

Updated Checklist of Mangrove-Associated Cyanobacterial Diversity to the End of 2020

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ABSTRACT: This review presents an overview of the diverse habitats of mangrove-associated cyanobacteria, based on published literature records from 1889 to 2020. The primary goal of this study is to document the cyanobacteria and to revise and update nomenclature to reflect current taxonomic knowledge for previously reported species. There are a total of 409 cyanobacterial species. The dominant order was *Oscillatoriales* with 147 species (88 *Oscillatoriaceae*, 40 *Microcoleaceae*, 9 *Coleofasciculaceae*, 8 *Gomontiellaceae*, and 2 *Borziaceae*). *Synechococcales* (23 *Merismopediaceae*, and *Leptolyngbyaceae*, 11 *Pseudanabaenaceae*, 16 *Synechococcales familia insertae sedis*, 3 *Synechococcaceae*, 2 *Chamaesiphonaceae*, *Coleosphaeriaceae* *Trichocoleusaceae* and *Oculatellaceae* had only one species) was the second most abundant order with 83 species. *Chroococcales* (47 *Chroococcaceae*, 11 *Microcystaceae*, 8 *Aphanothecaceae*, 2 *Entophysalidaceae*, *Gomphosphaeriaceae*, *Stichosiphonaceae* and *Cyanothricaceae* had only 1 species) was the third most abundant order with 73 species. *Nostocales* (27 *Nostocaceae*, 12 *Calotrichaceae*, 10 *Scytonemataceae* and *Rivulariaceae*, 5 *Aphanizomenonaceae*, 2 *Hapalosiphonaceae* and *Chlorogloeopsidaceae*, *Heteroscytonemataceae*, *Microchaetaceae* and *Tolypothrichaceae* had one species each) was the fourth most abundant order with 70 species. *Pleurocapsales* had 26 species (8 *Xenococcaceae*, 7 *Dermocarpellaceae* and *Hyellaceae* and 4 *Hydrococcaceae*). *Spirulinales* had 7 *Spirulinaceae* species, *Chroococciopsidales* had 2 *Chroococciopsidaceae* species and *Gloeobacterales* had only one *Gloeobacteraceae* species.

KEY WORDS: Cyanobacteria, mangrove environment, marine, edaphic, epiphytic, epipsammic, benthic, planktic

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INTRODUCTION

Cyanobacteria are one of the most fascinating and significant groups of oxygen-evolving, gram-negative, photoautotrophic microorganisms from evolutionary, phylogenetic and ecological perspectives. Due to their wide range of adaptability to harsh and unfavourable conditions, cyanobacteria are found in all ecological habitats extending from the extremely cold deserts of the Arctic and Antarctic Zones (Mataloni, Komárek, 2004; Zaki et al., 2020) to the very extreme hot springs (Miller, Castenholz, 2000). Whilst cyanobacteria are regarded as cosmopolitans, this term should be used carefully because while certain species are extensively distributed, the majority of the group is confined to well-delimited habitats (Komárek, 1985, 1994; Komárek, Komarkova-Legnerova, 2007). Certain species are widely distributed but always occur in the same sort of environment, reflecting their ecological preferences and adaptations to diverse habitats.

Regarding cyanobacterial biodiversity, the literature shows that the tropics and subtropics are still understudied, and their biodiversity is considerably underestimated. It is assumed that less than 10% of tropical cyanobacterial diversity is known (Komárek, 2006). The studies on cyanobacteria in mangrove environments are very important because of their high capability to fix nitrogen, making them ideal candidates for future restoration and rehabilitation of destroyed mangroves (Bashan et al., 1998).

Conducting surveys is necessary to fulfil the research gaps that exist in this area regarding the distribution pattern of the mangrove-associated cyanobacteria across the world. The given checklist serves as a reliable catalogue for the forthcoming principal research interest in this area.

MATERIAL AND METHODS

The documentation of mangroves-associated cyanobacteria have been listed purely based on the available published works of literature. To create a catalogue of species and respective articles in which they are cited, we referred to 82 research papers and books published nationally and internationally. Cyanobacteria are observed in a variety of habitats, including epipsammic/edaphic, epiphytic, planktic, benthic and epilithic forms, which are considered to be prevalent in mangrove environments. A list of publications, together with the location of study areas and their respective country are given in the Table. In some literature, the occurrence of cyanobacterial species may not be mentioned specifically, such species are listed under the category, 'mangrove environment'. Different methods adopted for the cyanobacterial collection were discussed in the original research literature which is cited in the present study.

The list is exclusively based on the published research findings. Names of taxa are given with author citations. Species are classified according to their respective family. The species are classified based on the current classification system and the entity of the taxonomically accepted species are verified by Guiry and Guiry (2021).

TABLE: List of scientific publications used in this study. References habitats and locations/countries are provided here. References are arranged in chronological order

No.	References	Habitat	Location/Country
1	Moebius, 1889	Mangrove environment	Joinville's mangroves, Brazil
2	Joly, 1951	Mangrove environment	Paraná State, Brazil
3	Joly, 1957	Mangrove environment	Santos, Brazil
4	Millard, Broekhuysen, 1970	Mangrove environment	St. Lucia estuary, South Africa
5	Burkholder, Almodovar, 1973	Epiphytic	Puerto Rico
6	Dor, 1975	Epiphytic	Sinai estuary
7	Potts, Whitton, 1977	Epipsammic	Aldabra Atoll
8	Potts, 1979	Epipsammic	Sinai estuary
9	Potts, 1980	Epilithic, Epiphytic	Sinai estuary
10	Potts, Whitton, 1980	Epipsammic	Aldabra Atoll
11	Beanland, Woelkerling, 1983	Epiphytic	Spencer Gulf, South Australia
12	Sant'Anna et al., 1983	Mangrove environment	Ilha do Cardoso, Brazil
13	Oliveira, 1984	Mangrove environment	Brazil
14	Carmo, 1987	Mangrove environment	North of Baía de Vitória, Espírito Santo State, Brazil
15	Ramachandran, Venugopalan, 1987	Planktic	Portonovo, TamilNadu, India
16	Sant'Anna, 1988	Mangrove environment	São Paulo, Southern Brazil
17	Santra et al., 1988	Epiphytic	West Bengal, India
18	Coppejans, Gallin, 1989	Mangrove environment	Gazi Bay, Kenya
19	Lambert et al., 1989	Epiphytic	South Africa
20	Rodriguez, Stoner, 1990	Epiphytic	Laguna Joyuda, west coast of Puerto Rico
21	Steinke, Naidoo, 1990	Epiphytic	St. Lucia estuary, South Africa
22	Silva, 1991	Epiphytic	Inhaca Island, Mozambique
23	Kannan, Vasantha, 1992	Planktic	Pichavaram, Tamil Nadu, India
24	Hussain, Khoja, 1993	Mangrove Swamps, Epilithic	Farasan Archipelago, Saudi Arabia
25	Mann, Steinke, 1993	Epiphytic	Beachwood Mangrove Nature Reserve, South Africa
26	Branco et al., 1994	Epiphytic	South-east region of Brazil and the south of Mozambique
27	Dhargalkar, 1994	Mangrove environment	India
28	Phillips et al., 1994	Epiphytic	Beachwood Mangrove Nature Reserve, South Africa
29	Saifullah, Taj, 1995	Epiphytic	Karachi, Pakistan
30	Toledo et al., 1995a	Epiphytic	North-western Mexico
31	Toledo et al., 1995b	Epiphytic	North-western Mexico
32	Branco et al., 1996	Epipsammic, Epiphytic	Cardoso Island mangroves, São Paulo State, Brazil

33	Phillips et al., 1996	Epiphytic	Beachwood Mangrove Nature Reserve, South Africa
34	Branco et al., 1997	Epiphytic, Mangrove environment	Cardoso Island mangroves, São Paulo State, Brazil
35	Saifullah et al., 1997	Epiphytic	Balochistan, Pakistan
36	Bashan et al., 1998	Epiphytic	Laguna de Balandra and western Ensenada de La Paz, Mexico
37	Gab-Alla, 2000	Epiphytic	Nabq area, Egypt
38	Zaib-Un-Nisa et al., 2000	Epiphytic	Karachi, Pakistan
39	Banerjee, Santra, 2001	Planktic	Sundarbans, India
40	Nogueira, Ferriera-Correia, 2001	Mangrove environment	São Luís, state of Maranhão, Brazil
41	Selvakumar, Sundararaman, 2001	Epiphytic	Muthupet estuary, Tamil Nadu, India
42	Branco et al., 2003	Epiphytic, Mangrove environment	Ilha de Itamaracá, north coast of the State of Pernambuco, Brazil
43	Kyaruzi et al., 2003	Mangrove environment	Maruhubi, Zanzibar
44	Sen, Naskar, 2003	Planktic, Epipsammic, Epilithic, Epizoic	Sundarbans, India
45	Steinke et al., 2003	Epiphytic	Kosi System, South Africa
46	Sudha, 2005	Mangrove environment	Muthupet, Tamil Nadu, India
47	Sudha et al., 2007	Mangrove environment	Muthupet, Tamil Nadu, India
48	Bano, Siddiqui, 2007	Edaphic, Epiphytic, Epizoic, Epilithic, Coastal waters of mangrove environment, Rock pool waters of mangrove environment, mangrove swamps	Buleji, Pakistan
49	Essien et al., 2008	Epipsammic	Qua Iboe Estuary, Nigeria
50	Nedumaran et al., 2008	Epiphytic, Planktic	Pichavaram, Tamil Nadu, India
51	Pena-Salamanca, 2008	Epiphytic	Buenaventura bay, Pacific coast of Colombia
52	Rajkumar et al., 2009	Planktic	Pichavaram, Tamil Nadu, India
53	Tessy, Saritha, 2010	Mangrove environment	Poyya, Thrissur, Kerala, India
54	Boopathi, 2011	Epiphytic	Pichavaram and Muthupet, Tamil Nadu, India
55	Leon-Tejera et al., 2011	Epiphytic	Baja California Sur, Mexico
56	Rigonato et al., 2012a	Epiphytic	Cardoso Island, Sao Paulo State, Brazil
57	Rigonato et al., 2012b	Epipsammic	Cardoso Island, Sao Paulo State, Brazil
58	Perez-Estrada et al., 2012	Epiphytic	Baja California Sur, Mexico

59	Silambarasan et al., 2012	Mangrove environment	Parangipettai, Ariyankuppam and Mudasal odai, Tamil Nadu, India
60	Sakthivel, Kathiresan, 2013	Mangrove environment	Pichavaram, Parangipettai and Mudasal odai, Tamil Nadu, India
61	Paul, Saritha, 2013	Mangrove environment	Poyya, Thrissur, Kerala, India
62	Saifullah et al., 2014	Planktic	Sarawak, Malaysia
63	Fatimahsari et al., 2014	Epiphytic	Cagar Alam Pulau Dua (CAPD) Serang, Banten Indonesia
64	Shamina et al., 2014	Mangrove environment	Kerala, India
65	Rao et al., 2015	Planktic	Visakhapatnam, India
66	Barman et al., 2015	Mangrove environment	Sundarbans, India
67	Huisman et al., 2015	Epiphytic	Shark Bay, Western Australia
68	Mohamed, Al-Shehri, 2015	Mangrove environment	Ash Shuqaiq, Al Qahmah and Amaq, Saudi Arabia
69	Ram, Shamina, 2015	Epiphytic, Planktic, Benthic	Kerala, India
70	Ahmed et al., 2016	Mangrove environment	Karachi, Pakistan
71	Joseph, Saramma, 2016	Mangrove environment	Cochin, India
72	Bhuvaneshwari, Muruganandam, 2016	Mangrove environment	Thondiyakadu, Tamil Nadu, India
73	Alvarenga et al., 2016	Epiphytic	Sao Paulo, Brazil
74	Ramamurthy, Abhinand, 2016	Mangrove environment	Manakudy, Tamil Nadu, India
75	Ans, Mendez, 2017	Mangrove environment	Ernakulam, Kerala, India
76	Kumar et al., 2017	Mangrove environment	Muthukuda, Tamil Nadu, India
77	Ram, Shamina, 2017	Mangrove environment	Kerala, India
78	Chakraborty et al., 2018	Epipsammic	Sundarbans, India
79	Chakraborty et al., 2019	Epipsammic	Sundarbans, India
80	Priya et al., 2019	Mangrove environment	Kodiakkarai, Tamil Nadu, India
81	Singh, Bhadury, 2019	Planktic	Sundarbans, India
82	Ram, Paul, 2020	Mangrove environment	Kerala, India

RESULTS AND DISCUSSION

As the goal was to look for scientific papers published in this respective study area, we noted that the first published works date the year 1889. The results of the survey indicated 409 mangrove-associated cyanobacterial species (List). The order *Oscillatoriales* was the richest one (147 taxa) followed by *Synechococcales* (83), *Chroococcales* (73), *Nostocales* (70), *Pleurocapsales* (26), *Spirulinales* (7), *Chroococciidiopsidales* (2), and *Gloeobacterales* (1) (List, see below; Fig. 1).

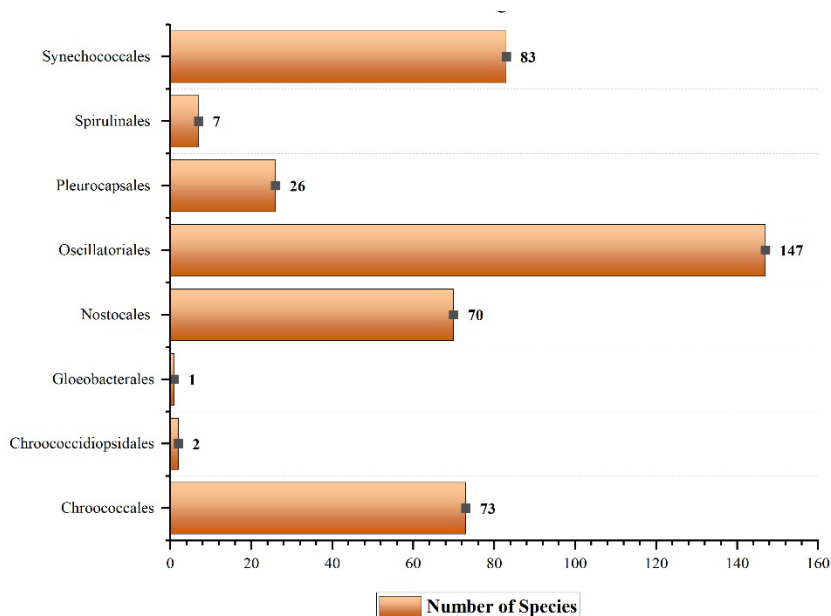


FIG. 1: Graphical position and taxon number of mangrove-associated cyanobacteria according to order

List of cyanobacterial species reported from the previous studies from 1889–2020

(Habitat: BE – Benthic; EC – Epiphyllic; ED – Edaphic; EL – Epilithic; EP – Epiphytic; ES – Epipsammic; EZ – Epizoic; ME – Mangrove environment; PC – Pelagic; PH – Periphytic; PL – Planktic). Citations – in brackets cited literature taken from the Table).

Chroococcales – Aphanothecaceae: *Aphanothece bullosa* (Meneghini) Rabenhorst 1865, EP (47); *A. castagnei* (Kützing) Rabenhorst 1865, ES (31), ME (39, 41, 70); *A. elabens* (Brébisson ex Meneghini) Elenkin 1938, ME (68); *A. microscopica* Nageli 1849, ME (46, 47), EZ (48); *A. nidulans* P.Richter 1884, ME (46, 47), EZ (48); *A. nidulans* P.Richter 1884, ME (46, 47), EZ (48); *A. pallida* (Kützing) Rabenhorst 1863, EP (69), ME (77); *A. saxicola* Nageli 1849, ME (27), EP (32); *A. stagnina* (Sprengel) A.Braun 1863, EP (22), ME (40), PL (44), EL (48).

Chroococcales – Chroococcaceae: *Chondrocystis dermochroa* (Nageli ex Kützing) Komárek & Anagnostidis 1995, ME (71); *Chroococcus cohaerens* (Brébisson) Nageli 1849, EZ, EL, ED, Coastal waters of ME (48), ME (71); *C. dispersus* (Keissler) Lemmermann 1904, EP (48); *C. giganteus* West 1892, ME (24); *C. gomontii* Nygaard 1926, EP (48); *C. hansgirgii* Schmidle 1900, EP, EL (19, 45, 48); *C. indicus* Zeller 1873, EP, ED (48); *C. macrococcus* (Kützing) Rabenhorst 1863, ME (24), EP, ME (48); *C. major* Komárek & Komakova-Legnerova 2007, ME (60); *C. membraninus* (Meneghini) Nageli 1849, EP (32); *C. minor* (Kützing) Nageli 1849, EP (22, 32), ME (46, 47, 68, 72, 80), EP, EL, EZ (48), PL (50); *C. minutus* (Kützing) Nageli 1849, ME (24, 46, 47, 60, 68, 71), EP, EZ, EL, ED, Rockpool waters of ME (48), EP (54); *C. montanus* Hansgirg 1893, EP, EZ (48, 54), ME (71); *C. obliteratus* Richter 1885, EP (55, 58); *C. pallidus* Nageli 1849, EL (48); *C. schizodermaticus* West 1892 Rockpool waters of ME (48); *C. spelaeus* Ercegovic 1925 ME (24, 59, 71); *C. tenax* (Kirchner) Hieronymus 1892, ME, EL (24), EP (48), PL (50); *C. turgidus* (Kützing) Nageli 1849, ME (18, 24, 27, 46, 47, 59, 60, 64, 68, 71, 74, 77), EP, EZ, ED, Coastal waters of ME (19, 45, 48), PL (50); *C. turgidus* var. *maximus* Nygaard 1926, EP (22); *C. turicensis* (Nageli) Hansgirg 1887, ME (24); *C. varius* A.Braun 1876, ME (59); *C. westii* J.B.Petersen 1923, ME (24); *Cyanobacterium cedrorum* (Sauvageau) Komárek, J.Kopecky & Cepak 1999, ME (48, 71, 72, 80);

Cyanosarcina spectabilis (Geitler) Kovacik 1988, EP, EZ, EL, ED, Rockpool waters of ME (38, 48), ME (60); *Dactylococcopsis raphidioides* Hansgirg 1888, ME (71); *Gloeocapsa aeruginosa* Kützing 1843, PL (44), ME (46, 47); *G. calcarea* Tilden 1898, EP (48), ME (72, 80); *G. compacta* Kützing 1847, EP, EL (48), ME (71, 72, 80); *G. decorticans* (A.Braun) P.Richter 1930, ES (44); *Gloeocapsa gelatinosa* Kützing 1843, EP, EZ, EL, ED, ME (48, 71), *G. granosa* (Berkeley) Kützing 1847, ME (46, 47); *G. kuetzingiana* Nageli ex Kützing 1849, PL (44), ED (48); *G. livida* (Carmichael) Kützing 1847, ME (71); *G. punctata* Nageli 1849, EL (44), EZ (48), ME (66); *G. quaternata* Kützing 1846, ME (71); *G. rupestris* Kützing 1847, ES (44), ME (71); *G. sanguinea* (C.Agardh) Kützing 1843, ME (24); *G. stegophila* (Itzigsohn) Rabenhorst 1863, ME (46, 47, 60, 68); *Gloeocapsopsis crepidinum* (Thuret) Geitler ex Komárek 1993, ME, EL (24, 38, 40, 46, 47, 48, 60, 71); *G. pleurocapsoides* (Novacek) Komárek & Anagnostidis ex Komárek 1993, EP (48), ME (60); *Gloeotheca fuscolutea* (Nageli ex Kützing) Nageli 1849, EP (48); *G. palea* (Kützing) Nageli 1849, ES (32), EZ (48); *G. rhodochlamys* Skuja 1949, EZ (48); *G. rupestris* (Lyngbye) Bornet 1880, EP, EZ (32, 48, 38); *G. samoensis* Wille 1913, EP, EZ, EL, ED, Rockpool water, coastal waters of ME (48); *Lightfootiella montana* (Lightfoot) Hasler, Pentecost, Jahodarova, Dvorak et Pouluckova 2018, EP (20).

Chroococcales – Cyanotrachiaceae: *Johannesbaptistia pellucida* (Dickie) W.R.Taylor & Drouet 1938, ME (18, 24, 46, 47, 60, 71), EP (41), PL (44), EL (48).

Chroococcales – Entophysalidaceae: *Entophysalis conferta* (Kützing) Drouet & Daily 1948, ME (24); *E. granulosa* Kützing 1843, ES (10), ME (24, 60).

Chroococcales – Gomphosphaeriaceae: *Gomphosphaeria aponina* Kützing 1836, ME (24, 74); *G. aponina* var. *multiplex* Nygaard 1926, ME (24).

Chroococcales – Microcystaceae: *Microcystis aeruginosa* (Kützing) Kützing 1846, PL (50), ME (59, 60, 72, 76, 80); *M. bengalensis* Banerjii 1936, PL (44); *M. flosaquae* (Wittrock) Kirchner 1898, ME (74); *Microcystis halophila* var. *macrococca* (Hansgirg) P.C.Silva 1996, ME (24); *M. lamelliformis* Holsinger 1954, ME (74); *M. orissica* West 1911, ME (71); *M. protocystis* W.B.Crow 1923, ME (72, 80); *M. pulverea* (H.C.Wood) Forti 1907, ME (74); *M. robusta* (H.W.Clark) Nygaard 1925, EP (41), ME (72, 80); *M. smithii* Komárek & Anagnostidis 1995, PL (44), ME (46, 47), EP (54); *M. viridis* (A.Braun) Lemmermann 1903, ED (48).

Chroococcales – Stichosiphonaceae: *Stichosiphon mangle* L.H.Z.Branco, S.M.F.Silva, & C.L.Sant'Anna 1995, EP (26, 32); *S. sansibaricus* (Hieronymus) F.E.Drouet & W.A.Daily 1956, ME (44, 74).

Chroococciidiopsidales – Chroococciidiopsidaceae: *Chroococciidiopsis cubana* Komárek & Hindak 1975, EP (32); *C. indica* Desikachary 1959, EP (38), EP, EZ, ED, ME (48).

Gloeobacterales – Gloeobacteraceae: *Gloeobacter violaceus* Rippka, J.B.Waterbury & Cohen-Bazire 1974, ME (74).

Nostocales – Aphanizomenonaceae: *Anabaenopsis arnoldii* Aptekar 1926, PL (44); *Dolichospermum flosaquae* (Brébisson ex Bornet & Flahault) P.Wacklin, L.Hoffmann & J.Komárek 2009, ME (66); *D. spiroides* (Klebhan) Wacklin, L.Hoffmann & Komárek 2009, ME (72, 80); *Nodularia spumigena* Mertens ex Bornet & Flahault 1888, ME (24, 46, 47, 74); ES (49); EP (50); *N. spumigena* var. *major* Bornet & Flahault 1886, ME (24).

Nostocales – Calotrichaceae: *Calothrix aeruginosa* Woronichin 1923, EP (9, 67); *C. bharadwajae* G.De Toni 1939, ME (59); *C. breviarticulata* West & G.S.West 1897, ME (68); *C. brevissima* G.S.West 1907, EP, ED (48), ME (59); *C. castellii* Bornet & Flahault 1886, EP (54); *C. clavata* G.S.West 1914, ME (66); *C. confervicola* C.Agardh ex Bornet & Flahault 1886, ME (24); *C. contarenii* Bornet & Flahault 1886, ES (10), EP (19, 45), ME (46, 47, 60, 72, 80); *C. fusca* Bornet & Flahault 1886, EL (48); *C. ghosei* Bharadwaja 1935, ME (72, 80); *C. pulvinata* C.Agardh ex Bornet & Flahault 1886, ME, EL(24), EP (50); *C. scopulorum* C.Agardh ex Bornet & Flahault 1886, EL (9), EP (19, 22, 45), ME (24, 46,47, 60, 68).

Nostocales – Chlorogloeopsidaceae: *Chlorogloeopsis früschi* (A.K.Mitra) A.K.Mitra & D.C.Pandey 1967, EP (48), ME (60, 71).

Nostocales – Hapalosiphonaceae: *Hapalosiphon welwitschii* West & G.S.West 1897, ME (46, 47, 74); *Mastigocoleus testarum* Lagerheim ex Bornet & Flahault 1886, EL (9), EZ (44).

Nostocales – Heteroscytonemataceae: *Heteroscytonema crispum* (Bornet ex De Toni) G.B.McGregor & Sendall 2018, EP (67), ME (60).

Nostocales – Microchaetaceae: *Microchaete grisea* Thuret ex Bornet & Flahault 1886, EL (48), ME (60).

Nostocales – Nostocaceae: *Anabaena iyengarai* Bharadwaja 1935, ME (59, 60); *A. orientalis* S.C.Dixit 1936, ME (72, 80); *A. oscillarioides* Bory ex Bornet & Flahault 1886, ME (24); *A. sphaerica* Bornet & Flahault 1886, ME (59, 60, 66, 68, 74); *A. torulosa* Lagerheim ex Bornet & Flahault 1886, ME (59); *Cylindrospermum majus* Kützing ex Bornet & Flahault 1888, PL (50); *Desmonostoc muscorum* (C.Agardh ex Bornet & Flahault) Hrouzek & Ventura 2013, PL, BE (69), ME (74, 77); *Hydrocoryne enteromorphoides* (Grunow ex Bornet & Flahault) Umezaki & M.Watanabe 1994, ME, PC (24); *Nostoc carneum* C.Agardh ex Bornet & Flahault 1886, ME (66); *N. commune* Vaucher ex Bornet & Flahault 1888, ME (66); *N. ellipsoforum* Rabenhorst ex Bornet & Flahault 1886, ME (66, 77); *N. linckia* Bornet ex Bornet & Flahault 1886, EP (44), ME (72, 80); *N. microscopicum* Carmichael ex Bornet & Flahault 1886, ME (64, 77); *N. oryzae* (F.E.Fritsch) J.Komárek & K.Anagnostidis 1989, EP (54); *N. paludosum* Kützing ex Bornet & Flahault 1886, ME (50, 77); *N. passerinianum* Bornet & Thuret ex Bornet & Flahault 1886, BE (69), ME (77); *N. punctiforme* Hariot 1891, PL (44); *Raphidiopsis curvata* Fritsch & M.F.Rich 1930, PL (44); *R. indica* R.N.Singh 1942, PL (44), ME (60); *Richelia intracellularis* J.Schmidt 1901, ME (74); *Trichormus doliolum* (Bharadwaja) Komárek & Anagnostidis 1989, PL (44); *T. khannae* (Skuja) Komárek & Anagnostidis 1989, ME (71); *T. anomalus* (F.E.Fritsch) Komárek & Anagnostidis 1989, PL (44), Rock pool water, Coastal waters of ME (48); *T. ellipsoforum* (F.E.Fritsch) Komárek & Anagnostidis 1989, ME (59); *T. gelatinicola* (Ghose) Komárek & Anagnostidis 1989, PL (44); *T. variabilis* (Kützing ex Bornet & Flahault) Komárek & Anagnostidis 1989, ME (24, 66), PL (50); *Wollea ambigua* (C.B.Rao) R.Y.Singh 1942, PL (23, 50).

Nostocales – Rivulariaceae: *Dichothrix baueriana* Bornet & Flahault 1886, ME (59, 60, 74); *D. penicillata* Zanardini ex Bornet & Flahault 1886, ME, EL (24); *D. utahensis* Tilden 1898, EP (67); *Phyllonema aviceniicola* Alvarenga, Rigonato, Branco, Melo & M.F.Fiore 2016, EC (73); *Kyrtuthrix dalmatica* Ercegovic 1929, EL (9); *K. maculans* (Gomont) I.Umezaki 1958, EL (9); *Gardnerula corymbosa* De Toni 1936, ES (9); *Rivularia atra* Roth ex Bornet & Flahault 1886, EP (19, 45); *R. bullata* Berkeley ex Bornet & Flahault 1886, EP (19, 45); *R. polyotis* Roth ex Bornet & Flahault 1886, EP (11, 37), ME (24).

Nostocales – Scytonemataceae: *Scytonema hofmannii* C.Agardh ex Bornet & Flahault 1886, EP (19, 45), EL (24, 44); *S. arcangelii* Bornet & Flahault 1886, ME (40); *S. bohneri* Schmidle 1901, ME (66, 77), PL (69); *S. chiasmum* Geitler 1925, ME (59); *S. insulare* C.L.Sant'Anna 1988, ME (16, 40); *S. leptobasis* S.L.Ghose 1931, PL (69), ME (77); *S. saleyeriense* Weber Bosse 1913, ME (24); *S. varium* Kützing ex Bornet & Flahault 1886, ME (59); *Scytonematopsis crustacea* (Thuret ex Bornet & Flahault) Kovacik & Komárek 1988, ME (27, 46, 47, 60, 68), ES (7, 10), EP (9, 22, 35, 44), ME, EL (24); *S. pilosa* (Harvey ex Bornet & Flahault) I.Umezaki & M.Watanabe 1994, EL (9).

Nostocales – Tolypothricaceae: *Tolypothrix tenuis* Kützing ex Bornet & Flahault 1886, ME (71).

Oscillatoriales – Borziaceae: *Borzia susedana* Ercegovic 1925, EP (48); *B. trilocularis* Cohn ex Gomont 1892, EP, EZ, EL, rock pool water, ME (48).

Oscillatoriales – Coleofasciculaceae: *Anagnostidinema acutissimum* (Kufferath) Strunecky, Bohunicka, Johansen et Komárek 2017, EP, ME (38, 48); *A. deflexum* (W. et G.S.West) Strunecky, Bohunicka, Johansen, Capkova, Raabova, Dvoraak et Komárek 2017, EP (48), ME (71); *A. ionicum* (Skuja) Strunecky, Bohunicka, Johansen, Capkova, Raabova, Dvorak et Komárek 2017, ED, ME (48); *A. lemmermannii* (Woloszynska) Strunecky, Bohunicka, Johansen, Capkova, Raabova, Dvorak et Komárek 2017, EL (48); *Coleofasciculus chthonoplastes* (Thuret ex Gomont) Siegesmund, Johansen et Friedl 2008, ME (1, 4, 18, 24, 27, 34, 40, 42, 44, 45, 46, 47, 60, 64, 66, 68, 74, 77), ES (7, 10), EP (19, 21, 22, 25, 28, 33, 35, 36, 50, 54); *Geitlerinema calcuttense* (Biswas) Anagnostidis 1989, EP (41), ME (71); *Geitlerinema claricentrosom* (N.L.Gardner) Anagnostidis 1989, EP (41), Coastal waters of ME (48); *G. earlei* (N.L.Gardner) Anagnostidis 1989, ME (27); *G. splendidum* (Greville ex Gomont) Anagnostidis 1989, EL, ED (48), ME (60).

Oscillatoriales – Gomontiellaceae: *Hormoscilla pringsheimii* Anagnostidis & Komárek 1988, ED (48); *Katagnymene accurata* Geitler 1982, EL, EZ, EP (48); *Komvophoron anabaenoides* (C.-C.Jao & Y.Y.Li) Anagnostidis & Komárek 1988, ME (48); *K. crassum* (Vozzhennikova) Anagnostidis & Komárek 1988, EZ 48; *K. epiphyticum* Anagnostidis & Komárek 1988, ED (48); *K. minutum* (Skuja) Anagnostidis & Komárek 1988, ED (48); *K. pallidum* (Skuja) Anagnostidis & Komárek 1988, EZ (48); *K. schmidlei* (Jaag) Anagnostidis & Komárek 1988, ME (48, 46, 47, 71).

Oscillatoriales – Microcoleaceae: *Arthrospira gigantea* (Schmidle) Anagnostidis 1998, EP, EL, Rock pool water of ME (48); *A. platensis* Gomont 1892, PL (44, 65), ME (24, 66, 74), EP (22); *A. tenuis* Bruhl & Biswas 1922, ME (71); *Johanseninema constrictum* (Szafer) Hasler, Dvorak & Poulickova 2014, EL, ME (48); *Kamptonema animale* (C.Agardh ex Gomont) Strunecky, Komárek & J.Smarda 2014, ME (46, 72, 80), EP, ME (47, 48); *K. (chlorinum)* (Kützing ex Gomont) Strunecky, Komárek & J.Smarda 2014, ED (48), ME (60, 68, 82), ES (44), EP (19, 45); *K. cortianum* (Meneghini ex Gomont) Strunecky, Komárek & J.Smarda 2014, ME (46, 47, 59); *K. formosum* (Bory ex Gomont) Strunecky, Komárek & J.Smarda 2014, ME (24, 46, 47, 59, 60, 68, 72, 74, 75, 80); *K. jasarvense* (Vouk) Strunecky, Komárek & J.Smarda 2014, ME (71); *K. laetevirens* (H.M.Crouan & P.L.Crouan ex Gomont) Strunecký, Komárek & J.Smarda 2014, ME (46, 47, 71), EP (48); *K. okenii* (C.Agardh ex Gomont) Strunecky, Komárek & J.Smarda 2014, ED (48), ME (24, 72, 77, 80, 82), EP (28, 33); *K. proteus* (Skuja) Strunecky, Komárek & J.Smarda 2014, ME (48); *Limnospira maxima* (Setchell & N.L.Gardner) Nowicka-Krawczyk, Muhlsteinova & Hauer 2019, ME (72, 80); *Microcoleus amoenus* (Gomont) Strunecky, Komárek & J.R.Johansen 2013, ME (74); *M. favosus* (Gomont) Strunecky, Komárek & J.R.Johansen 2013, EP (48); *M. lacustris* Farlow ex Gomont 1892, ME (66); *M. lyngbyaceus* Kützing ex Forti 1907, EP (5); *M. paludosus* Gomont 1892, ME (66); *M. vaginatus* Gomont ex Gomont 1892, ME (14, 24); *M. weeksiae* Setchell & N.L.Gardner 1918, ME (34, 42); *Oxynema aestuarii* Chakraborty et Mukherjee 2018, ES (78); *O. acuminatum* (Gomont) Chatchawan, Komárek, Strunecky, Smarda & Peerapornpisal 2012, ME (46, 47, 68, 71, 72, 80), EP (48); *Planktothrix agardhii* (Gomont) Anagnostidis & Komárek 1988, EP, EL, ED (48), PL, EP (50); *P. clathrata* (Skuja) Anagnostidis & Komárek 1988, EP, EZ, ED, rock pool waters, coastal waters of ME (48); *P. compressa* (Utermohl) Anagnostidis & Komárek 1988, EP, EZ, EL, ED, ME (48); *P. mougeotii* Anagnostidis & Komárek 1988, EP, EZ, EL, ED, rock pool water of ME (48); *P. planctonica* (Elenkin) Anagnostidis & Komárek 1988, EP (48); *P. rubescens* (De Candolle ex Gomont) Anagnostidis & Komárek 1988, EP (54), ME (72, 80); *Porphyrosiphon ceylanicus* (Wille) Anagnostidis & Komárek 1988, ME (24); *P. notarisii* Kützing ex Gomont 1892, EP (41); *Pseudophormidium radiosum* (Gomont) Anagnostidis & Komárek 1988, ME (72, 80); *Pseudoscytonema malayense* (Biswas) Elenkin 1949, EP, EZ, EL, ED (48); *Sirocoleum guyanense* Kützing ex Gomont 1892, ME (3); *Symploca hydroides* Kützing ex Gomont 1892, EL (24), ME (60); *S. muscorum* Gomont ex Gomont 1892, ME (24), EL (48), *Symplocastrum friesii* (Gomont) Kirchner 1898, ME (46, 47); *Trichodesmium erythraeum* Ehrenberg ex Gomont 1892, PL (23, 50, 52, 62), ME (59, 60, 74, 76), PC (24); *Tychonema bornetii* (Zukal) Anagnostidis & Komárek 1988, ME (12); *T. bourrellyi* (J.W.G.Lund) Anagnostidis & Komárek 1988, EL, ED (48); *T. rhodonema* (Skuja) Anagnostidis & Komárek 1988, EZ (48).

Oscillatoriales – Oscillatoriaceae: *Blennothrix cantharidosma* (Gomont ex Gomont) Anagnostidis & Komárek 1988, ME (24); *B. lyngbyacea* (Kützing ex Gomont) Anagnostidis & Komárek 1988, ME (24), EP (29), ES (44); *Limnoraphis birgei* (G.M.Smith) J.Komárek, E.Zapomelova, J.Smarda, J.Kopecky, E.Rejmankova, J.Woodhouse, B.A.Neilan & J.Komarkova 2013, ME (24, 60, 66, 68), EP (35), PL (44); *L. cryptovaginata* (Schkorbatov) J.Komárek, E.Zapomelova, J.Smarda, J.Kopecky, E.Rejmankova, J.Woodhouse, B.A.Neilan & J.Komarkova 2013, EP (48), ME (71); *L. hieronymusii* (Lemmermann) J.Komárek, E.Zapomelova, J.Smarda, J.Kopecky, E.Rejmankova, J.Woodhouse, B.A.Neilan & J.Komarkova 2013, ME (74), PL (44); *Lyngbya aestuarii* Liebman ex Gomont 1892, ME (46, 47), EP, ME (48), PL (50), EP (51), ES (8); ME (24, 40, 4, 47, 60); *L. borgertii* Lemmermann 1907, EP, ED (48); *L. cinerascens* Kützing ex Biswas 1926, EP (19); *L. confervoides* C.Agardh ex

Gomont 1892, EP (19, 21, 22, 25, 28, 33, 51), ME (2, 4, 24, 34, 44, 46, 47, 59, 60, 66, 72, 80), PL (50), ES (10); *L. lutea* Gomont ex Gomont 1892, ME (24, 46,47), ES (44), EP (19, 20); *L. major* Meneghini ex Gomont 1892, EP (48, 50), ME (59); *L. majuscula* Harvey ex Gomont 1892, EP (22, 29, 35, 54), ME (46, 47, 59, 60, 66, 72, 74, 80), ES (10, 49), ME, EL, PC (24), PL (44); *L. martensiana* Meneghini ex Gomont 1892, ME (24, 34, 42, 46, 47, 60, 64, 66, 68, 71, 77), EL (9), EP, ED, Coastal waters of ME (48), EP (54); *L. semiplena* J.Agardh ex Gomont 1892, EP (35, 42, 67), ME (46, 47, 71), PL (44); *L. sordida* Gomont 1892, ME (24, 66); *L. spiralis* Geitler 1932, ME (24); *L. spirulinoides* Gomont ex Gomont 1892, Rock pool waters of ME (48); *L. usteri* Schmidle 1904, EP (54); *Oscillatoria lutea* C.Agardh 1824, ME (34, 40); *O. nitida* C.Agardh ex Corda 1836, EZ (48); *O. annae* Goor 1918, EP (69), ME (27, 56, 47, 77), EZ, Rock pool waters of ME (48); *O. chilensis* Biswas 1932, ME (77); *O. corallinae* Gomont ex Gomont 1890, EP (19, 35), ME (40); *O. crassa* (C.B.Rao) Anagnostidis 2001, ME (77); *O. curviceps* C.Agardh ex Gomont 1892, ME (24, 34, 82); *O. earlei* N.L.Gardner 1927, EP (41); PL (44); ME (24, 34, 60, 64, 68, 77, 82), EZ, ED, Rock pool waters of ME (48); *O. geitleriana* Elenkin 1949, EP (54), ME (60); *O. grossegranulata* Skuja 1956, EZ (48); *O. indica* P.C.Silva 1996, PL (50), ME (46, 47, 59, 60, 64, 68, 71, 72,76, 77, 80); *O. jenensis* G.Schmid 1921, EP (22); *O. limosa* C.Agardh ex Gomont 1892, EP (19, 25, 45), ME (27, 70, 72, 80, 82), PH (44), PL (65); *O. obscura* Bruhl & Biswas 1922, EP (54), ME (66, 77); *O. ornata* Kützing ex Gomont 1892, EP (69), ME (64, 77, 82); *O. perornata* f. *attenuata* Skuja 1949, ME (64, 77); *O. perornata* Skuja 1949, ME (72, 80), EZ, Rock pool water, coastal waters of ME (48); *O. princeps* Vaucher ex Gomont 1892, EP (48), ME (24, 27, 34, 60, 66, 70, 82), PL (44); *O. proboscidea* Gomont 1892, EP (19, 28, 33); ME (46, 47); *O. raytonensis* Cholnoky 1955, EP (48); *O. sancta* Kützing ex Gomont 1892, ED, Rock pool waters of ME (48), ME (60, 68); *O. simplicissima* Gomont 1892, ME (34); *O. subbrevis* Schmidle 1901, ME (34, 44, 46, 47, 66, 72, 80, 82), EP (19, 21, 28, 33, 54), PL (23); *O. tenuis* C.Agardh ex Gomont 1892, EP (41, 48), ME (46, 47, 59, 60, 68, 71, 74) ES (44); *O. variabilis* C.B.Rao 1936, EP, EZ, ED, rock pool waters of ME, (48); *O. vizagapatensis* C.B.Rao 1938, EP (41, 48), ME (77); *Phormidium anomalum* (Bharadwaja) Anagnostidis & Komárek 1988, EP, EZ, EL, ED, rock pool water, coastal waters of ME (48); *P. stagninum* Anagnostidis 2001, ME (68); *P. abronema* Skuja 1949, ME (71); *P. acula* (Bruhl & Biswas) Anagnostidis & Komárek 1988, ME (66, 71, 82); *P. allorgei* (Freymy) Anagnostidis & Komárek 1988, EL, EP (9), ME (24, 34), EP, EZ, EL, coastal water of ME (48); *P. ambiguum* Gomont 1892, EP (19, 29, 45, 48, 54, 59, 60, 68, 72); *P. anomalum* C.B.Rao 1937, ME (72); *P. baculum* (Gomont ex Gomont) Anagnostidis 2001, EP (19, 21); *P. bohneri* Schmidle 1902, ME (71, 77), EP (69); *P. boryanum* (Bory ex Gomont) Anagnostidis & Komárek 1988, EP (69), ME (77); *P. breve* (Kützing ex Gomont) Anagnostidis & Komárek 1988, ME (46, 47, 70, 72, 80), EP, EL, ED, rock pool water of ME (48); *P. ceylanicum* Wille 1924, EP, EZ, EL, ED, rock pool water, coastal waters of ME (48); *P. chalybeum* (Mertens ex Gomont) Anagnostidis & Komárek 1988, ME (48, 60, 82); *P. corium* Gomont ex Gomont 1892, ED (48), ME (34, 46, 47, 60, 71); *P. diguetii* (Gomont) Anagnostidis & Komárek 1988, EP (54); *P. dimorphum* Lemmermann 1908, ME (71); *P. endolithicum* Ercegovic 1932, EP (48); *P. foreau* (Freymy) Umezaki & Watanabe 1994, ME (71); *P. holdenii* (Forti) Branco, Sant'Anna, Azevedo & Sormus 1997, EP (34); *P. incrustatum* Gomont ex Gomont 1892, EP, EZ, EL, ED, rock pool waters of ME (48); *P. insigne* Anagnostidis 2001, EL (48); *P. inundatum* Kützing ex Gomont 1892, EP, EL (48); *P. jadinianum* Gomont 1893, EP, EZ, EL, ED, rock pool water, coastal waters of ME (48); *P. jenkelianum* G.Schmid 1914, ME (71); *P. koprophilum* (Skuja) Anagnostidis 2001, EP, EZ, ED (48), EP (54); *P. kuetzingianum* (Kirchner ex Hansgirg) Anagnostidis & Komárek 1988, EP (48); *P. lucidum* Kützing ex Gomont 1892, EP, EZ, ED, rock pool waters of ME (48); *P. martinii* (Freymy) Anagnostidis & Komárek 1988, EP, Rock pool waters of ME (48), ME (71); *P. minnesotense* (Tilden) Drouet 1942, ME (27); *P. muscorum* (C.Agardh) Dalla Torre & Sarnthein 1901, EP (48); *P. nigroviride* (Thwaites ex Gomont) Anagnostidis & Komárek 1988, ES (49), ME (27, 42, 46, 47, 53, 60, 61, 68), EP (19, 21), EP (28, 33), PL (44), EP, ME (48); *P. nigrum* (Vaucher ex Gomont) Anagnostidis & Komárek 1988, EP (22); *P. puteale* (Montagne ex Gomont) Anagnostidis & Komárek 1988, ME (71, 72, 80); *P. rubidum* (Freymy) Anagnostidis & Komárek 1988, ME (66); *P. rubriterricola* N.L.Gardner 1927, EP (34, 54), ME (66); *P. schultzei* (Lemmermann) Anagnostidis & Komárek 1988, ME (48, 71, 77, 80), EP (19, 28, 33); *P. stagninum* C.B.Rao 1938, PL (44), EP (54), ME (59, 60); *P. subincrustedatum* Fritsch &

M.F.Rich 1929, EP (48); *P. submembranaceum* Kützing ex Gomont 1892, ES (10), ME (42); *P. uncinatum* Gomont ex Gomont 1892, EP, EL, ED, ME (48), EP (54), ME (72); *P. usteri* Schmidle 1904, EP (54); *P. willei* (N.L.Gardner) Anagnostidis & Komárek 1988, ME (46, 47, 60, 68, 71), EP, EZ, EL (48); *Plectonema puteale* Kirchner ex Hansgirg 1893, ME (59); *Potamolinea aerugineo-caerulea* (Gomont) M.D.Martins & L.H.Z.Branco 2016, EP (69), ME (71, 77).

Pleurocapsales – Dermocarpellaceae: *Cyanocystis flahaultii* (Sauvageau) Komárek & Anagnostidis 1995, EP, EZ, Rock pool water of ME (48); *C. hemisphaerica* (Setchell & N.L.Gardner) Kaas 1985, EP, EZ, ED (48), ME (24); *C. olivacea* (Reinsch) Komárek & Anagnostidis 1986, ME (60, 71), EP (19, 45); *C. sphaeroidea* (Setchell & N.L.Gardner) Komárek & Anagnostidis 1986, EP (32); *Dermocarpella stellata* H.Leon-Tejera & G.Montejano 2000, EP (55, 58); *Stanieria cyanosphaera* (Komárek & Hindak) Komárek & Anagnostidis 1986, EP (38), EP, EZ (48); *S. sphaerica* (Setchell & N.L.Gardner) Anagnostidis & Pantazidou 1991, ME (46, 47).

Pleurocapsales – Hydrococceaceae: *Hormathonema violaceonigrum* Ercegovic 1930, ES (10); *H. luteobrunneum* Ercegovic 1930, ES (9); *Hydrococcus rivularis* Kützing 1833, EP (45); *Myxohyella papuana* L.Hoffmann 1992, EP (67).

Pleurocapsales – Hyellaceae: *Chamaecalyx leibleiniae* (Reinsch) Komárek & Anagnostidis 1986, EP (22, 44), ME (46, 47, 59, 60); *C. swirenkoi* (Schirshoff) Komárek & Anagnostidis 1986, EP, EZ, ME (48), ME (24); *Hyella balani* Lehmann 1903, ES (7, 8), ME (24); *H. caespitosa* Bornet & Flahault 1888, ES (9), EP (38), ME (46, 47, 48, 60); *Pleurocapsa fuliginosa* Hauck 1885, ES (10); *Radaisia gardneri* Komárek & Anagnostidis 1995, ME (24); *Solentia stratosa* Ercegovic 1927, EL (9).

Pleurocapsales – Xenococceaceae: *Myxosarcina burmensis* Skuja 1949, EP (38), ME (46, 47, 60, 71); *M. concinna* Printz 1921, ME (46, 47, 59, 74); *Foliisarcina bertiogensis* D.O.Alvarenga, J.Rigonato, L.H.Z.Branco, I.S.Melo & M.F.Fiore 2016, EC (73); *Xenococcus chaetomorphae* Setchell & N.L.Gardner 1918, ME (24), EP (55, 58); *X. cladophorae* (Tilden) Setchell & N.L.Gardner 1918, ME (24), EP (44, 48); *X. pyriformis* Setchell & N.L.Gardner 1918, ME (40); *X. schousboei* Thuret 1880, EP (42), ME (24); *Xenotholus kernerii* (Hansgirg) M.Gold-Morgan, G.Montejano & J.Komárek 1994, EP (19, 21, 45), EP, EZ, EL (48).

Spirulinales – Spirulinaceae: *Glaucospira laxissima* (G.S.West) Simic, Komárek & Dordevic 2014, ME (24, 66); *Spirulina labyrinthiformis* Gomont 1892, ME (46, 47, 48, 60, 70, 71, 75), ES (10); *S. major* Kützing ex Gomont 1892, ME (24, 34, 42, 59, 60, 68, 70), EP (41), PL (44, 50), EP, EZ, EL, ED, Rock pool waters of ME (48); *S. meneghiniana* Zanardini ex Gomont 1892, ME (24, 66), ED (48); *S. princeps* West & G.S.West 1902, ME (24), ES (44); *S. subsalsa* Oersted ex Gomont 1892, EP (45, 54), ME (24, 46, 47, 53, 59, 60, 61, 64, 66, 68, 72, 74, 80), EP, EZ, ED, Rock pool waters of ME (48), PL (50), ES (10), EP, ES (19), EP (28, 33, 35); *S. subtilissima* Kützing ex Gomont 1892, ED (48), EP (54), ME (74, 76).

Synechococcales – Chamaesiphonaceae: *Chamaesiphon confervicola* A.Braun 1864, EP (44); *C. siderophilus* Starmach 1929, ME (74).

Synechococcales – Coelosphaeriaceae: *Coelosphaerium dubium* Grunow 1865, ME (71); *C. kuetzingianum* Nageli 1849, EP (48, 54).

Synechococcales – Leptolyngbyaceae: *Euryhalinema mangrovii* Chakraborty et Mukherjee 2019, ES (79); *Leibleinia epiphytica* (Hieronymus) Compere 1985, ME (24); *L. subtilis* (Holden) Anagnostidis & Komárek 1988, EP (58); *Leptoelongatus litoralis* Chakraborty et Mukherjee in Chakraborty 2019, ES (79); *Leptolyngbya africana* (Lemmermann) Anagnostidis & Komárek 1988, ME (48); *L. angustissima* (West & G.S.West) Anagnostidis & Komárek 1988, ME (46, 47, 71); *L. cebennensis* (Gomont) I.Umezaki & M.Watanabe 1994, ME (46, 47), EP, EZ, EL, ED, rock pool waters of ME (48); *L. crosbyana* (Tilden) Anagnostidis & Komárek 1988, EP (20), ME (40); *L. foveolarum* (Gomont) Anagnostidis & Komárek 1988, EP, EZ, EL, ED, coastal waters of ME (48), ME (66, 71); *L. fragilis* (Gomont) Anagnostidis & Komárek 1988, ME (24, 27, 40, 46, 47, 59, 60, 68, 74), EP (35, 44, 50, 54), EL (48); *L. lagerheimii* (Gomont ex Gomont) Anagnostidis & Komárek 1988, EP (34), EL (48); *L. laminosa* (Gomont ex Gomont) Anagnostidis & Komárek 1988, EP (48); *L. nostocorum* (Bornet ex Gomont) Anagnostidis & Komárek 1988, ME (71); *L. perelegans* (Lemmermann) Anagnostidis & Komárek 1988, ME (34, 42), EP (48); *L. polysiphoniae* (Fremy) Anagnostidis 2001, EP (48); *L. purpurascens* (Gomont ex Gomont) Anagnostidis &

Komárek 1988, ME (42), ME (71); *L. tenuis* (Gomont) Anagnostidis & Komárek 1988, ME (34, 46, 47, 59, 60, 66, 68, 70, 71, 80), EP (38, 50, 54), EP, EZ, Rockpool water, Coastal pool water of ME (48); *L. terebrans* (Bornet & Flahault ex Gomont) Anagnostidis & Komárek 1988, ME (24, 46, 47, 59, 60, 80); *L. valderiana* (Gomont) Anagnostidis & Komárek 1988, EP, EZ, EL, ED, rock pool water, coastal waters of ME (48), EP (54), ME (59, 60, 66, 71, 74); *Phormidesmis mollis* (Gomont) Turicchia, Ventura, Komarkova & Komárek 2009, ME (24, 42, 64, 71, 77), EP (34, 38, 48, 69); *Planktolynghya limnetica* (Lemmermann) Komarkova-Legnerova & Cronberg 1992, ME (77); *P. minor* (Geitler & Ruttner) Komárek & Cronberg 2001, ME (66); *Stenomitos frigidus* (F.E.Fritsch) Miscoe & J.R.Johansen 2016, ME (66).

Synechococcales – Merismopediaceae: *Aphanocapsa stagnalis* (Lemmermann) Belyakova 2004, ME (71); *A. roseana* De Bary in Rabenhorst 1870, EP (69), ME (77); *A. biformis* A.Braun 1879, ED (48), ME (72, 80); *A. brunnea* (A.Baun ex Kützing) Nägeli 1849, ME (71); *A. conferta* (West & G.S.West) Komarkova-Legnerova & Cronberg 1994, EP (19, 28, 33, 45); *A. grevillei* (Berkeley) Rabenhorst 1865, ME, EL (24), EP (69), ME (77); *A. koordersii* K.M.Strom 1923, EP (41); *A. litoralis* Hansgirg 1892, ME (24, 46, 47, 59, 60, 72, 80), EP (35, 41, 50, 55, 58), PL, ES (44), EP, EZ, EL, Coastal waters of ME (48); *A. muscicola* (Meneghini) Wille 1919, EP, EL (19), EP (45); *A. reinboldii* (Richter) Komárek & Anagnostidis 1995, ES (9); *A. rivularis* (Carmichael) Rabenhorst 1865, EP, Rockpool waters of ME (48); *Eucapsis minuta* F.E.Fritsch 1912, ME (71); *Limnococcus limneticus* (Lemmermann) Komarkova, Jezberova, O.Komárek & Zapomelova 2010, Coastal waters of ME (48); *Merismopedia convoluta* Brébisson ex Kützing 1849, EP, ME (48), ME, PC (24); *M. elegans* A.Braun ex Kützing 1849, ME (24, 60, 64, 77), ED, ME (48); *M. glauca* (Ehrenberg) Kützing 1845, ME (24, 60, 66, 74), EP, EZ, EL, ED, coastal water of ME (48); *M. litoralis* (Oersted) Rabenhorst 1865, ME (24); *M. minima* G.Beck 1897, EP, EL (48), ME (66); *M. tenuissima* Lemmermann 1898, ME (24); ES (44), EP, ED (48); *M. tranquilla* (Ehrenberg) Trevisan 1845, ME (24, 32, 66), EP (48); *Synechocystis aquatilis* Sauvageau 1892, EP (38), ME (48, 66, 71); *S. pevalekii* Ercegovic 1925, EP (38), EP, EZ, EL, ED, Rockpool water, coastal water of ME (48), ME (60, 66, 72, 74, 80); *S. salina* Wislouch 1924, ME (24, 71).

Synechococcales – Oculatellaceae: *Drouetiella lurida* (Gomont) Mai, J.R.Johansen & Pietrasiak 2018, EP (48).

Synechococcales – Pseudanabaenaceae: *Limnothrix chlorospira* (Skuja) Hindak & Trifonova 1989, EP, EZ, EL, ED, rock pool water, coastal waters of ME (48); *L. guttulata* (Goor) I.Umezaki & M.Watanabe 1994, ED, Rock pool waters of ME (48); *Pseudanabaena amphigranulata* (Goor) Anagnostidis 2001, EP (54); *P. biceps* Bocher 1946, EP (48); *P. catenata* Lauterborn 1915, ME (24, 68), EP, EZ, EL, ED, rock pool water, coastal waters of ME (48); *P. galeata* Bocher 1949, EP, rock pool water of ME (48); *P. limnetica* (Lemmermann) Komárek 1974, EZ (48), ME (60, 68, 71, 72, 80); *P. lonchoides* Anagnostidis 1961, EP, ED (48), EP (38); *P. mucicola* (Naumann & Huber-Pestalozzi) Schwabe 1964, ME (71), EP, ED (48); *P. papillaterminata* (Kisselev) Kukuk 1959, EP, Coastal waters of ME (48), EP (38); *Yonedaella lithophila* (Ercegovic) Umezaki 1962, EP (34, 42).

Synechococcales – Synechococcales familia insertae sedis: *Dasygloea lamyi* (Gomont ex Gomont) Senna & Komárek 1998, PL (44); *Heteroleibleinia gardneri* (Geitler) Anagnostidis & Komárek 1988, ME (46, 47), EP, EZ, EL, ED, coastal waters of ME (48), EP (54); *H. infixia* (Freymy) Anagnostidis & Komárek 1988, Coastal waters of ME (48), ME (60); *H. mesotricha* (Skuja) Anagnostidis & Komárek 1988, ME (59, 60); *H. willei* (Setchell & N.L.Gardner) Guiry & D.M.John 2021, ME (24, 34, 71), EP, EL, ED, Rockpool waters of ME (48), ME (71); *H. chaetomorphae* (Iyengar & Desikachary) Anagnostidis & Komárek 1988, ME (46, 47, 60), EP (54); *H. kuetzingii* (Schmidle) Compere 1985, Among other algae (9), EP (34); *Jaaginema angustissimum* (West & G.S.West) Anagnostidis & Komárek 1988, ME (71); *J. kuetzingianum* (Nägeli ex Gomont) Anagnostidis & Komárek 1988, ME (71); *J. neglectum* (Lemmermann) Anagnostidis & Komárek 1988, ED, Rock pool waters of ME (48), EP (54), ME (71), ED, Rock pool waters of ME (48); *J. pseudogeminatum* (G.Schmid) Anagnostidis & Komárek 1988, ME (48, 71); *J. quadripunctulatum* (Bruhl & Biswas) Anagnostidis & Komárek 1988, EP (48); *J. subtilissimum* (Kützing ex Forti) Anagnostidis & Komárek 1988, ME (46, 47, 71); *Schizothrix arenaria* Gomont 1892, EP (19), ME (24, 34); *S. calcicola* Gomont 1892, EP (9), ES (10), ME (24); *S. telephoroides* Gomont 1890, EP (41).

Synechococcales – Synechococcaceae: *Lemmermanniella obesa* M.T.P.Azevedo, C.A.Souza & M.Menezes 1999, EP (34), ME (40); *Synechococcus elongatus* (Nageli) Nageli 1849, EP (32, 48), ME (46, 47, 59, 71); *S. moorigangaii* Singh & Bhadury 2019, PL (81).

Synechococcales – Trichocoleusaceae: *Trichocoleus acutissimus* (N.L.Gardner) Anagnostidis 2001, ME (46, 47, 64); *T. tenerrimus* (Gomont) Anagnostidis 2001, ME (24, 34, 40).

As we compiled this list, we verified that several materials could not be included because they were not up to the species-level identification. Since these cyanobacteria are composed of simple filaments and frequently exhibit high morphological variability, the identification of specific and even generic levels becomes considerably more challenging. The insufficiency of literature focused on the cyanobacterial flora in mangrove environments, which would minimise inappropriate comparisons with the specimens of major misidentifications, adding to the problem of biodiversity research in cyanobacteria in general.

It was from the 1990s that the cyanobacteria in mangrove environments began to be more intensely studied and with that there was a significant increase in the knowledge of mangrove-associated cyanobacterial biodiversity (Fig. 2).

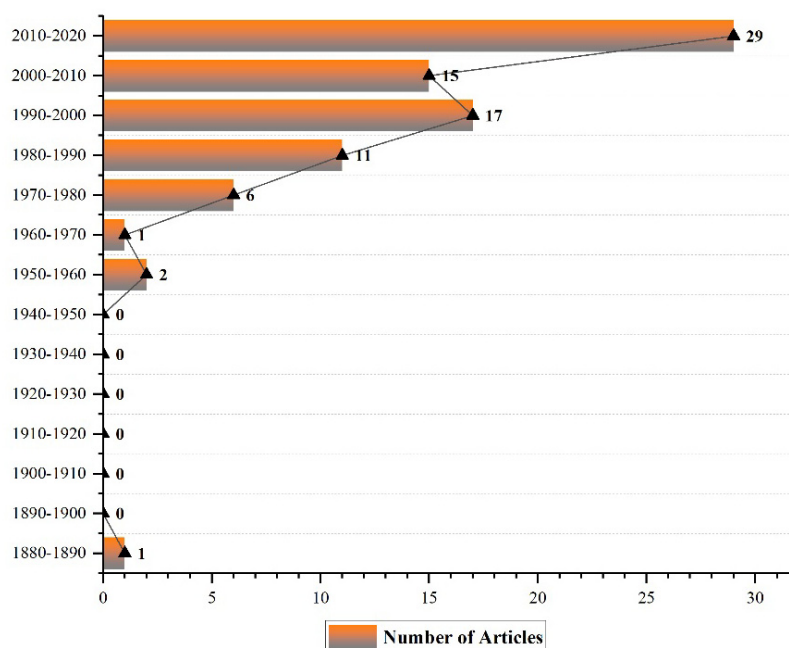


FIG. 2: Number of research articles used in this study (from 1889–2020)

A pronounced increase in taxonomic studies has been carried out during the previous decades. Based on this scenario, it is critical to address methods for studying and learning about the great wealth of cyanobacteria in the mangrove ecosystem, as well as their biotechnological potential, in the face of rapid destruction of their environments with the consequent loss of biodiversity.

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REFERENCES

- Ahmed Y.Z., Shafique S., Zaib-Un-Nisa B., Siddique P.J.A. 2016. Seasonal abundance of six dominant filamentous cyanobacterial species in microbial mats from mangrove backwaters in Sandspit Pakistan. *Pak. J. Bot.* 48(4): 1715–1722.
- Alvarenga D.O., Rigonato J., Branco L.H.Z., Melo I.S., Fiore M.E. 2016. *Phyllonema aviceniicola* gen. nov., sp. nov. and *Foliisarcina bertioensis* gen. nov., sp. nov., epiphyllic cyanobacteria associated with *Avicennia schaueriana* leaves. *Int. J. Syst. Evol. Microbiol.* 66: 689–700.
- Ans A.K., Mendez R.M. 2017. Seasonal variation in the physicochemical characteristics and microalgae of selected mangrove ecosystems in Ernakulam. *J. Environ. Sci., Toxicol. Food Technol.* 11(5): 1–5.
- Banerjee A., Santra S.C. 2001. Phytoplankton of the rivers of Indian Sundarban mangrove estuary. *Indian Biol.* 33(1): 67–71.
- Bano A., Siddiqui P.J.A. 2007. Diversity of cyanobacterial species distribution on rocky coast of Buleji, Pakistan. *Int. J. Biol. Biotechnol.* 4: 31–39.
- Barman N., Satpati G.G., Pal R. 2015. A morphotaxonomic account of cyanobacterial diversity of Indian Sundarbans. *J. Algal Biomass Util.* 6(3): 39–46.
- Bashan Y., Puente M.E., Myrold D.D., Toledo G. 1998. In vitro transfer of fixed nitrogen from diazotrophic cyanobacteria to black mangrove seedlings. *FEMS Microbiol. Ecol.* 26(3): 165–170.
- Beanland W.R., Woelkerling, Wm J. 1983. *Avicennia* canopy effects on mangrove algal communities in Spencer Gulf, South Australia. *Aquat. Bot.* 17: 309–313.
- Bhuvaneshwari T., Muruganandam A. 2016. Cyanobacterial biodiversity at marine environment from Thoniyakadu, Thiruvapur district, south east coast of India. *Int. J. Adv. Res.* 4(4): 1639–1644.
- Boopathi T. 2011. *Aquatic epiphytic cyanobacterial diversity of mangroves and its potential application in the development of mangrove plants*: PhD (Biol.). Thiruchirappalli, Tamil Nadu, India.
- Branco L.H.Z., Silva S.M.F., Santanna C.L. 1994. *Stichosiphon mangle* sp. nova, a new cyanophyte from mangrove environments. *Arch. Für Hydrobiol.* 72: 1–7.
- Branco L.H.Z., Sant'Anna C.L., Azevedo M.T.P., Sormus L. 1996. Cyanophyte flora from Cardoso Island mangroves, São Paulo State, Brazil. 1. *Chroococcales. Algal. Stud.* 80: 99–111.
- Branco L.H.Z., Sant'Anna C.L., Azevedo M.T.P., Sormus L. 1997. Cyanophyte flora from Cardoso Island mangroves, São Paulo State, Brazil. 2. *Oscillatoriales. Algal. Stud.* 84: 39–52.
- Branco L.H.Z., Moura A.N., Silva A.C., Bittencourt-Oliveira M.C. 2003. Biodiversity and biogeographical considerations of Cyanobacteria from a Mangrove area of Pernambuco State, Brazil. *Acta Bot. Braz.* 17(4): 585–596.

- Burkholder P.R., Almodovar L.R. 1973. Studies on mangrove algal communities in Puerto Rico. *Florida Sci.* 36(1): 66–74.
- Carmo T.M.S. 1987. In: *Anais do Simpósio Ecossistemas da Costa Sul e Sudeste Brasileira*. Vol. 1. Acad. Ciênc. Estado São Paulo. P. 180.
- Chakraborty S., Maruthanayagam V., Achari A., Mahansaria R., Pramanik A., Jaisankar P., Mukherjee J. 2018. *Oxynema aestuarii* sp. nov. (*Microcoleaceae*) isolated from an Indian mangrove forest. *Phytotaxa*. 374(1): 24–40.
- Chakraborty S., Maruthanayagam V., Achari A., Pramanik A., Jaisankar P., Mukherjee J. 2019. *Euryhalinema mangrovii* gen. nov., sp. nov. and *Leptoelongatus litoralis* gen. nov., sp. nov. (*Leptolyngbyaceae*) isolated from an Indian mangrove forest. *Phytotaxa*. 422(1): 58–74.
- Coppejans E., Gallin E. 1989. Macroalgae associated with the mangrove vegetation of Gazi Bay (Kenya). *Bull. Soc. Roy. Bot. Belgique/Bull. Koninklijke Belgische Bot. Ver.* 122(1): 47–60.
- Dhargalkar V.K. 1994. In: *Conservation of mangrove forest genetic resources: A training manual*. M.S. Swaminathan Res. Found., Madras and Int. Tropical Timber Org., Japan. Pp. 279–282.
- Dor I. 1975. The blue-green algae of the mangrove forests of Sinai. *Rapp. Comm. Int. Mer. Medit.* 23: 109–110.
- Essien J.P., Antai S.P., Benson N.U. 2008. Microalgae biodiversity and biomass status in Qua Iboe Estuary mangrove swamp, Nigeria. *Aquat. Ecol.* 42(1): 71–81.
- Fatimahsari T.K., Fitri S.G.S., Khastini R.O. 2014. *Epiphytic cyanobacteria on Avicennia marina pneumatophore in mangrove ecosystem of Cagar Alam Pulau Dua (CAPD) Serang, Banten*: Proc. Int. Conf. Res. Pp. 177–182.
- Gab-Alla Ali A-F. A. 2000. Biodiversity and distribution of epiphytes community associated with pneumatophores of *Avicennia marina* (Forssk.) Vierh, along Egyptian Red Sea Coast. *Egypt. J. Aquat. Biol. Fish.* 4(1): 179–196.
- Guiry M.D., Guiry G.M. 2021. *AlgaeBase*. World-wide electron. publ. Nat. Univ. Ireland, Galway. <https://www.algaebase.org>; searched on 28 August 2021
- Huisman J. M., Kendrick A.J., Rule M.J. 2015. Mangrove-associated macroalgae and cyanobacteria in Shark Bay, Western Australia. *J. Roy. Soc. Western Austral.* 98: 45–68.
- Hussain M.I., Khoja T.M. 1993. Intertidal and subtidal blue-green algal mats of open and mangrove areas in the Farasan Archipelago (Saudi Arabia), Red Sea. *Bot. Mar.* 36(5): 377–388.
- Joly A.B. 1951. Contribuição para o conhecimento da flora algológica do Estado do Paraná. *Bol. Inst. Paul. Oceanográf.* 2(1): 125–138.
- Joly A.B. 1957. Contribuição ao conhecimento da flora ficológica marinha da Baía de Santos e arredores. *Bol. Fac. Filosof.Ciênc. Univ. São Paulo. Sér. Bot.* 14: 1–199.
- Joseph, S., Saramma, A.V. (2016). Species diversity of cyanobacteria in Cochin estuary. *J. Mar. Biol. Associat. India.* 58(1): 55–63.
- Kannan L., Vasantha K. 1992. The ecology of mangroves and related ecosystems. *Hydrobiologia.* 247: 77–86.
- Komárek J. 1985. Do all cyanophytes have a cosmopolitan distribution? Survey of the freshwater cyanophyte flora of Cuba. *Algol. Stud.* 71: 359–386.
- Komárek J. 1994. Current trends and species delimitation in the cyanoprokaryote taxonomy. *Algol. Stud.* 75: 11–29.

- Komárek J. 2006. Cyanobacterial taxonomy: current problems and prospects for the integration of traditional and molecular approaches. *Algae*. 21(4): 349–375.
- Komárek J., Komarkova-Legnerova J. 2007. Taxonomic evaluation of the cyanobacterial microflora from alkaline marshes of northern Belize. 1. Phenotypic diversity of coccoid morphotypes. *Nova Hedw.* 84: 65–111.
- Kumar S.D., Santhanam P., Ananth S., Kaviyarasan M., Dhanalakshmi B., Park M.S., Kim M.K. 2017. Seasonal variation of physico-chemical parameters and phytoplankton diversity in the Muthukuda mangrove environment, southeast coast of India. *J. Mar. Biol. Ass. India*. 59(2): 19–33.
- Kyaruzi J.J., Kyewalyanga M.S., Muroke M.H.S. 2003. Cyanobacteria composition and impact of seasonality on their in-situ nitrogen fixation rate in a mangrove ecosystem adjacent to Zanzibar town. *Western Indian Ocean J. Mar. Sci.* 2(1): 35–44.
- Lambert G., Steinke T.D., Naidoo Y. 1989. Algae associated with mangroves in southern African estuaries: Cyanophyceae. *South Afr. J. Bot.* 55(5): 476–491.
- Leon-Tejera H., Perez-Estrada C.J., Montejano G., Serviera-Zaragoza E. 2011. Biodiversity and temporal distribution of *Chroococcales* (Cyanoprokaryota) of an arid mangrove on the east coast of Baja California Sur, Mexico. *Fottea*. 11(1): 235–244.
- Mann F.D., Steinke T.D. 1993. Biological nitrogen fixation (acetylene reduction) associated with blue-green algal (cyanobacterial) communities in the Beachwood Mangrove Nature Reserve. II. Seasonal variation in acetylene reduction activity. *South Afr. J. Bot.* 59(1): 1–8.
- Mataloni G., Komárek J. 2004. *Gloeocapsopsis aurea*, a new subaerophytic cyanobacterium from maritime Antarctica. *Polar Biol.* 27: 623–628.
- Millard N.A.H., Broekhuysen G.J. 1970. The ecology of South African estuaries. Pt X. *Zool. Afr.* 5(2): 277–307.
- Miller S.R., Castenholz R.W. 2000. Evolution of Thermotolerance in Hot Spring Cyanobacteria of the Genus *Synechococcus*. *Appl. Environ. Microbiol.* 66(10): 4222–4229.
- Moebius M. 1889. Bearbeitung der Van H. Schenk in Brasilien Gesammelten Algen. *Hedwigia*. 28(5): 309–347.
- Mohamed Z.A., Al-Shehri A.M. 2015. Biodiversity and toxin production of cyanobacteria in mangrove swamps in the Red Sea off the southern coast of Saudi Arabia. *Bot. Mar.* 58(1): 23–34.
- Nedumaran T., Thillairajasekar K., Perumal P. 2008. Mangrove associated cyanobacteria at Pichavaram, Taminadu. *Seaweed Res. Util.* 30: 77–85.
- Nogueira N.M.C., Ferreira-Correia M.M. 2001. *Cyanophyceae*/Cyanobacteria in red mangrove forest at mosquitos and coqueiros estuaries, São Luís, State of Maranhão, Brazil. *Brazil. J. Biol.* 61(3): 347–356.
- Oliveira E.C. 1984. In: *Hydrobiology of the Mangal: The Ecosystem of the Mangrove Forests*. The Hague, Boston, F. D. Pp. 55–66.
- Paul P.T., Saritha M.K. 2013. *Biodiversity and quantitative assessment of phytoplankton in Poyya backwater, Thrissur District, Kerala*: Proc. UGC Sponsor. Nat. Conf. Dep. Bot. Changanacherry: Assumption College. Pp. 31–37.
- Pena-Salamaca E.J. 2008. Spatial and temporal dynamics of algal biomass associated with mangrove roots in Buenaventura Bay, Pacific coast of Colombia. *Bull. Mar. Coast. Res.* 37(2): 55–70.
- Perez-Estrada C.J., Leon-Tejera H. and Serviere-Zaragoza E. 2012. Cyanobacteria and macroalgae from an arid environment mangrove east coast of the Baja California Peninsula. *Bot. Mar.* 55(2): 187–196.

- Phillips A., Lambert G., Granger, J.E., Steinke T.D. 1994. Horizontal zonation of epiphytic algae associated with *Avicennia marina* (Forssk.) Vierh. pneumatophores at beachwood mangroves nature reserve, Durban, South Africa. *Bot. Mar.* 37(6): 567–576.
- Phillips A., Lambert G., Granger J.E., Steinke T.D. 1996. Vertical zonation of epiphytic algae associated with *Avicennia marina* (Forssk.) Vierh pneumatophores at Beachwood Mangroves Nature Reserve, Durban South Africa. *Bot. Mar.* 39(1–6): 167–175.
- Potts M. 1979. Nitrogen fixation (acetylene reduction) associated with communities of heterocystous and nonheterocystous blue-green algae in mangrove forests of Sinai. *Oecologia.* 39(3): 359–373.
- Potts M. 1980. Blue-green algae (*Cyanophyta*) in marine coastal environments of the Sinai Peninsula; distribution, zonation, stratification and taxonomic diversity. *Phycologia.* 19(1): 60–73.
- Potts M., Whitton B.A. 1977. Nitrogen Fixation by Blue-Green Algal Communities in the Intertidal Zone of the Lagoon of Aldabra Atoll. *Oecologia.* 27: 275–283.
- Potts M., Whitton B.A. 1980. Vegetation of intertidal zone of the lagoon of Aldabra, with particular reference to the photosynthetic prokaryotic communities. *Proc. Roy. Soc. B. Biol. Sci.* 208(1170): 13–55.
- Priya N., Venkatesan G., Muruganandam A. 2019. Bio-diversity of cyanobacteria at Kodiakkarai coast and mangrove in south east coast of Tamil Nadu, India. *J. Emerg. Technol. Innov. Res.* 6(6): 162–170.
- Rajkumar M., Permal P., Prabu V.A., Perumal N.V., Rajasekhar K.T. 2009. Phytoplankton diversity in Pichavaram mangrove waters from south east coast of India. *J. Environ. Biol.* 30(4): 489–498.
- Ram A.T., Paul P.T. 2020. The Genus *Oscillatoria* Vaucher (Cyanobacteria) from selected mangrove environments of Southern Kerala, India. *Chron. Human. Cult. Stud.* 6(5): 13–14.
- Ram A.T., Shamina M. 2015. Mangrove Associated Cyanobacterial Diversity at Kottayam District, Kerala, India. *Int. J. Chem. Biol. Sci.* 1(10): 20–24.
- Ram A.T., Shamina M. 2017. Cyanobacterial diversity from seven mangrove environments of Kerala, India. *World News Nat. Sci.* 9: 91–97.
- Ramachandran S., Venugopalan V.K. 1987. Nitrogen fixation by blue-green algae in Portonovo marine environments. *J. Mar. Biol. Ass. India.* 29(1–2): 337–343.
- Ramamurthy V., Abhinand R.L. 2016. A study on environmental quality and diversity of microbes in the Manakudy mangroves. *World J. Pharm. Res.* 5(8): 949–960.
- Rao M.D.S., Kaparapu J., Rao M.N.G.M. 2015. Microalgal population in mangrove habitats of the Visakhapatnam, east coast of India. *J. Algal Biomass Util.* 6(2): 5–10.
- Rigonato J., Alvarenga D.O., Andreote F.D., Diaz A.C.F., Melo I.S., Kent A., Fiore M.F. 2012a. Cyanobacterial diversity in the phyllosphere of a mangrove forest. *FEMS Microbiol. Ecol.* 80(2): 312–322.
- Rigonato J., Kent A.D., Alvarenga D.O., Andreote F.D., Beirigo R.M., Vidal-Torrado P., Fiore M.F. 2012b. Drivers of cyanobacterial diversity and community composition in mangrove soils in south-east Brazil. *Environ. Microbiol.* 15(4): 1103–1114.
- Rodriguez C., Stoner A.W. 1990. The epiphyte community of mangrove roots in a tropical estuary: distribution and biomass. *Aquat. Bot.* 36(2): 117–126.
- Saifullah S.M., Taj G. 1995. In: *The Arabian Sea, living marine resources and the environment*. Lahore: Vanguard Books Ltd. Pp. 407–414.
- Saifullah S.M., Aisha K., Rasool F. 1997. Algal epiphytes on mangroves of Balochistan, Pakistan. *Pak. J. Bot.* 29(2): 191–197.

- Saifullah A.S.M., Hena M.K.A., Idris M.H., Halimah A.R., Johan I. 2014. Composition and diversity of phytoplankton from mangrove estuaries in Sarawak, Malaysia. *J. Biol. Sci.* 14(5): 361–369.
- Sakthivel K., Kathiresan K. 2013. Cyanobacterial diversity from mangrove sediment of south east coast of India. *Asian J. Biodiver.* 4(1): 190–203.
- Sant'Anna C.L. 1988. *Scytonemataceae (Cyanophyceae)* from the State of São Paulo, southern Brazil. *Nova Hedw.* 46(3–4): 519–539.
- Sant'Anna C.L., Bicudo R.M.T., Pereira H.A.S.L. 1983. *Nostocophyceae (Cyanophyceae)* do Parque Estadual da Ilha do Cardoso, Estado de São Paulo, Brasil. *Rickia.* 10: 1–27.
- Santra S.C., Pal U.C., Maity H., Bandyopadhyaya G. 1988. Blue-green algae in saline habitats of West Bengal: systematic account. *Biol Mem.* 14: 81–108.
- Selvakumar G., Sundararaman M. 2001. Mangrove associated cyanobacterial species in Muthupet estuary. *Seaweed Res. Util.* 23(1–2): 19–22.
- Sen N., Naskar K. 2003. *Algal flora of Sundarbans mangals*. Delhi: Daya Publ. House. 315 p.
- Shamina M., Saranya T., Ram A.T. 2014. Cyanobacterial biodiversity at mangrove vegetation of Kadalundi, Kerala. *J. Microbiol.* 3: 15–16.
- Silambarasan G., Ramanathan T., Kathiresan K. 2012. Diversity of marine cyanobacteria from three mangrove environments in Tamilnadu coast, south east coast of India. *Curr. Res. J. Biol. Sci.* 4(3): 235–238.
- Silva S.M.F. 1991. Cyanophyceae associated with mangrove trees at Inhaca Island, Mozambique. *Bothalia.* 21(2): 143–150.
- Singh T., Bhadury P. 2019. Description of a new marine planktonic cyanobacterial species *Synechococcus moorigangaii* (Order: *Chroococcales*) from Sundarbans mangrove ecosystem. *Phytotaxa.* 393(3): 263–277.
- Steinke T.D., Naidoo Y. 1990. Biomass of algae epiphytic on pneumatophores of the mangrove, *Avicennia marina*, in the St. Lucia Estuary. *South Afr. J. Bot.* 56(2): 226–232.
- Steinke T.D., Lubke R.A., Ward C.J. 2003. The distribution of algae epiphytic on pneumatophores of the mangrove *Avicennia marina*, at different salinities in the Kosi system. *South Afr. J. Bot.* 69(4): 546–554.
- Sudha S.S. 2005. *Studies on fungi and microalgae of Muthupet mangrove environs*. India. PhD (Biol.) Thesis. Thiruchirappally, Tamilnadu.
- Sudha S.S., Panneerselvam A., Thajuddin N. 2007. Seasonal variation of cyanobacteria at Muthupet mangrove environs, Tamilnadu, South India. *Seaweed Res. Util.* 29(1–2): 263–271.
- Tessy P.P., Saritha M.K. 2010. *Biodiversity of microalgae in Poyya mangrove ecosystem, Thrissur District*: Proc. 22nd Kerala Sci. Congr. Peechi: KFRI. Pp. 29–30.
- Toledo G., Bashan Y., Soeldner A. 1995a. Cyanobacteria and black mangroves in northwestern Mexico: colonization, and diurnal and seasonal nitrogen fixation on aerial roots. *Canad. J. Microbiol.* 41(11): 999–1011.
- Toledo G., Bashan Y., Soeldner A. 1995b. In vitro colonization and increase in nitrogen-fixation of seedling roots of black mangrove inoculated by a filamentous cyanobacterium. *Can. J. Microbiol.* 41(11): 1012–1020.
- Zaib-Un-Nisa, Mansoor S.N., Siddiqui P.J.A. 2000. Species diversity of cyanobacteria growing on pneumatophores and in the adjacent surface sediments in a mangrove swamp at Sandspit backwaters, Karachi. *Pak. J. Mar. Biol.* 6(1): 59–68.
- Zaki S., Merican F., Muangmai N., Convey P., Broady P. 2020. Discovery of microcystin-producing *Anagnostidinema pseudacutissimum* from cryopreserved Antarctic cyanobacterial mats. *Harm. Algae.* 93: 1–7.