

ANNOTATED LIST OF ALGAE OF SINGAPORE (I)

by

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The algae as a group has been grossly neglected in Singapore. To date the only taxonomic works available are those on euglenoids (Prowse, 1958; Skvortzov, 1968), diatoms (Prowse, 1962a), freshwater flagellates (Prowse, 1962b) and desmids (Prowse, 1957; 1969). The most comprehensive non-taxonomic study is that by A. Johnson (1973b) who recorded a total of 141 species of Chlorophyceae, 7 species of Xanthophyceae, 12 species of Chrysophyceae, 30 species of Bacillariophyceae, 9 species of Cryptophyceae, 15 species of Dinophyceae, 1 species of Chloromonadineae, 48 species of Euglenophyceae, 28 species of Cyanophyceae and 13 species of 'Zoomastigophora', all from the University of Singapore pond. In a further paper, on the distribution of freshwater algae (including the University of Singapore pond), A. Johnson (1978) recorded a total of 379 species from the various classes, 75 more than her previous communication.

Other studies on local algae include those occurring in other freshwater ponds (A. Johnson, 1966; D.S. Johnson, 1972); in soils (A. Johnson, 1962; 1973a); and in miscellaneous habitats (A. Johnson, 1974/75; A. Johnson & Awan, 1972). Studies on marine algae are limited, and these include those by Weber (1913-1928); Burkill *et al.* (1968); A. Johnson (1958, 1976); Lee, L.M. (1968); Lee S.K. (1966); Purchon & Enoch (1954); and Ku (1969).

It is the intention of this paper to list all species of algae that have been reported for Singapore, together with their locality, based essentially on the above-listed literature as well as on unpublished studies of this Department. Collections made by the Botanic Gardens are also included. Because of the limited taxonomic studies on algae, this list would, I am sure, prove to be useful to current as well as future researchers. For convenience, taxonomic arrangements generally follow Fritsch (1971, 1972).

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1. CYANOPHYCEAE

The cell contains no proper chromatophore, the photosynthetic pigments being diffused through the peripheral cytoplasm. Pigments include chlorophyll, carotene, phycocyanin, and phycoerythrin. The colour of the cell is usually blue-green. Sugars and glycogen are the common products of photosynthesis. The cell is simple and does not contain a nucleus. All members have a membrane around the cell. Propagation is by simple division or other vegetative means.

The Class is divided into five orders of which four occur locally:

- 1.1. *Chroococcales*. Plants are unicellular, or where colonial, these are commonly palmelloid. Multiplication is by cell divisions and the formation of endospores.
- 1.2. *Chamaesiphonales*. Mainly unicellular or colonial epiphytes or lithophytes. Multiplication is by endospores or exospores.
- 1.3. *Nostocales*. Filamentous, often showing false branching. Heterocysts are commonly present, often with hormogones, hormocysts or akinetes.
- 1.4. *Stigonematales*. Filamentous, with true branching or dichotomous branching, often showing heterotrichous condition.

1.1. CHROOCOCCALES

* Key to the Genera

1. Cells with pseudofilamentous growth, of gelatinous, hemispherical or irregularly folded hollow thallus *Placoma*
1. Cells unicellular or forming colonies, not forming filament-like growth ... 2
 2. Cells single, or a few together in a shapeless colony 3
 2. Cells many in a single colony 7
3. Cells spherical 4
3. Cells elongate 6
 4. Without individual mucilage envelope *Synechocystis*
 4. With a distinct envelope 5
5. Sheath vesicular *Gloeocapsa*
5. Sheath not vesicular *Chroococcus*
 6. Cell division transverse, with a firm vesicular sheath *Gloeotheca*
 6. Cell division transverse, without such a sheath *Synechococcus*
7. Cells without any regular or definite arrangement 8
7. Cells with definite arrangement in distinct colonies 13
 8. Cells in an amorphous mucilage, with or without a few distinct sheaths round the individual cells 9
 8. Cells with distinct individual envelopes or sheaths, colonial mucilage not homogeneous 11
9. Cells typically well packed into microscopic colonies of definite shapes, mostly planktonic *Microcystis*
9. Cells loosely arranged, mostly not planktonic, forming macroscopic colonies 10
 10. Cells spherical *Aphanocapsa*
 10. Cells ellipsoidal to cylindrical *Aphanothece*
11. Individual sheaths vesicular and broad, and formed one in another 12
11. Individual sheaths not vesicular, cells spherical *Chroococcus*
 12. Cells spherical *Gloeocapsa*
 12. Cells ellipsoidal to cylindrical *Gloeotheca*
13. Colony tabular or flat, cells in regular transverse and longitudinal rows *Merismopedia*

* Modified after T.V. Desikachary (1959). *Cyanophyta*. Indian Council Agricultural Research, New Delhi.

13. Colony a hollow sphere with cells arranged uniformly along the margin...14

14. Cells spherical, colonial mucilage homogeneous *Coelosphaerium*

14. Cells pear-shaped or nearly spherical, colonial mucilage not homogeneous, cells with distinct mucilage sheaths *Gomphosphaeria*

Aphanocapsa elachista West & West

Fish pond in Sembawang; catchment reservoirs.

Aphanocapsa pulchra (Kütz.) Rabenh.

University of Singapore and Nanyang University ponds; fish ponds in Sembawang.

Aphanocapsa sp.

University of Singapore pond.

Aphanothece saxicola Näeg.

In soils collected from branches of *Fagraea fragrans* and *Swietenia macrophylla*.

Aphanothece stagnina (Spr.) A. Br.

Fish ponds.

Chroococcus giganteus West

In soils collected from branches of *Swietenia macrophylla*.

Chroococcus limneticus Lemm.

Fish ponds in Sembawang.

Chroococcus minutus (Kütz.) Näeg.

Alluvial and cultivated soils; exposed sub-soils; fish pond in Sembawang.

Chroococcus multicoloratus Wood

Soil from Botanic Gardens jungle.

Chroococcus pallidus Näeg.

In soil collected from branches of *Swietenia macrophylla*.

Chroococcus schizodermaticus West

Grassland soils.

Chroococcus turgidus (Kütz.) Näeg.

Grassland and alluvial soils; exposed sub-soils; catchment reservoirs; fish ponds in Sembawang; University of Singapore pond; in soils collected from branches of *Fagraea fragrans* and *Swietenia macrophylla*.

Chroococcus varius A. Br.

Soil from Sunlit Path, MacRitchie Reservoir.

Chroococcus sp. 1

Soil from University of Singapore.

Chroococcus sp. 2

Belukar soils; exposed sub-soils.

Coelosphaerium kuetzingianum Näeg.

University of Singapore and Nanyang University ponds; catchment reservoirs; fish ponds in Sembawang.

Coelosphaerium naegelianum Ung.

Sembawang fish ponds.

Gloeocapsa cf. *compacta* Kütz.

Catchment reservoirs; University of Singapore pond; fish ponds in Sembawang.

Gloeotheca sp.

University of Singapore pond; fish ponds in Sembawang.

Gomphosphaeria aponina Kütz.

Fish ponds in Sembawang.

Merismopedia minima Beck.

University of Singapore pond; Nee Soon swamp; fish ponds in Sembawang.

Microcystis aeruginosa Kütz.

Cultivated soils; exposed sub-soils; fish ponds in Sembawang; catchment reservoirs.

Microcystis robusta (Clark) Nygaard.

University of Singapore pond.

Placoma sp.

Zone of high water reap tide to low water reap tide at Tanjong Teritip.

Synechococcus aeruginosus Näeg.

Grassland and cultivated soils; exposed sub-soils; fish ponds.

Synechococcus cedrorum Sauv.

Soil from MacRitchie Reservoir forest.

Synechocystis aquatilis Sauv.

University of Singapore and Nanyang University ponds; fish ponds in Sembawang.

1.2. CHAMAESIPHONALES

Key to the Genera

1. Plants filamentous *Endonema*
1. Plants unicells 2
 2. Reproduction by exospores *Chamaesiphon*
 2. Reproduction by endospores 3
3. Apex of cell produced into a mucilage-bristle *Clastidium*
3. Apex of cell not produced into a mucilage-bristle *Stichosiphon*

Chamaesiphon fuscus (Rostaf.) Hansg.

Exposed sub-soils.

Clastidium setigerum Kirch.

University of Singapore pond.

Endonema sp.

Stichosiphon sansibaricus (Hieron.) Drouet & Daly.

University of Singapore pond; fish ponds.

1.3. NOSTOCALES

* Key to the Genera

1. Trichomes without false branching or with incipient false branching 2
1. Trichomes usually with false branching 18
 2. Without heterocysts, spores commonly absent 3
 2. Without heterocysts and spores 9
3. Trichomes many in a sheath *Microcoleus*
3. Trichomes without a sheath or singly within a sheath 4
 4. Trichomes with a prominent sheath 5
 4. Trichomes without a sheath 7
5. Sheath mucilaginous *Phormidium*
5. Sheath firm 6
 6. Filaments not in bundles *Lyngbya*
 6. Filaments mostly in erect bundles *Symploca*
7. Trichomes more or less straight *Oscillatoria*
7. Trichomes spirally coiled 8
 8. Cells of trichomes not visible or unicellular *Spirulina*
 8. Cells of trichomes clearly visible *Arthrospira*
9. Trichomes differentiated into base and apex *Microchaete*
9. Trichomes not so differentiated 10
 10. Trichomes without a firm sheath 11
 10. Trichomes with firm sheath 17
11. Heterocysts present 12
11. Heterocysts absent 16
 12. Intercalary heterocysts generally in pairs *Anabaenopsis*
 12. Intercalary heterocysts generally single 13

* Modified after Desikachary (1959).

- 13. Heterocysts commonly terminal, with a single large spore adjoining *Cylindrospermum*
- 13. Heterocysts rarely terminal, generally intercalary 14
- 14. End cells elongated, hair-like, colourless *Aphanizomenon*
- 14. End cells not so 15
- 15. Filaments single or in a formless gelatinous mass *Anabaena*
- 15. Filaments generally in a definite colony *Nostoc*
- 16. Trichomes attenuated, end cells often pointed *Raphidiopsis*
- 16. Trichomes not attenuated, end cells not pointed *Pseudanabaena*
- 17. Cells very short and discoid *Nodularia*
- 17. Cells not discoid *Aulosira*
- 18. Without an intercalary meristematic zone and generally without a terminal hair 19
- 18. With an intercalary meristematic zone and a terminal hair 20
- 19. False branches usually in pairs *Scytonema*
- 19. False branches usually single and often next to a terminal heterocyst *Tolypothrix*
- 20. Filaments in a spherical or hemispherical thallus *Gloeotrichia*
- 20. Filaments free, simple or forming dichotomously branched corymbose thallus *Calothrix*

Anabaena anomala Fritsch
Belukar soils.

Anabaena azollae Strasb.
Found in symbiotic association with the water fern, *Azolla caroliniana*, which occurs in the University of Singapore pond, catchment reservoirs, and fish ponds.

Anabaena constricta (Szaf.) Geitler
Fish pond in Sembawang; University of Singapore and Nanyang University ponds.

Anabaena fertilissima Rao
Alluvial and cultivated soils.

Anabaena flos-aquae (Lyngb.) Breb. ex Born & Flah.
Fish ponds in Sembawang; University of Singapore pond.

Anabaena fuellebornii Schmid.
Alluvial soils; fish ponds.

Anabaena oryzaea Fritsch
Grassland soils.

Anabaena oscillarioides Borg ex Born. & Flah.
Fish pond in Sembawang.

Anabaena spiroides Kleb.
Alluvial soils; fish ponds in Sembawang.

Anabaena utermohlii Geitler
Fish pond in Sembawang.

Anabaena sp.
Grassland soils.

Anabaenopsis raciborskii Wolosz.
Fish ponds in Sembawang; University of Singapore pond.

Anabaenopsis tanganyikae (West) Wolosz. & Miller
Fish ponds in Sembawang; University of Singapore pond.

Anabaenopsis sp.
University of Singapore pond.

Aphanizomenon flos-aquae (L.) Ralfs
Fish ponds.

Arthrospira gomontiana Setchell
Nee Soon swamps.

Arthrospira jenneri Stizenb. ex Gom.
University of Singapore pond.

Arthrospira tenuis Bruhl. & Biswas
Belukar soils; exposed sub-soils.

Aulosira aenigmatica Frémy
Exposed sub-soils.

Aulosira pseudoramosa Bharadw.
Soil from University of Singapore.

Aulosira sp.
Fish ponds.

Calothrix sp.
University of Singapore pond; fish ponds.

Cylindrospermum sphaerica Prasad
Disturbed soils.

Cylindrospermum sp.
University of Singapore pond; pond in Sembawang.

Gloeotrichia echinulata (J.E. Smith) P. Richter
In soil found on *Swietenia macrophylla*.

Gloeotrichia sp.
University of Singapore and Nanyang University ponds; catchment reservoirs; Nee Soon swamps.

Lyngbya aestuarii Liebm. ex Gom.

University of Singapore and Nanyang University ponds; Sembawang swamp.

Lyngbya birgei Smith

Exposed sub-soils; fish ponds in Sembawang.

Lyngbya connectens Bruhl ex Biswas

In soil collected from branches of *Swietenia macrophylla*.

Lyngbya contorta Lemm.

Fish ponds in Sembawang.

Lyngbya digueti Gom.

In soil collected from branches of *Swietenia macrophylla*.

Lyngbya kuetzingiana Kirch.

In soil collected from branches of *Swietenia macrophylla*.

Lyngbya kuetzingii Schmidle.

In soil collected from branches of *Swietenia macrophylla*.

Lyngbya limnetica Lemm.

Fish ponds in Sembawang; in soil collected from branches of *Swietenia macrophylla*; University of Singapore and Nanyang University ponds; Nee Soon swamps; catchment reservoirs.

Lyngbya majuscula Harv.

Intertidal pool at Pulau Hantu.

Lyngbya martensiana Menegh. ex Gom.

In soil collected from branches of *Swietenia macrophylla*.

Lyngbya mucicola Lemm.

Soil from exposed cleared building site.

Lyngbya polysiphoniae Frémy

Belukar soils.

Lyngbya sp. 1

Fish pond in Sembawang.

Lyngbya sp. 2

Soil from Sunlit Path, MacRitchie Reservoir.

Lyngbya sp. 3

Telok Paku beach.

Lyngbya sp. 4

University of Singapore pond.

Lyngbya sp. 5

Beaches at Labrador and Ponggol.

Microchaete tenera Thuret ex Born. & Flah.

Soil from University of Singapore.

Microcoleus vaginatus (Vauch.) Gom.
Soil from University of Singapore.

Nodularia spumigena Mert.
Fish ponds.

Nostoc commune Vauch. ex Born. & Flah.
In soil collected from branches of *Swietenia macrophylla*.

Nostoc microscopicum Carm. ex Born. & Flah.
Cultivated soils.

Nostoc muscorum Ag. ex Born. & Flah.
Grassland soils.

Nostoc punctiforme (Kütz.) Hariot.
Grassland soils.

Nostoc sp.
University of Singapore pond; Nee Soon swamps.

Oscillatoria annae van Goor
Alluvial and cultivated soils; exposed sub-soils.

Oscillatoria chalybea (Mert.) Gom.
Grassland soils; exposed sub-soils.

Oscillatoria chlorina Kütz. ex Gom.
Belukar and cultivated soils.

Oscillatoria fremyi de Toni
Belukar and cultivated soils.

Oscillatoria geitleriana Elenkin
Grassland soils.

Oscillatoria jasorvensis Vouk.
Belukar, grassland, alluvial and disturbed soils.

Oscillatoria limosa Ag. ex Gom.
Alluvial soils; exposed sub-soils; University of Singapore pond; Nee Soon swamps; fish ponds.

Oscillatoria miniata (Zanard.) Hauck ex Gom.
Grassland, alluvial and cultivated soils.

Oscillatoria obscura Bruhl & Biswas.
Grassland, cultivated and disturbed soils; exposed sub-soils.

Oscillatoria okeni Ag. ex Gom.
Belukar and alluvial soils.

Oscillatoria splendida Grev. ex Gom.
University of Singapore pond; catchment reservoirs; Nee Soon swamps.

Oscillatoria subtilissima Kütz.
Grassland soils.

Oscillatoria terebriformis Ag. ex Gom.
Grassland and cultivated soils.

Oscillatoria sp. 1
University of Singapore pond.

Oscillatoria sp. 2
Soil from University of Singapore.

Oscillatoria sp. 3
Labrador; Ponggol.

Phormidium angustissimum West & West
Soil from Botanic Gardens jungle.

Phormidium laminosum Gom.
University of Singapore and Nanyang University ponds; Nee Soon swamps.

Phormidium subincrustatum Fritsch & Rich.
Exposed sub-soils.

Phormidium truncicola Ghose
Exposed sub-soils.

Phormidium sp. 1
Beaches at Telok Paku and Ponggol.

Phormidium sp. 2
University of Singapore pond.

Pseudanabaena catenata Laut.
University of Singapore pond.

Raphidiopsis curvata Fritsch & Rich
Fish ponds in Sembawang; University of Singapore and Nanyang University ponds; catchment reservoirs; Nee Soon swamps.

Scytonema hofmanni Ag. ex Born. & Flah.
Cultivated soils.

Scytonema javanicum (Kütz.) Born ex Born. & Flah.
Soils from exposed building site and University of Singapore.

Spirulina gigantea Schmidle
University of Singapore and Nanyang University ponds; catchment reservoirs; fish ponds in Sembawang.

Spirulina labyrinthiformis (Menegh.) Gom.
Alluvial soils..

Symploca elegans Kütz. ex Gom.
Soil from exposed cleared building site.

Tolypothrix fragilis (Gardn.) Geitler
Soil from University of Singapore.

Tolypothrix phyllophila West & West
Disturbed soils; exposed sub-soils.

Tolypothrix tenuis (Kütz.) Johs. Schmidt em.
University of Singapore and Nanyang University ponds; Nee Soon swamps; catchment reservoirs.

1.4. STIGONEMATALES

*Key to the Genera

1. Pedicellate heterocysts present *Nostochopsis*
1. Pedicellate heterocysts absent 2
2. Hormogones present *Hapalosiphon*
2. Hormogones not known, endospores present *Westiellopsis*

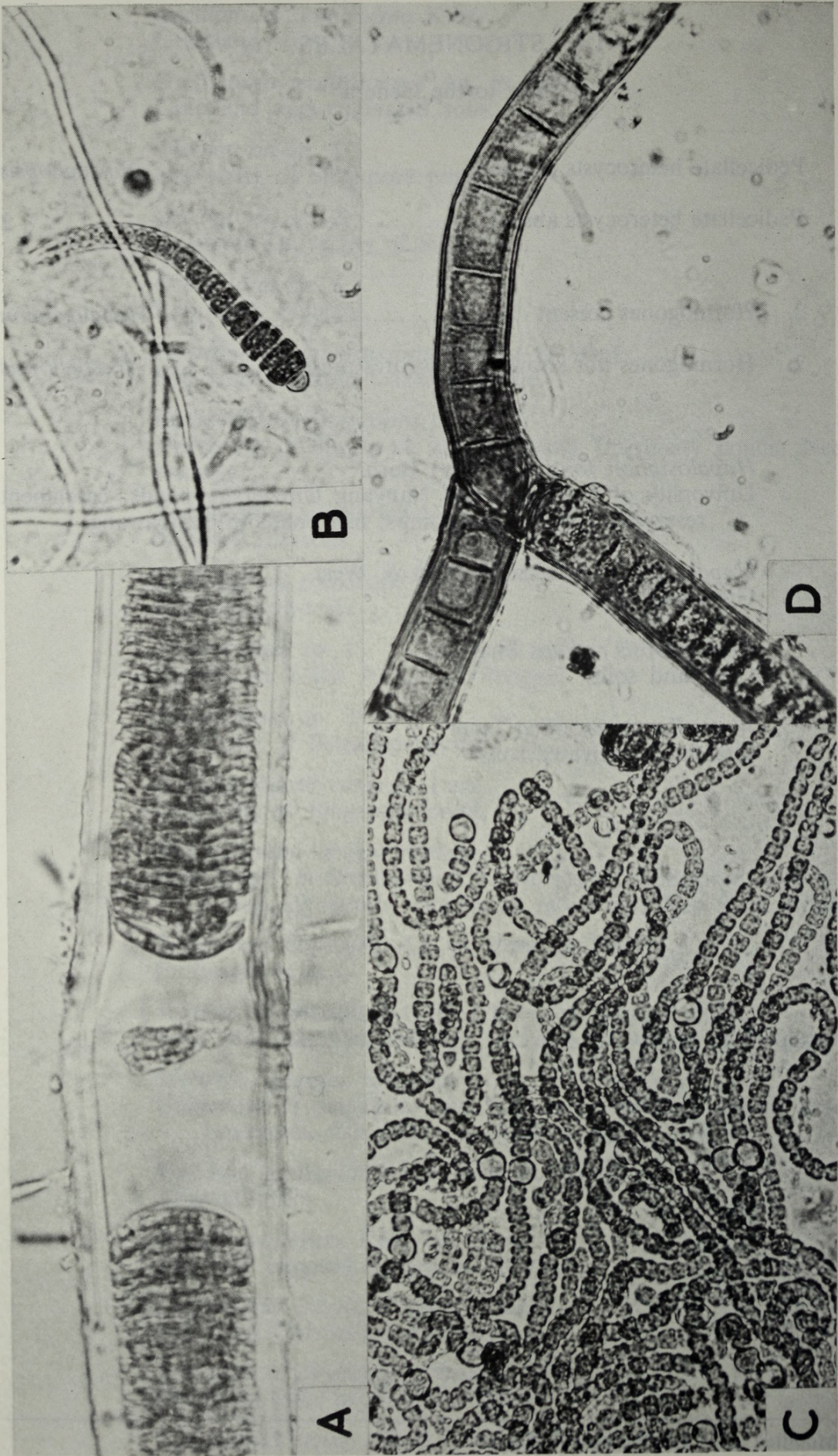
Hapalosiphon fontinalis (Ag.) Born.

University of Singapore and Nanyang University ponds; catchment reservoirs; Nee Soon swamps; fish ponds in Sembawang.

Hapalosiphon welwitschii West & West
Grassland soils.

Nostochopsis radians Bharadw.
Grassland soils.

Westiellopsis prolifica Janet
Grassland cultivated soils.



A, *Lyngbya* sp. X 2800; B, *Calothrix* sp. X 1600;
C, *Anabaena* sp. X 1600; D, *Scytonema* sp. X 1600.



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