Nostoc piscinale*Kützing ex Bornet and Flahault, *Oscillatoria subbrevis*Schmidle, *Phormidium ambiguum* Gomont, *Phormidium aerugineo-caeruleum* (Gomont) Anagnostidis and Komárek, *Phormidium bulgaricum* (Komárek) Anagnostidis and Komárek, *Phormidium kolkwitzii* Komárek, *Phormidium retzii* Kützing ex Gomont, *Planktothrix cladotata* (Skuja) Bornet, *Scytonema stuposum* f. *nanyohense* C.-C.Jao, *Tolypothrix rechingeri* (Wille) Geitler. Furthermore, it is found that among these 25 cyanobacterial species 4 species are previously reported such as Similipal biosphere reserve, Odisha (Bhakta et al., 2015; Bhakta et al., 2014; Jena et al., 2006). Our findings of present investigations and the occurrence of the cyanobacterial species were quite similar to the previous reports on subaerial cyanobacterial diversity from several subaerial parts of India (Bhakta et al., 2015; Bhakta et al., 2014; Keshari and Adhikary, 2014). Similar research was done on the dynamics of species richness of bark algae and cyanobacteria in South-East Asian rain forest mountainous settings (Neustupa and Škaloud, 2010). Many sub aerial cyanobacteria colonising tree bark under the names *Nostoc, Phormidium, Scytonema,* and *Stigonema* (Bhakta et al., 2015; Bhakta et al., 2014). Furthermore, cyanobacteria indicated that ecological niches have a substantial impact on species composition. Cyanobacteria are found abundantly in samples taken from the subaerial portion (Mikhailyuk et al., 2001). These findings suggest that micro habitat factors, particularly humidity and illumination, may be important in shaping the diversity and species composition of subtropical bark-growing cyanobacterial assemblages. The distribution may be due to the subtropical climate of the Similipal Biosphere Reserve which is comparable with similar works carried out by (Bhakta et al., 2015; Bhakta et al., 2014). Furthermore, it is found that Similipal biosphere reserve, Odisha. are an important habitat of bio-resources in terms of the presence of important microalgal species which are having many uses in aquaculture and biotechnological applications.

Conclusion

In the present field investigation, a total of 25 cyanobacterial species had been identified and documented from 50 samples. Furthermore, taxonomic enumeration of all the subaerial cyanobacterial species were characterised. Among them, 21 species are first time recorded from the Similipal biosphere reserve Odisha, India. Similipal Biosphere Reserve in Odisha is an unique habitat for
cyanobacterial diversity. The identified cyanobacteria can be used in different biotechnological applications in future.

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