

**A GUIDE TO THE IDENTIFICATION OF
COMMON BLUE-GREEN ALGAE
(CYANOPROKARYOTES) IN
AUSTRALIAN FRESHWATERS.**

Peter D. Baker¹ and Larelle D. Fabbro²

1. Cooperative Research Centre for Water Quality, Australian Water Quality Centre,
Salisbury, S.A. 5108
2. Biology Department, Central Queensland University, Rockhampton, Qld 4702

**Cooperative Research Centre for Freshwater Ecology
Identification Guide No. 25
2nd Edition**

© Copyright 1999, 2002. Cooperative Research Centre for Freshwater Ecology,
Albury.
This guide may not be reproduced in part or whole without the written permission
from the copyright owner.
Text and figures, © Copyright, Peter D. Baker and Larelle D. Fabbro

Identification Guide Series edited by John H. Hawking.

First published 1999, 2nd Edition published 2002 by the Cooperative Research Centre
for Freshwater Ecology, Ellis Street, Thurgoona, NSW 2640.

National Library of Australia Cataloguing-in-Publication

Baker, P.D. (Peter D.)
A guide to the identification of common blue-green algae
(Cyanoprokaryotes) in Australian freshwaters.

Bibliography.
ISBN 1 876144 48 3
ISSN 1321 – 280X

1. Cyanobacteria - Australia - Identification. I. Fabbro,
L.D. II. Cooperative Research Centre for Freshwater
Ecology (Australia). III. Title. (Series : Identification
guide (Cooperative Research Centre for Freshwater Ecology
(Australia))).

579.390994

Front cover:

Top left: *Cylindrospermopsis* sp.

Top right: *Anabaena* sp.

Centre: *Nodularia* sp.

Bottom left: *Phormidium* sp.

Bottom right: *Aphanizomenon* sp.

Background: *Gloeotrichia* sp.

Back cover:

Top left: *Lyngbya* sp.

Top right: *Cylindrospermopsis* sp.

Centre: *Microcystis* sp.

Bottom: *Microcystis* sp.

CONTENTS

Acknowledgements.....	iv
Introduction.....	1
Systems of Classification.....	1
Classification Criteria.....	2
Key to the Orders of the Cyanoprokaryota.....	3
Families of the Order.....	4
Key to the Genera of the Chroococcales.....	6
Common Taxa of the Chroococcales.....	8
<i>Coelosphaerium</i>	8
<i>Microcystis</i>	8
<i>Snowella</i>	9
Photomicrographs and Illustrations of Common Taxa of the Chroococcales.....	11
Key to the Genera of the Oscillatoriales.....	16
Common Taxa of the Oscillatoriales.....	18
<i>Arthrospira</i>	18
<i>Geitlerinema</i>	18
<i>Limnothrix</i>	18
<i>Oscillatoria</i>	19
<i>Phormidium</i>	19
<i>Planktothrix</i>	20
<i>Planktolyngbya</i>	21
<i>Pseudanabaena</i>	21
<i>Plectonema</i>	22
<i>Trichodesmium</i>	22
<i>Tychonema</i>	23
Photomicrographs and Illustrations of Common Taxa of the Oscillatoriales.....	24
Key to the Genera of the Nostocales.....	30
Common Taxa of the Nostocales.....	32
<i>Anabaena</i>	32
<i>Anabaenopsis</i>	35
<i>Aphanizomenon</i>	35
<i>Cylindrospermopsis</i>	37
<i>Cylindrospermum</i>	38
<i>Gloeotrichia</i>	39
<i>Nodularia</i>	40
<i>Nostoc</i>	40
Photomicrographs and Illustrations of Common Taxa of the Nostocales.....	41
Key to the Genera of the Stigonematales.....	51
Common Taxa of the Stigonematales.....	51
<i>Nostochopsis</i>	51
References.....	52
Glossary.....	53

ACKNOWLEDGEMENTS

Much of the contents of this guide was obtained through research funding by the Water Service Association of Australia (WSAA) through its research division UWRAA and the Central Queensland University.

The authors wish to thank the numerous people around Australia who have assisted in the collection and provision of samples for taxonomic research.

INTRODUCTION

Blue-green algae (Cyanophyta) or cyanobacteria are prokaryotic phototrophic organisms, which lack a defined nucleus and other membrane-bound organelles, such as chloroplasts and mitochondria, which are conspicuous in other algal groups. They are unique from other gram-negative bacteria and similar to eukaryotic algae in their capability for oxygen-evolving photosynthesis and the presence of the photosynthetic pigments chlorophyll *a*, phyco-cyanin and phyco-erythrin, which contribute to their characteristic colour. They are also comparable in size to other algae and have traditionally been classified with algae under the International Code of Botanical Nomenclature. More recently, they have been referred to as cyanoprokaryotes, to accommodate the taxonomic views of both phycologists and bacteriologists.

Cyanoprokaryotes are adapted to a wide range of aquatic habitats, including freshwater, marine and hypersaline environments. In freshwater habitats, they generally prefer neutral or alkaline pH, but can occur over a wide range of temperature and salinity conditions. They may be either planktonic or benthic and certain types may form symbiotic relationships with specific host plants. Certain planktonic forms produce characteristic water blooms under suitable environmental conditions, including nutrient enrichment and a stable physical environment. Many of the bloom-forming species can also affect the quality of water used for human and animal consumption, by the production of toxins and taste and odour compounds.

The purpose of this guide is to provide keys to the morphological identification of the reported genera of cyanoprokaryotes in Australia (both planktonic and benthic) and to facilitate the identification of the common taxa associated with freshwater blooms and the impairment of water quality. This document does not attempt to provide an identification to all reported taxa in Australia. The approach taken is to present keys, photographic images and illustrations of those taxa which are known or have potential to impair water quality and is intended primarily as a practical guide to those involved in water quality monitoring and research. For the first time, descriptions are provided in a single document for cyanoprokaryote taxa occurring in both temperate and sub-tropical climatic regions of Australia. Information is provided on bloom occurrence (Bl), toxin production (T) and production of odorous metabolites (O). The habitat (P = planktonic, Be = benthic) and recorded distribution is also provided for each species. Where toxicity and toxin production has been confirmed in the literature the symbol (T) is used, whereas (T?) refers to at least one report in Australia or elsewhere of suspected but unconfirmed toxicity.

SYSTEMS OF CLASSIFICATION

Over the last two decades, a general consensus on classification of cyanophytes/ cyanobacteria has been reached by phycologists and bacteriologists, whereby complementary field and laboratory studies are used to establish links between the original natural population and cultured strains isolated from the same population. The classification system for naturally occurring cyanoprokaryotes proposed by Anagnostidis and Komárek (1985) has followed this principle and an ongoing revision of previously described taxa is proceeding toward the preparation of a world monograph 'Index of Cyanoprokaryotes'. The first book entitled "Cyanoprokaryota, Part I, Chroococcales" by Komárek & Anagnostidis has recently been released in English. The orders Chroococcales and Oscillatoriales have required extensive revision, while the traditional system has essentially been retained for the Nostocales and

Stigonematales. This is the system which has been used in this guide to the identification of Australian cyanoprokaryotes.

CLASSIFICATION CRITERIA

Traditional classification above the level of species (order, family, genus) is ideally based upon clearly defined and stable descriptive morphological criteria. Cyanoprokaryotes may be unicellular or multicellular, the latter consisting of filamentous or colonial aggregations of cells with varying degrees of differentiation and complexity. Reproduction is asexual and replication is by simple cell division (binary fission), modified cell division into daughter cells, fragmentation of filamentous types to produce hormogonia or germination of specialised cells (akinetes). Cell division may occur in one, two or three planes and in single or multiple sequences within each cell. Major morphological features include the presence of upright, prostrate or undifferentiated aggregations of cells, the structure and form of filamentous branching and mucilaginous sheaths, the shape and symmetry of colonies or filaments (trichomes), the degree of constriction in trichomes at cell cross-walls, motility of trichomes, aggregation of trichomes and the position and shape of specialised cells (akinetes, heterocytes, apical cells).

Both descriptive and morphometric criteria are important for classification at the species and infra-species level. Morphological features which are commonly used include the shape and dimensions of vegetative cells, specialised cells, colonies and trichomes. In the case of measurable characters, statistical methods are necessary to define a central type and the range of variation in a certain character, and to discern separate taxa by establishing clear discontinuities between populations. Characters such as mucilaginous sheaths and gas vesicles may also be useful, even though they may be environmentally induced. It is the capability to produce these features, rather than their obligatory presence, that is important from a taxonomic viewpoint. Some features such as colony morphology may change according to the stage of development and it is critical to have a good understanding of the life cycle of each taxon. Classification at the species level may also be determined by differences in ecological habitat or geographic separation

The popular concept of a cosmopolitan distribution for cyanoprokaryotes has resulted in the adoption of taxonomic texts from Europe and North America for the identification of Australian taxa. However, while some species may be found in a similar niche all over the world, the technique of 'comparative iconography' may not be applicable for the identification of all Australian taxa. There is an obvious need to more rigorously compare taxa from Australia with similar specimens collected elsewhere in the world, utilising both traditional and alternative taxonomic criteria.

KEY TO THE ORDERS OF THE CYANOPROKARYOTA

(BLUE-GREEN ALGAE/CYANOBACTERIA)

- 1a. Unicellular forms or cells forming colonial or pseudo-filamentous aggregates; reproduction by binary or multiple cell fission **Chroococcales**
- 1b. Filamentous forms, reproduction by cell fission, by trichome fragmentation (to produce hormogonia) or by akinetes..... **2**
- 2a. Filamentous forms without specialised cells **Oscillatoriales**
- 2b. Filamentous forms with specialised cells (akinetes and/or heterocytes) **3**
-
- 3a. Cells divide perpendicular to the main axis; true branching lacking **Nostocales**
- 3b. Cells may divide in directions other than perpendicular to the main axis; true branching present **Stigonematales**

(Adapted from the taxonomic revisions of Anagnostidis & Komárek, 1985-1990).

FAMILIES OF THE ORDERS

Those families of the Cyanoprokaryotes recognised by Anagnostidis and Komárek (1986, 1988, 1990) and Komárek and Anagnostidis (1989), within each order of their revised classification system are listed below. The main deviation between this system and the more traditional system described previously by Fritsch (1977) is the establishment of the Oscillatoriales as a separate order from the Nostocales and the merging of the orders Chamaesiphonales, Pleurocapsales and Chroococcales into the one order, Chroococcales. Families marked thus (*) include taxa previously reported in Australia and catalogued in Day *et al.* (1995).

ORDER CHROOCOCCALES Wettstein

Unicellular, colonial, pseudoparenchymatic colonies or pseudofilamentous aggregates of definite or indefinite shape; without trichomes; heterocytes (heterocysts) and akinetes lacking; reproduction mainly by binary fission; cell division in one, two, or more perpendicular planes; facultative formation of exocytes and nanocytes (multiple fission).

Families:

- * Chamaesiphonaceae Borzi
- * Chroococcaceae Nageli.
Dermocarpellaceae Ginsburg-Ardre
- * Entophysalidaceae Geitler
- * Hydrococcaceae Kützing
- * Microcystaceae Elenkin
- Xenococcaceae Ercegovic

ORDER: OSCILLATORIALES Elenkin

Thallus multicellular and filamentous; simple trichomes, without true branching, with or without false branching; motile or immotile; heterocytes (heterocysts) and akinetes lacking; cells always divide perpendicular to the trichome axis; sheaths facultative or obligatory, reproduction by trichome fragmentation (to form hormogonia).

Families:

- Borziaceae Borzi
- Homeotrichaceae Elenkin
- * Oscillatoriaceae (S.F. Gray) Harv. ex Kirchner
- * Phormidiaceae Anagnostidis & Komárek
- * Pseudanabaenaceae Anagnostidis & Komárek
- * Schizotrichaceae Elenkin

ORDER: NOSTOCALES (Borzi) Geitler

Thallus multicellular and filamentous with true trichomes; isopolar or heteropolar; unbranched or falsely branched; true branching always lacking; heterocytes (heterocysts) and/or akinetes present, akinetes facultatively; cells always divide perpendicularly to the trichome axis, reproduction by trichome fragmentation (to form hormogonia) or akinetes.

Families:

- * Microchaetaceae Lemmermann
- * Nostocaceae Dumort
- * Scytonemataceae Kützing
- * Rivulariaceae Kützing

ORDER STIGONEMATALES Geitler

Filamentous with true filaments; sometimes combined with pseudofilaments; true branching always present (at least in part of the life cycle), with or without false branching; thallus heteropolar or isopolar; heterocytes occur facultatively in several genera, akinetes rarely; cells divide perpendicularly to the trichome axis and/or irregularly in more directions; reproduction by hormogonia, hormocytes, hormocysts, akinetes, nanocytes, planocytes and monocytes.

Families:

- Chloroglocopsaceae (Mitra) Mitra & Pandey
- * Capsosiraceae (Borzi) Geitler
- * Stigonemataceae (Hass.) Kirchner
- * Fischerellaceae Anagnostidis & Komárek
- Borzinemataceae Geitler
- Loriellaceae Geitler
- * Nostochopsaceae Geitler
- * Mastigocladaceae Geitler

ORDER CHROOCOCCALES

Key to the Genera of the Chroococcales

- 1a. Unicellular or colonial aggregates of irregularly arranged cells 2
 1b. Mostly colonial forms with a tendency to polarised growth in layers or pseudofilaments 3
- 2a. Unicellular or mucilaginous colonies; cell division in one, two or three planes perpendicular to each other in successive generations; cells grow into their original form before the next division 4
 2b. Small packet-like colonies with spherical, ovate or hemispherical cells often enclosed in a sheath confluent with a common mucilaginous envelope; cell division in three or more different planes; cells divide before growing into their original spherical form *Chroococcus*
- 3a. Cells spherical and isopolar; colonies of cells in vertical rows; individual cells enclosed in a mucilaginous sheath *Entophysalis*
 3b. Cells usually heteropolar 5
- 4a. Sheathed cells elongate to club-shaped; sessile, solitary or in groups; dividing asymmetrically at the distal (apical) end, generally into a single row *Chamaesiphon*
 4b. Attached parenchymatous thallus; colonies not sessile; cells dividing symmetrically; cells arranged in rows in marginal parts *Pleurocapsa*
- 5a. Cell division in one plane perpendicular to the long axis (Synecochocaceae) 6
 5b. Cell division in two perpendicular planes (Merismopediaceae) 7
 5c. Cell division in three perpendicular planes (Microcystaceae) 8
- 6a. Cells ovate, spherical or cylindrical 9
 6b. Cells more or less fusiform 10
- 7a. Cells not regularly arranged in flat sheets 15
 7b. Cells regularly arranged in flat sheets *Merismopedia*
- 8a. Colonies of few cells; in mucilaginous packets; sheaths often lamellate; grows attached to a submerged substrate *Gloeocapsa*
 8b. Colonies of many cells and indefinite shape enclosed by a common mucilaginous envelope; planktonic *Microcystis*
- 9a. Cylindrical unicells that are longer than broad *Synechococcus*
 9b. Colonial forms with cells enclosed within a mucilaginous envelope 11
- 10a. Fusiform straight solitary cells (or pairs of cells) conspicuously longer than broad *Myxobaktron*
 10b. Fusiform or tapered cells in colonies *Rhabdogloea*
- 11a. Colonies mainly spherical 12
 11b. Colonies not spherical or pseudofilamentous 13
 11c. Colonies pseudofilamentous and composed of cylindrical cells 14

- 12a. More of less spherical colonies with cells located one layer under surface *Lemmermaniella*
- 12b. Colonies of kidney shaped cells attached to the ends of gelatinous stalks that are visible after staining with methylene blue..... *Cyanonephron*
- 12c. Colonies with cells radiating from the centre of the colony in indistinct rows..... *Radiocystis*
-
- 13a Individual cells or small groups of cells enclosed by a definite gelatinous sheath *Gloeothece*
- 13b. Cells not enclosed by definite individual sheaths *Aphanothece*
-
- 14a. Cylindrical cells with rounded ends in mucilaginous colonies *Rhabdoderma*
- 14b. Cells embedded in mucilaginous rows in a net-like colony..... *Cyanodictyon*
-
- 15a. Colonies hollow, with cells arranged toward the periphery **16**
- 15b. Colonies not hollow; cells evenly and remotely distributed within the colonial mucilage *Aphanocapsa*
-
- 16a. Cells at the ends of branching gelatinous strands radiating from the centre of the colony **17**
- 16b. Colonies without radiating gelatinous strands *Coelosphaerium*
-
- 17a. Stalks fine, thread-like; cells spherical or irregularly oval, distant from one another *Snowella*
- 17b. Stalks wide and enveloping the individual cells; cells obovate or club-shaped and (after division) remain and grow joined together for a long part of the cell cycle *Gomphosphaeria*

Common Taxa of the Chroococcales

Various Chroococcales those are either less common or extremely small in size (eg. *Aphanocapsa* and *Aphanothece*) are not included in this guide and the reader is referred to McGregor and Fabbro (2001) for their identification.

Genus *Coelosphaerium* Nägelii

Colonies planktonic, microscopic in size, spherical, ovoid or irregularly rounded; enclosed by a narrow hyaline mucilaginous envelope; cells disposed irregularly in a single peripheral layer beneath the colonial envelope to form a hollow sac; cells spherical, with or without gas vesicles; cell division in two planes perpendicular to each other in successive generations and perpendicular to the surface of the colony; separating from one another soon after division.

Checklist of Common Taxa

Coelosphaerium confertum West et G. S. West (P) (Photo 1)

Coelosphaerium aff. *kützingianum* Naegelii (P, Bl, T) (NSW, Vic, Qld, NT) Photo 2

Key to the Common Species

1a. Colonies mostly spherical; 70–110 µm in diameter; cells 1.8-2.4 µm in diameter; without gas vesicles and characteristically distributed around the periphery of the colony in a fine row with interspersed increases in thickness as seen in Photo 1..... *Coelosphaerium confertum*

1b. Colonies globose or irregularly rounded; 20-40 µm in diameter; enclosed in an indistinct and homogeneous mucilaginous envelope; cells spherical or ovate, 2-4 µm diameter, L:B ratio no more than 1.5; closely and densely aggregated around the periphery of the colony; without gas vesicles *Coelosphaerium* aff. *kützingianum*

Genus *Microcystis* Kützing ex Lemmermann

Colonies planktonic or sedentary; variable in shape from spherical, ovoid, ellipsoidal, elongate, lobed, irregular or perforated to form masses of microscopic or macroscopic size; often composed of an aggregation of smaller colonies. Cells spherical, ovate or almost hemispherical when dividing, usually densely aggregated within an unstratified hyaline mucilaginous envelope; individual envelopes absent around cells; cell contents homogeneous or with numerous gas vesicles. Reproduction by vegetative division in three perpendicular planes in successive generations.

Checklist of Common Taxa

Microcystis aeruginosa (Kützing) Kützing (P, Bl, T, O) (Cosmopolitan) Photos 3-4, Fig. 1

Microcystis botrys Teiling (P, Bl, ?T, O) (Qld) Photos 5-7

Microcystis cf. *firma* (Kützing) Schmidle (P, Bl, ?T) (Qld) Photo 8

Microcystis flos-aquae (Wittrock) Kirchner (P, Bl, ?T) (Cosmopolitan) Photo 9, Fig. 1

Microcystis ichthyoblabe Kützing (P, Bl, ?T, O) (Qld) Photo 10

Microcystis panniformis Komárek et al. (P, Bl, T, O) (NSW, SA, Qld) Photo 11

Microcystis protocystis Crow (P, Bl, ?T, O) (Qld) Photo 12

Microcystis wesenbergii Komárek (P, Bl) (NSW, SA, Vic, Qld) Photo 13, Fig. 2

Microcystis aff. *wesenbergii* Komárek (P, Bl) (Qld) Photo 14

Key to the Common Species

- 1a. Cells 1-2.5 μm in diameter and distributed within thin filmy mucilage..... *M. cf. firma*
1b. Cells greater than 2 μm in diameter and distributed within various colonial forms..... 2
- 2a. Colonies with a wide mucilaginous envelope..... 3
2b. Colonial mucilage narrow (< 1 μm wide), cells spherical, generally 3-4 μm in diameter, densely aggregated in irregularly spherical colonies, often with well defined borders..... *M. flos-aquae*
- 3a. Boundary of the colonial mucilage sharply defined and refractive..... 4
3b. Boundary of the colonial mucilage indistinctly defined 5
- 4a. Boundary of the colonial mucilage sharply defined and refractive; colonies irregular in shape, often lobed and fenestrate; cells spherical, 4.5-7.5 μm in diameter, sparsely distributed and well within the colonial envelope *M. wesenbergii*
4b. Boundary of the colonial mucilage sharply defined, often segmentally indented and refractive; colonies regular and often rectangular in shape; cells spherical, 4.5-7.5 μm in diameter, normally linearly arranged within the colonial envelope *M. aff. wesenbergii*
- 5a. Cells 2.5–3.0 μm in diameter, densely packed in somewhat spherical sub-colonies *M. ichthyoblabe*
5b. Cells \geq 3 μm in diameter..... 6
- 6a. Cells spherical, generally 5-7 μm in diameter; colonies highly variable in morphology, but commonly elongated, clathrate or net-like with lobed protrusions; colonial mucilage broad; cells densely aggregated or in smaller colonies invested in the common mucilage *M. aeruginosa*
6b. Colonies spherical or in the shape of a thick irregular plate, rarely elongated \pm indistinctly clathrate..... 7
- 7a. Colonies somewhat spherical with radial hyaline gelatinous processes or protrusions observable with phase contrast microscopy; cells 5 – 6 μm in diameter *M. botrys*
7b. Colonies generally macroscopic in the shape of irregularly defined thick plates, up to 4 mm in diameter; colony outline may be irregular; cells 3-5 μm in diameter, normally evenly and densely distributed throughout the colony although slight clumping may be evident in some colonies..... *M. panniformis*
7c. Colonies with sparsely and irregularly arranged cells in diffuse homogenous colourless mucilage; cells 4.2–7.4 μm in diameter..... *M. protocystis*

Genus *Snowella* Elenkin

Colonies spherical or irregularly oval; smooth, colourless and wide mucilaginous envelopes; fine, mucilaginous, pseudo-dichotomously branched and sometimes fasciculating stalks within the colonies, which are sometimes widened in the center. Cells spherical or slightly elongated, with or without gas vesicles, joined to the ends of stalks, but distant from one another.

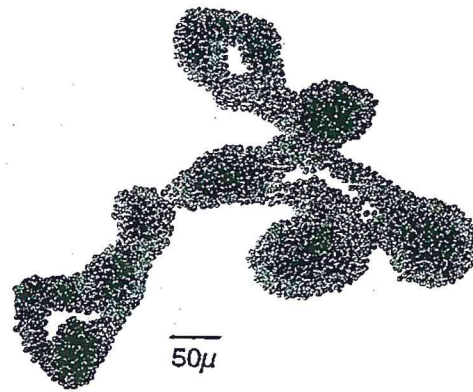
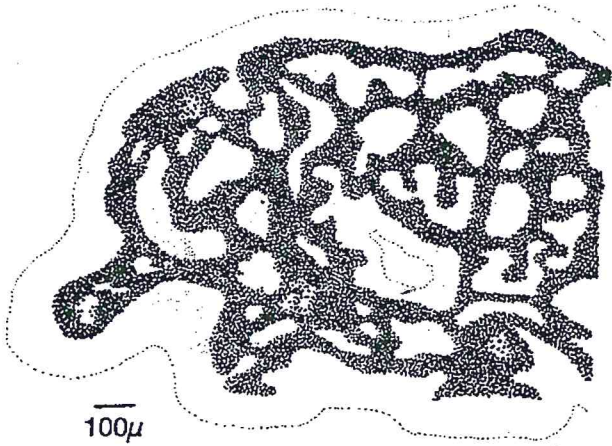
Checklist of Common Taxa

Snowella litoralis (Häyrén) Komárek & Hindák (P, BI T?) (Qld) Photo 15

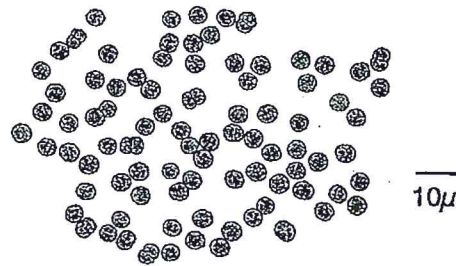
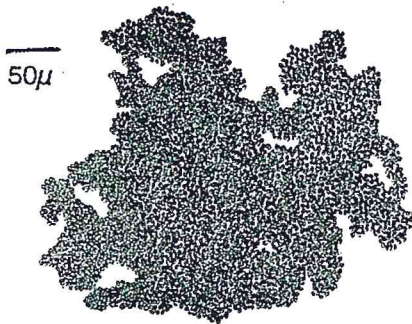
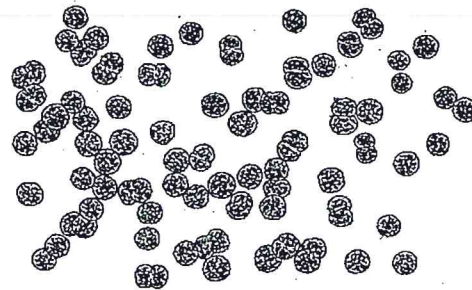
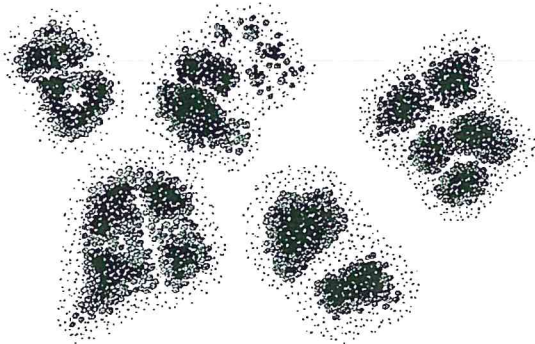
***Snowella litoralis* (Häyrén) Komárek & Hindák**

Description: Planktonic, spherical colonies 20-40µm in diameter with a distinct colourless and wide mucilaginous envelope. Individual cells, yellow-green in colour, without gas vesicles, spherical, 2.0-2.5 µm in diameter and arranged distant from one another around the periphery of the colony at the ends of fine gelatinous strands.

Figure 1



***Microcystis aeruginosa*
f. *aeruginosa***



***Microcystis aeruginosa*
f. *flos-aquae***

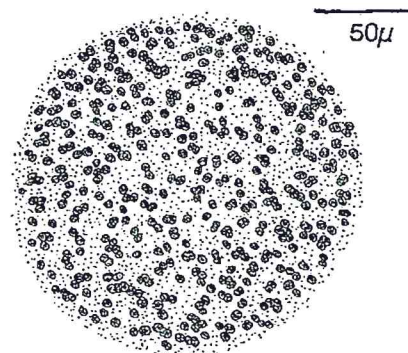
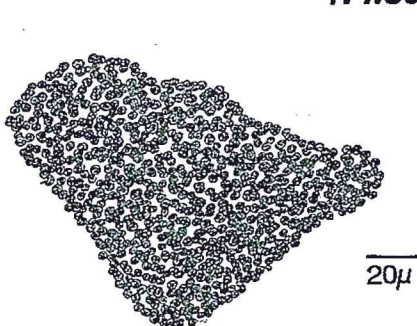
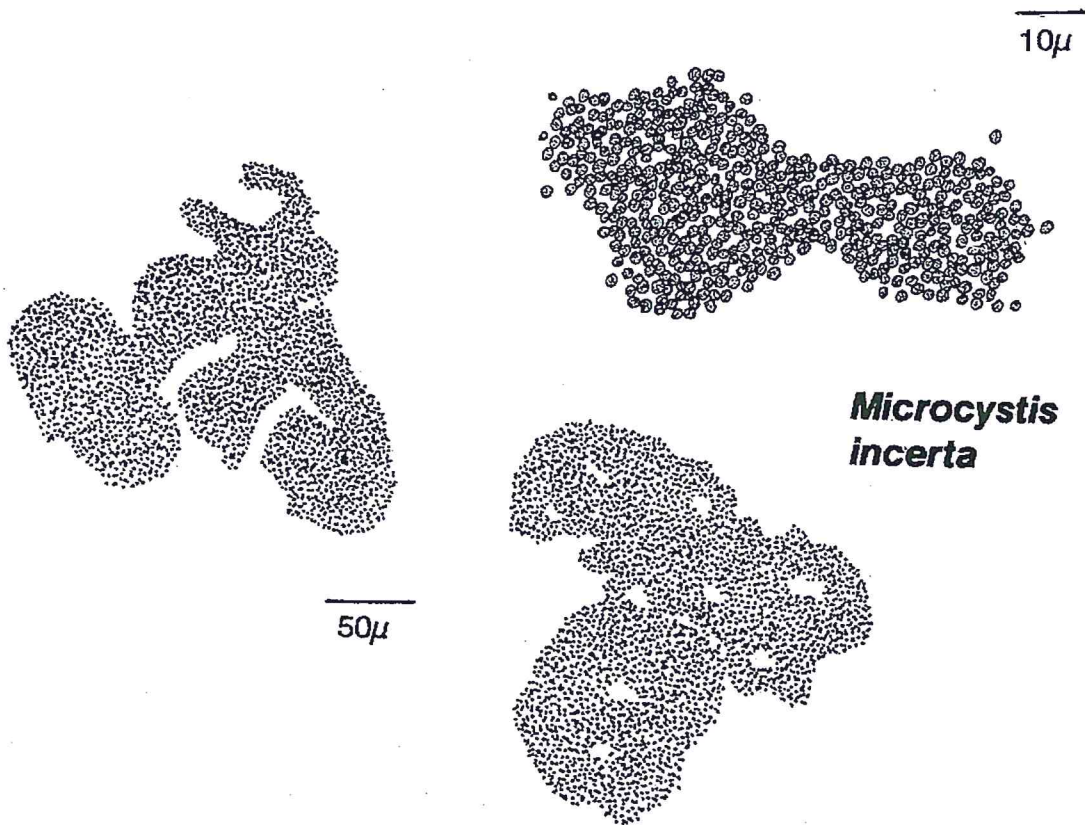
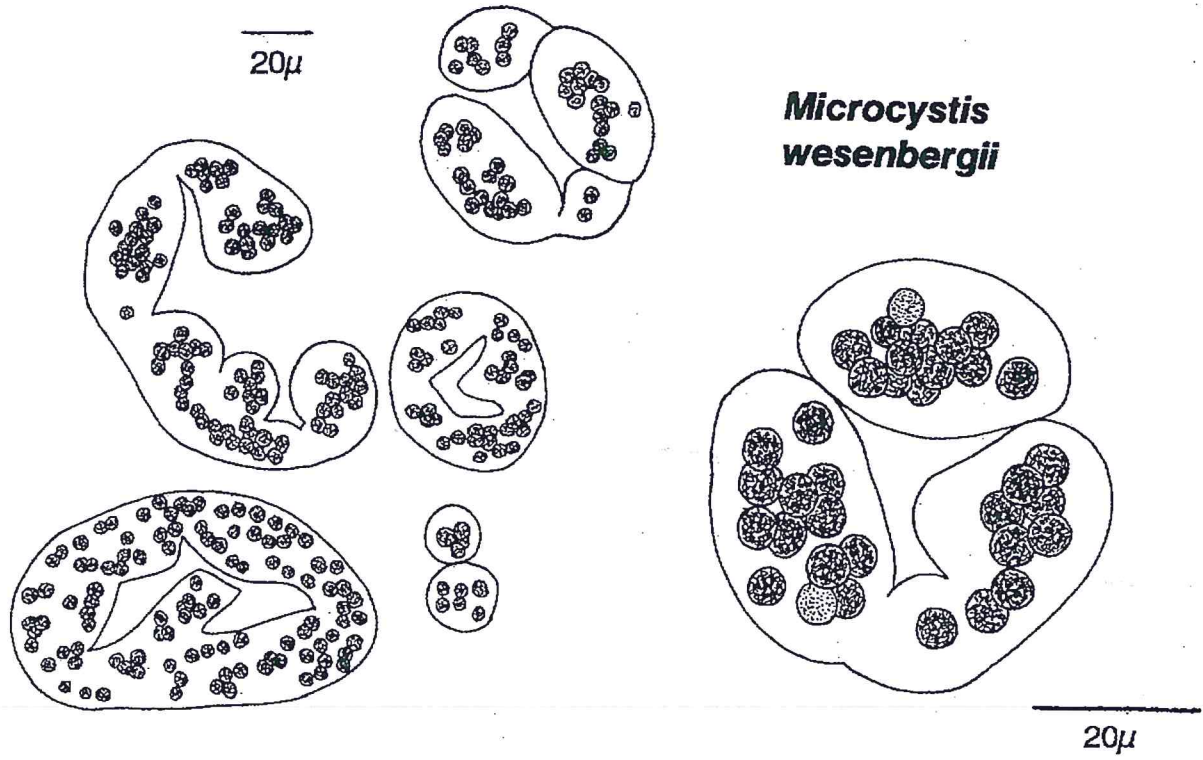
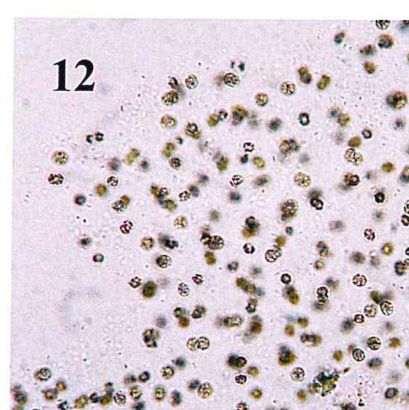
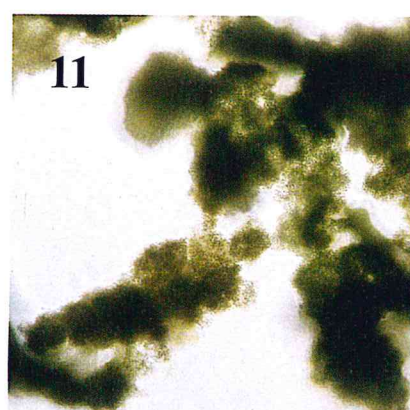
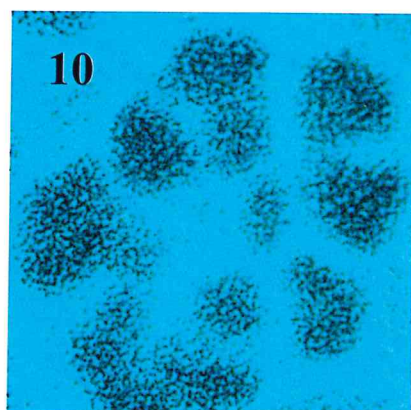
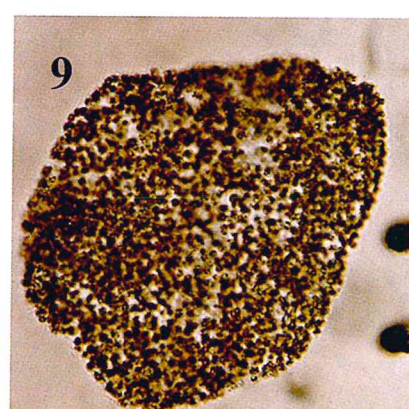
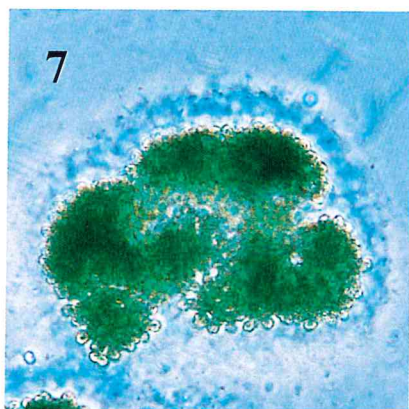
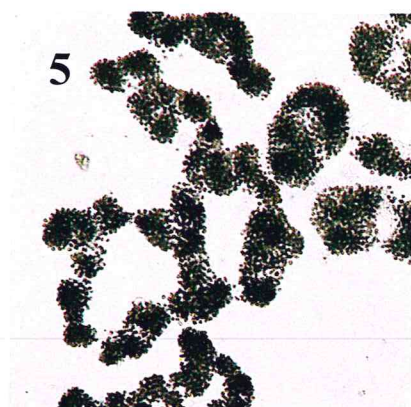
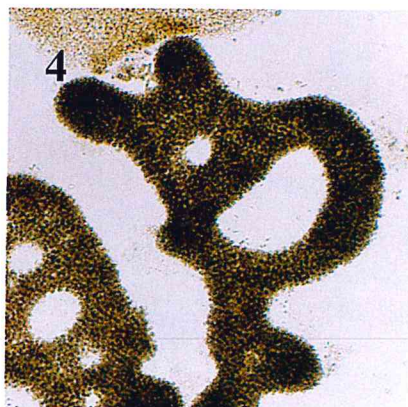
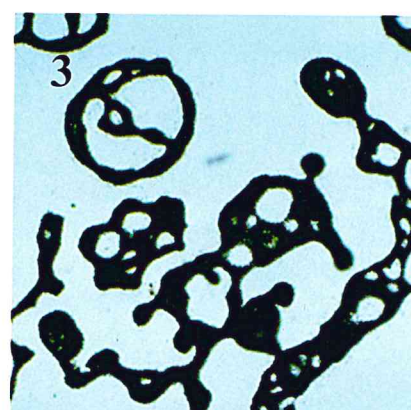
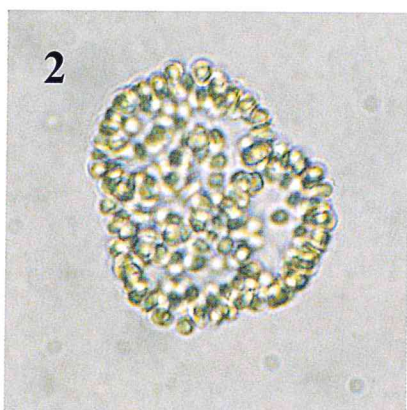
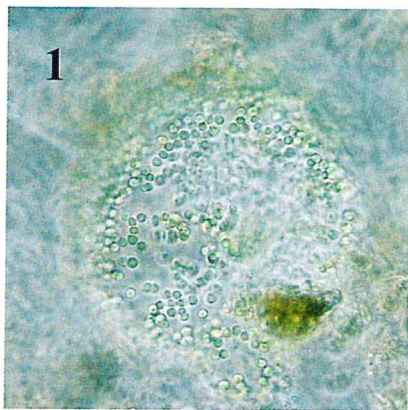
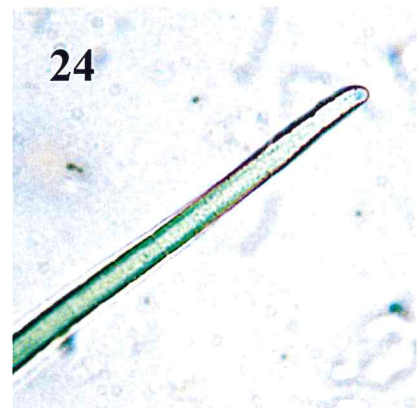
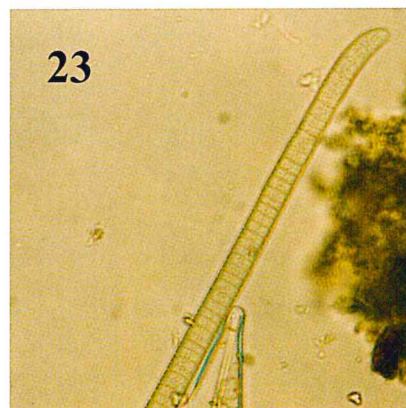
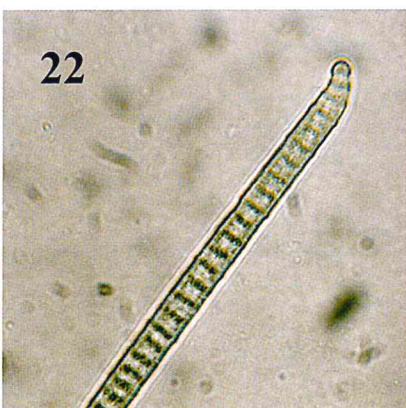
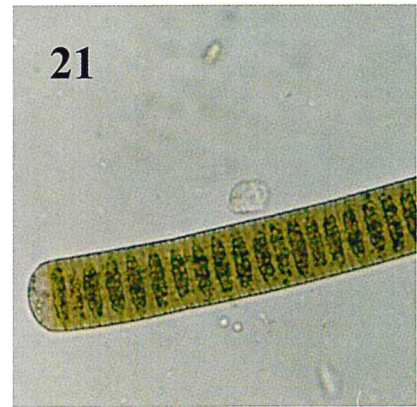
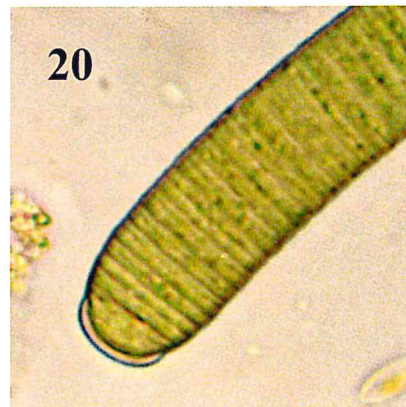
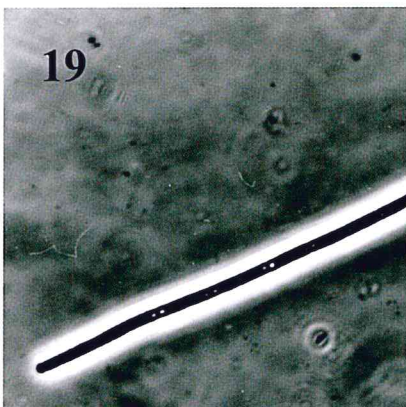
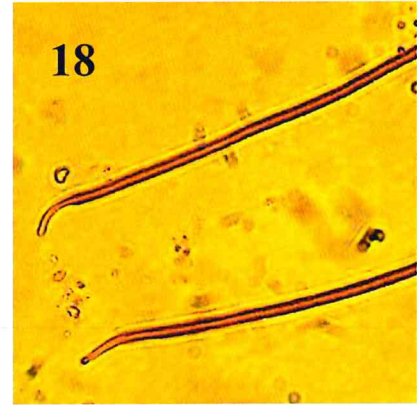
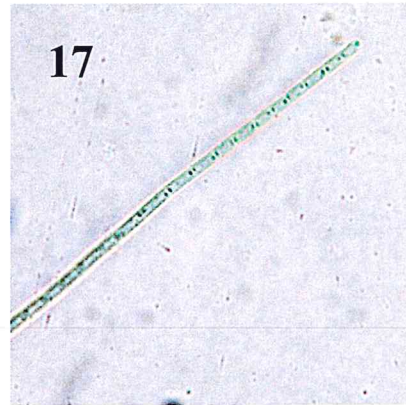
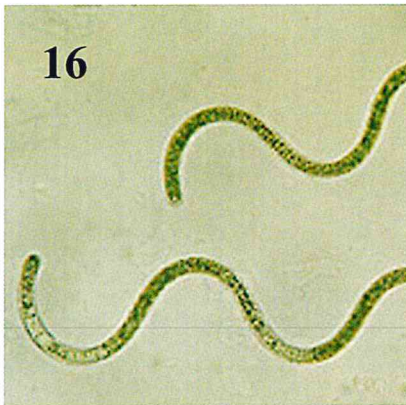
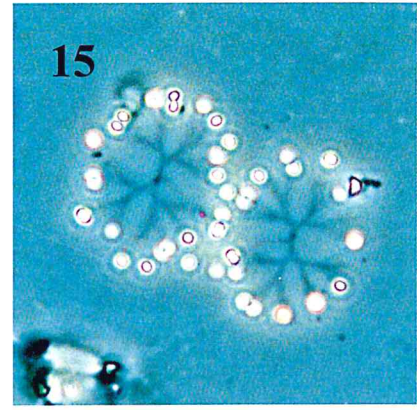
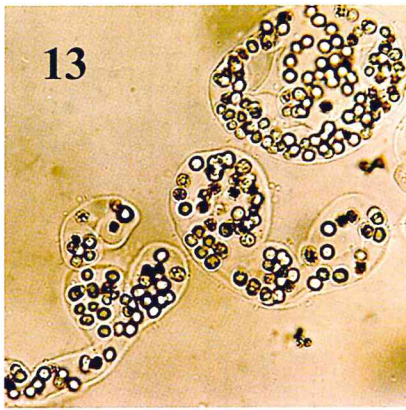


Figure 2



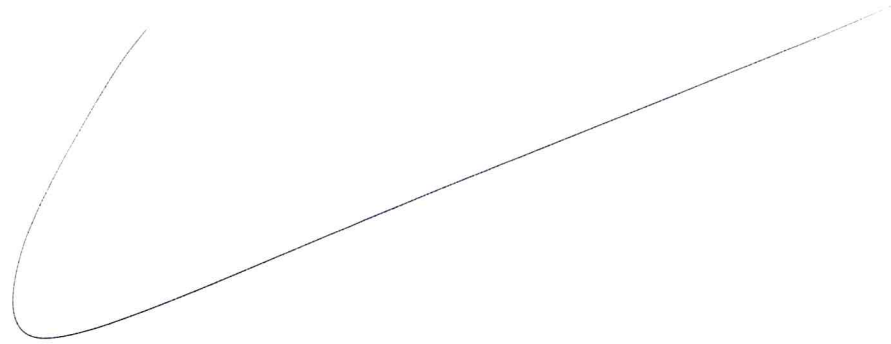


Photos 1-12: (1) *Coelosphaerium confertum*; (2) *Coelosphaerium* aff. *kuetzingianum*; (3-4) *Microcystis aeruginosa*; (5-7) *Microcystis botrys*; (8) *Microcystis firma*; (9) *Microcystis flos-aquae*; (10) *Microcystis ichthyoblabe*; (11) *Microcystis panniformis*; (12) *Microcystis protocystis*.



Photos 13-24: (13) *Microcystis wesenbergii*; (14) *Microcystis* aff. *wesenbergii*; (15) *Snowella littoralis*; (16) *Arthrospira* aff. *maxima*; (17) *Geitlerinema unigranulatum*; (18) *Geitlerinema splendidum*; (19) *Limnothrix* aff. *planctonica*; (20) *Oscillatoria princeps*; (21) *Oscillatoria sancta*; (22) *Phormidium amoenum*; (23-24) *Phormidium formosum*.

Blank
Page



ORDER OSCILLATORIALES

Key to the Genera of the Oscillatoriales

- 1a. Trichome division without necridic cells; cells in trichomes mostly longer than wide 2
1b. Trichome division with the aid of necridic cells: cells in trichomes generally shorter than wide or iso-diametric 3
- 2a. Several trichomes within a sheath closed at the apex (heteropolar filaments); trichomes immotile *Schizothrix*
2b. Trichomes rarely within a sheath; if present, isopolar and never more than one trichome per sheath (*Pseudanabaenaceae*) 4
- 3a. Cells more or less iso-diametric; cells grow to full size before the next division (*Phormidiaceae*) 5
3b. Cells discoid; much shorter than wide; cell division and formation of transverse cell walls occurs in rapid sequence (*Oscillatoriaceae*) 6
- 4a. Epiphytic forms; filaments solitary, wavy, 1.5-12 μ m wide *Leibleinia*
4b. Not epiphytic, filaments generally narrow 7
- 5a. Trichomes with regularly spiralled coils; sheaths absent 8
5b. Trichomes straight or flexuous, not spirally coiled 9
- 6a. False branching lacking, motile 10
6b. False branching present, non-motile *Plectonema*
- 7a. Trichomes with fine but distinct sheaths often extending beyond the trichome at both ends, gas vesicles lacking *Planktolyngbya*
7b. Trichomes generally without distinct sheaths; gas vesicles present or absent..... 11
- 8a. Trichomes with distinct cross-walls *Arthrospira*
8b. Trichomes with indistinct cross-walls *Spirulina*
- 9a. Sheaths lacking; or if present containing only one trichome 12
9b. Sheaths present; more than one trichome in a sheath 13
- 10a. Trichomes always with distinct sheaths *Lyngbya*
10b. Trichomes usually without sheaths *Oscillatoria*
- 11a. Cells very distinctly constricted at cell walls..... *Pseudanabaena*
11b. Cells not very distinctly constricted at cross-walls..... 14
- 12a. Planktonic forms, containing gas vesicles 15
12b. Predominately mat-like forms attached to a submerged substrate; without gas vesicles 16
- 13a. Sheaths lamellated; often numerous trichomes within a sheath *Hydrocoleum*
13b. Sheaths not lamellated; few (2-4) trichomes within a sheath *Microcoleus*
- 14a. Gas vesicles present; trichomes solitary..... *Limnothrix*

- 14b. Gas vesicles absent; trichomes in clusters or mats but rarely solitary..... *Geitlerinema*
- 15a. Trichomes deeply constricted at cross-walls; often forming fasciculated bundles
..... *Trichodesmium*
- 15b. Trichomes solitary; only slightly constricted at the cross-walls *Planktothrix*
- 16a. Plant mass with erect tufts; sheaths obligatory *Symploca*
- 16b. Plant mass without erect tufts17
- 17a. Mat-like thallus ; sheaths and false-branching may be present..... *Phormidium*
- 17b. Solitary trichomes or fine mats; cells often with prominent granules or “alveolar” in
appearance; cells virtually colourless but capable of chromatic adaption..... *Tychonema*

Common taxa of the Oscillatoriales

Genus *Arthrospira* Stizenberger

Planktonic or benthic, some species forming dense water blooms. Trichomes, cylindrical, motile, solitary or in fine mats, regularly spirally coiled; sheaths rarely present; with or without gas vesicles, uniformly broad or briefly tapering toward the apex, transverse walls distinct, cells more or less iso-diametric, sometimes granulate; apical cell broadly rounded, calyptra present in some species; false branching lacking.

Checklist of Common Taxa

Arthrospira aff. *maxima* Setchell & Gardner (P, BI, O) (NSW, Vic, SA, Qld) Photo 16, Fig. 3

Arthrospira aff. *maxima* Setchell & Gardner

Description: Trichomes solitary, not constricted or tapering, 4.5-6.5 µm broad, with gas vesicles, regularly and loosely spirally coiled. Spiral windings uniformly broad, 20-37.5 µm broad, 30-65 µm between windings; vegetative cells discoid, 1.5-3.5 µm long, usually less than half as long as broad, cross-walls often indistinct. Terminal cells broadly rounded, without a calyptra.

Genus *Geitlerinema* (Anagnostidis)

Benthic, tychoplanktonic or planktonic; motile trichomes in clusters or mats, rarely solitary; sheaths absent; cells long, cylindrical without gas vesicles.

Checklist of Common Taxa

Geitlerinema unigranulatum (Singh) Komárek & Azevedo (Be, P, BI, O) (SA, Qld) Photo 17

Geitlerinema splendidum (Gomont) Anagnostidis (Be, P, BI, O) (SA, Qld) Photo 18

Key to the Common Species

- 1a. Trichomes 2.0-2.7 µm wide sharply tapering to apex; apical cell capitated; cells 3.7-7.0 µm long.....*G. splendidum*
1b. Straight to wavy trichomes 2.1-2.4 µm wide; apical cell cylindrical and rounded; cells 3.0-9.0 µm long with single granules at the cross walls..... *G. unigranulatum*

Genus *Limnothrix* Meffert

Planktonic, trichomes straight or slightly bent, solitary without sheaths, generally immotile, cross-wall constrictions and cross-walls generally indistinct; cells long, cylindrical containing polar or central gas vesicles, apical cells rounded or tapered, non-capitate, generally containing a gas vesicle.

Checklist of Common Taxa

Limnothrix aff. *planctonica* (Van Goor) Meffert (P, BI), (Cosmopolitan)
Photo 19

Limnothrix aff. *planctonica* (Van Goor) Meffert

Description: Trichomes more or less straight, constrictions and cross-walls indistinct, 1.2-2.0 µm broad, cells cylindrical, up to 9.5 µm long, cells sometimes contain small rounded polar gas vesicles which are close to cross-walls, apical cells rounded, sometimes containing a polar gas vesicle.

Note that care should be taken to differentiate between these temperate forms with gas vesicles and tropical forms with granules that are more closely aligned to *Geitlerinema unigranulatum*.

Genus *Oscillatoria* Vaucher

Mostly benthic forms; filamentous, either solitary or forming aggregated masses; generally without a sheath, straight or entangled, without constrictions; clearly motile with a gliding or oscillating movement; cells discoid, without gas vesicles, dividing in rapid multiple sequence before reaching their original size, often with a row of granules on either side of the cross-walls; apical cell rounded or swollen and capitate, sometimes calyptrate.

Checklist of Common Taxa

Oscillatoria princeps Vaucher (Be/P, O) (NSW, Vic, SA, Qld, NT) Photo 20

Oscillatoria sancta (Kütz.) Gomont (Be/P, O) (Qld, SA) Photo 21

Key to the Common Species

- 1a. Trichomes 22-50 µm broad; apical cell broadly rounded, slightly capitate, sometimes calyptrate; cells 3.5-5 µm long, granulate..... *O. princeps*
1b. Trichomes 18-20 µm broad, highly granular with darker lens shaped areas; cells 2-6 µm long; apical cell broadly rounded *O. sancta*

Genus *Phormidium* Kützting

Mostly benthic; forming a mat-like thallus, trichomes cylindrical, straight, waved or irregularly coiled, unstricted or slightly constricted at the cross-walls, false branching lacking, clearly motile by gliding, creeping or oscillating motion, cells more or less iso-diametric or shorter or longer than broad, without gas vesicles, cells growing into more or less the original size before the next division.

Checklist of Common taxa

Phormidium aff. *amoenum* (Kütz.) Anagnostidis & Komárek (Be, ?T, O) (Qld, SA) Photo 22

Phormidium formosum (Bory ex Gom.) Anagnostidis and Komárek (Be, ?T, O) (Qld, SA) Photos 23,24

Phormidium retzii (C. Agardh) Gomont (Be) (Qld) Photo 25

Key to the Common Species

- 1a. Trichome ends normally tapered, often curved or hooked at one or both ends; not calyptrate or capitate; cells 4.4-6.5 μm broad; 5-7.5 μm long; ∇ cell wall constrictions..... *P. formosum*
- 1b. Trichomes briefly attenuated and often hooked at the apices; often capitate dome or cone shaped, sheaths not apparent; cells more or less isodiametric or slightly shorter than broad; 5.5 –8.5 μm broad, 2.5-8.5 μm long; clearly granulated either side of the cross walls..... *P. amoenum*
- 1c. Trichomes cylindrical; not capitate or calyptrate; ∇ fine hyaline sheath; cells 5.6 –6.2 μm broad, 3.5-3.8 μm long; apical cell flatly rounded; cell content green to bluish-green often with small granules..... *P. retzii*

Genus *Planktothrix* Anagnostidis & Komárek

Planktonic; trichomes cylindrical, straight or slightly flexuous, solitary, isopolar, without false branching, slightly constricted or unconstricted at the cross-walls, slightly tapering or not tapering toward the apices, sheaths rarely present; Cells slightly shorter than wide or isodiametric, rarely longer than wide, containing gas vesicles, terminal cells occasionally with thickened outer walls or calyptra when fully developed.

Checklist of Common Taxa

- Planktothrix agardhii* (Gom.) Anagnostidis & Komárek 1988 (P, BI, ?T, O) (Qld, Vic) **Photo 26**
- Planktothrix mougeotii* (Küetz. ex Forti) Anagnostidis & Komárek 1988 (P, BI) (Qld, NSW, Vic, SA) **Photo 27, Fig. 4**
- Planktothrix perornata* f. *attenuata* (Skuja) Anagnostidis & Komárek 1988 (P, BI, O) (SA, Vic, NSW, Qld) **Photo 28, Fig. 4**
- Planktothrix raciborskii* (Woloszynska) Anagnostidis & Komárek 1988 (P, BI) (Qld) **Photo 29**
- Planktothrix* aff. *planctonica* (Elenk.) Anagnostidis & Komárek 1988 (P, BI) (NSW, Vic, SA, Qld) **Photo 30, Fig. 4**

Key to the Common Species

- 1a. Trichomes less than 8 μm broad 2
- 1b. Trichomes greater than 8 μm broad 3
- 2a. Trichomes 4.5-5 μm broad, straight, not constricted, often tapered toward the apices; apical cell rounded or bluntly conical, sometimes capitate, rarely with calyptra; cells 2.5-3 μm long *P. agardhii*
- 2b. Trichomes 4.5-6.0 μm broad, straight, not constricted, not tapering towards the apices; apical cells undifferentiated; cells 2-4 μm long *P. mougeotii*
- 3a. Trichomes 9.5-10.5 μm broad; not constricted at the cross-walls; cells shorter than broad, 2.5-5.0 μm long; apical cell characteristically conical..... *P. raciborskii*
- 3b. Apical cell not conical..... 4
- 4a. Trichomes 9-11 μm broad, generally attenuated and curved at one or both apices; blackish in colour, slightly constricted at the cross-walls; cells shorter than broad, 2.5-5.0 μm long; apical cell hemispherical at the tapered end or flatly rounded at the non-tapered end, not capitate or calyptrate *P. perornata* f. *attenuata*

4b. Trichomes 12-16.5 µm broad, uniformly broad, not attenuated or curved at the apices; blackish in colour, not constricted at the cross-walls; cells much shorter than wide, 1.5-3.5 µm long; apical cell flatly rounded, sometimes with a thickened membrane..... *P. aff. planctonica*

Genus *Planktolyngbya* Anagnostidis & Komárek

Planktonic, trichomes cylindrical, solitary, immotile, straight or irregularly to regularly coiled, narrow in breadth, surrounded by a fine but distinct mucilaginous sheath, false branching occurs rarely; cells isodiametric or longer than broad, constrictions at the cross-walls present but indistinct, gas vesicles not present, cells growing to the original size before the next division, reproduction by the disintegration of trichomes without the formation of necridic cells.

Checklist of Common Taxa

Planktolyngbya subtilis (W. West) Anagnostidis & Komárek (P, BI, T?) (SA, Vic, NSW, Qld)
Photo 31, Fig. 5

Planktolyngbya aff. contorta (Lemm.) Anagnostidis & Komárek (P, BI) (SA, Vic, NSW, Qld)
Photo 32, Fig. 5

Key to the Common Species

- 1a Trichomes straight, 1.0-1.5 µm broad, cells 3.0-7.5 µm long, slightly constricted at the cross-walls *P. subtilis*
1b. Trichomes loosely coiled or sigmoidal, 0.8-1.2 µm broad; breadth of coils 9-14 µm and distance between coils 15-30 µm; cells cylindrical, 1.0-3.5 µm long, slightly constricted at the cross-walls *P. aff. contorta*

Genus *Pseudanabaena* Lauterborn

Planktonic or benthic; trichomes solitary or aggregated in fine mats of tangled trichomes; firm sheaths lacking, fine thin diffluent mucilaginous sheaths rarely occur in some genera, without true or false branching; motility by gliding or trembling; cells iso-diametric or mainly longer than wide, clearly constricted at the cross-walls, appearing to be separated by 'hyaline gelatinous bridges'; terminal cells sometimes lightly attenuated at the apex, without calyptra, sometimes with characteristic apical protrusions, cells with or without gas vesicles, but localised when present at the poles or in the centre of cells.

Checklist of the Common Taxa

Pseudanabaena galeata Bocher (P, BI, T?, O) (SA, NSW, Vic) Photo 33, Fig. 6

Pseudanabaena limnetica (Lemm.) Komárek (P, BI, O) (SA, NSW, Vic, Qld) Photo 34, Fig. 6

Key to the Common Species

- 1a. Planktonic; trichomes solitary, straight or flexuous, not attenuated, without a sheath, 1.5-2.2 µm broad; cells short cylindrical, 3.5-7.5 µm long, clearly constricted at the cross-walls; appearing to be separated from one another, refractive gas vesicles at the ends of cells including the apical cell *P. galeata*

1b. Planktonic; trichomes solitary, straight or flexuous, not attenuated, without a sheath, 1.2-2.0 μm broad, constricted at the cell-walls, but cells abutting; cells cylindrical but rounded at the edges, 4.5-7.0 μm long, gas vesicles not present; apical cell slightly rounded at the apex
..... *P. limnetica*

Genus *Plectonema* Thuret

Solitary or in aggregated woolly mats; trichomes cylindrical, uniformly broad throughout, constricted at the cross-walls; falsely branched trichomes arising singly or in pairs; enclosed by a firm distinct sheath; no heterocytes; no gas vesicles; cells discoid or barrel shaped; apices usually not capitate.

Checklist of Common Taxa

Plectonema wollei Farlow (Be/P, T), (Qld) Photos 35,36

Plectonema tomasinianum (Kütz.) Bornet (Be/P) (Qld)

Key to the Common Species

1a. Plant mass dark greenish-brown or blue-green in colour; filaments 12-22 μm broad; sheaths 2-3 μm broad; false branching common; trichomes constricted at the cross-walls; cells 10-20 μm long, 5-10 μm broad..... *P. tomasinianum*

1b. Plant mass a greenish-black woolly mat of entangled filaments; filaments 30-48 μm wide, often without a sheath; false branching uncommon; trichomes not or slightly constricted at the cross-walls; hormogonia common; cells discoid, 4-12 μm long, 30-48 μm broad
..... *P. wollei*

Genus *Trichodesmium* Ehrenberg

Planktonic; trichomes cylindrical, straight or curved, laterally joined forming free-floating fasciculated colonies joined by diffluent mucilage, but not enclosed by a gelatinous sheath, slight gliding motility, without false branching, constricted at the cross-walls; uniformly broad or slightly tapering toward the apices, Cells more or less isodiametric containing gas vesicles, apical cell undifferentiated or rounded and slightly capitate.

Checklist of the Common Taxa

Trichodesmium iwanoffianum Nygaard (P, Bl) (SA, Vic, NSW, Qld) Photo 37, Fig. 3

Trichodesmium iwanoffianum Nygaard

Description Trichomes mostly solitary and only occasionally observed in parallel fasciculated colonies, straight or slightly curved, 4.0-10.5 μm broad, uniformly broad or slightly tapering toward the apices, distinctly constricted at the cross-walls, gelatinous sheath not apparent. Cells discoid to compressed spherical or barrel-shaped, 1.3-5.0 μm long, apical cell rounded and rarely longer than wide, without a calyptra and not capitate.

Genus *Tychonema* Anagnostis & Komárek

Trichomes solitary or in fine mats; pale greyish-pink, purplish, reddish or dirty olive-green, benthic, tycho planktic or planktic, cylindrical, 2-16 microns broad, mostly without sheaths, reduced motility, without false branching, unconstricted at the cross-walls, straight or slightly curved and uniformly broad. Cells more or less iso-diametric, without gas vesicles (aerotypes), but often with prominent granules inside the cells; cells virtually colourless, but capable of chromatic adaptation; “alveolar” in appearance with specially oriented thylakoids. Apical cells rounded, sometimes with thickened cell walls or narrow calyptras. Reproduction by disintegration of trichomes at necridic cells.

Checklist of the Common Taxa

Tychonema bornetti (Zukal) Anagnostidis & Komarek (Be, O, T) (ACT, SA, Qld) Photos 38,39.

***Tychonema bornetti* (Zukal) Anagnostidis & Komárek**

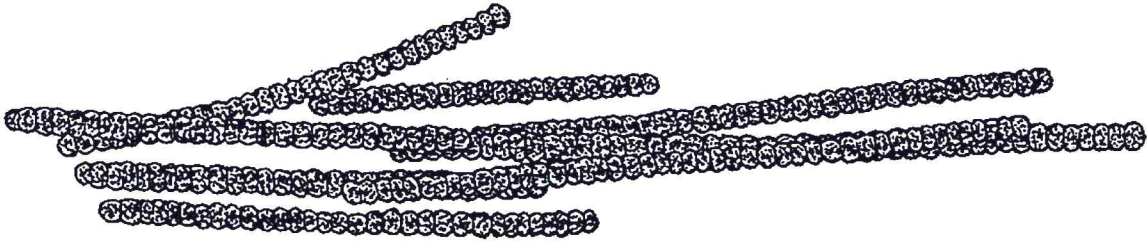
Description: Trichomes aggregated in a mat-like thallus, olive-green to brown in colour; attached to the sediments in the littoral margins of lakes. Trichomes straight or slightly curved, cylindrical, uniformly broad, mucilaginous sheaths not apparent; approximately 10 microns broad, not constricted at the cross-walls. Cells more or less colourless, 3.5-6.5 microns long depending on state of cell division, mostly one third to two thirds as long as broad; often granulated at the cross-walls. Apical cells widely rounded, hemispherical or flat-rounded.

Figure 3

10 μ



*Trichodesmium
iwanoffianum*

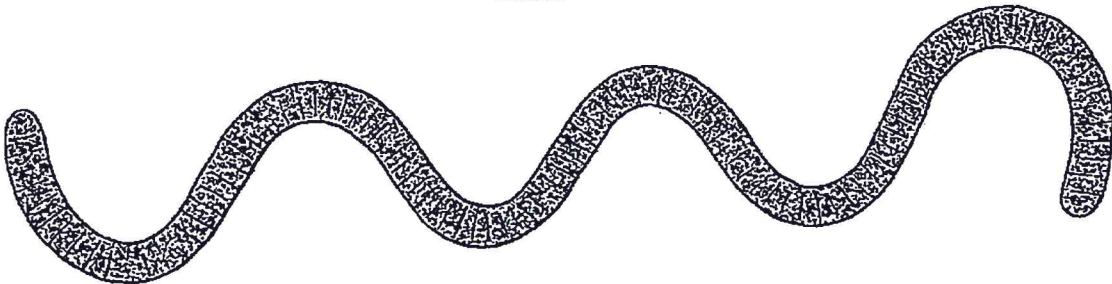


20 μ

20 μ



*Arthrospira
cf maxima*

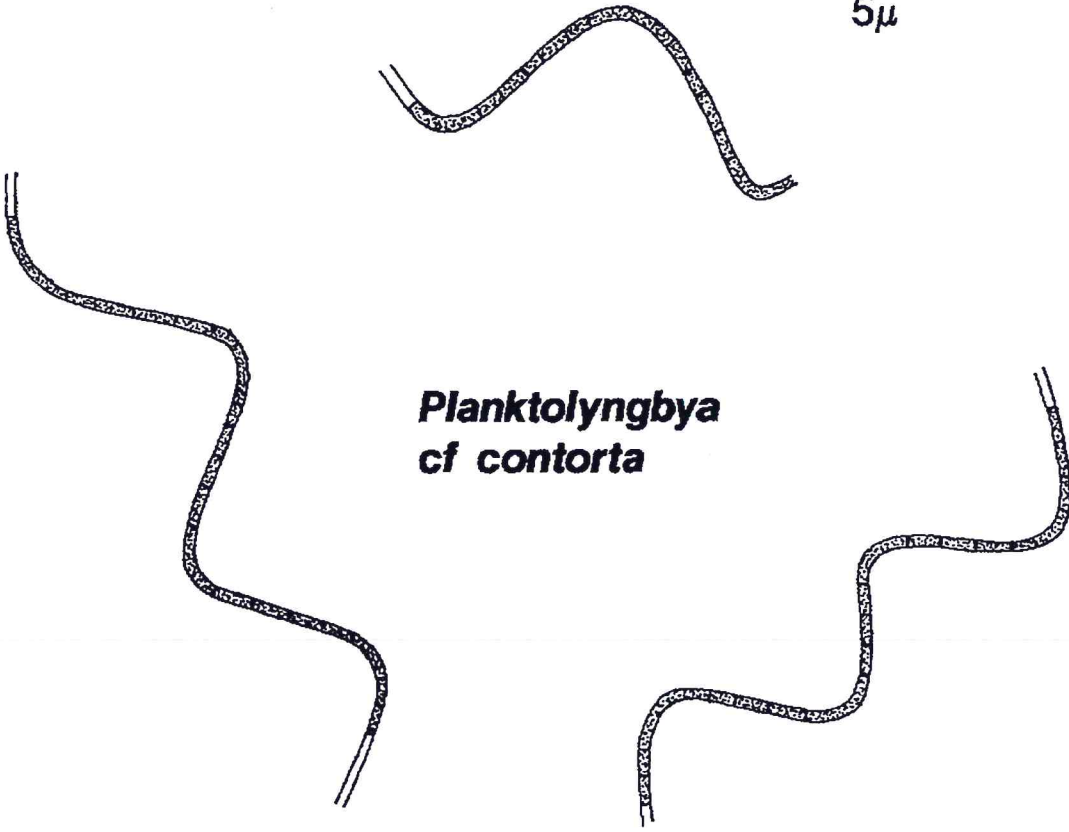


20 μ

Figure 4

5 μ

**Planktolyngbya
cf contorta**



**Planktolyngbya
subtilis**

5 μ

5 μ

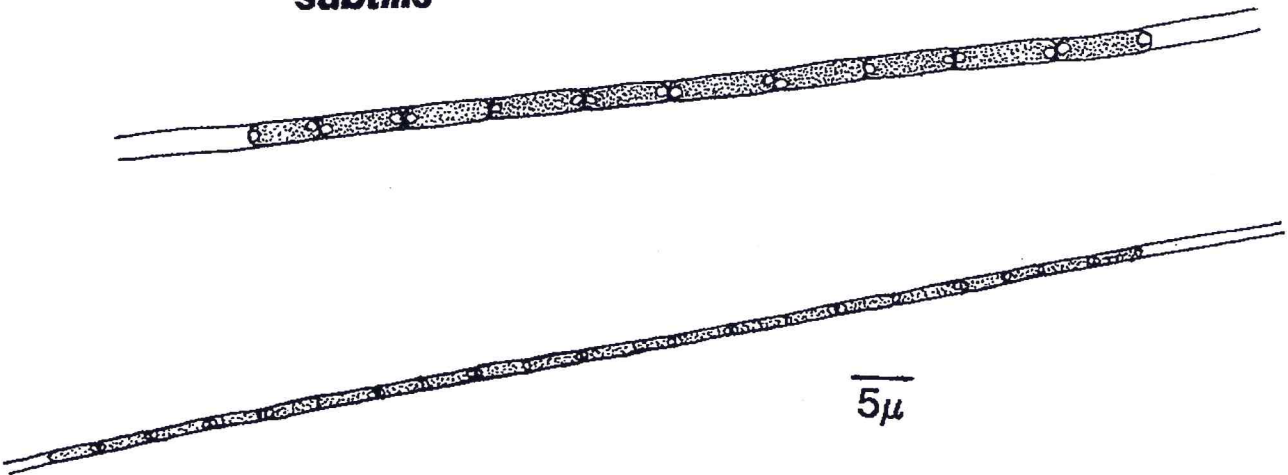
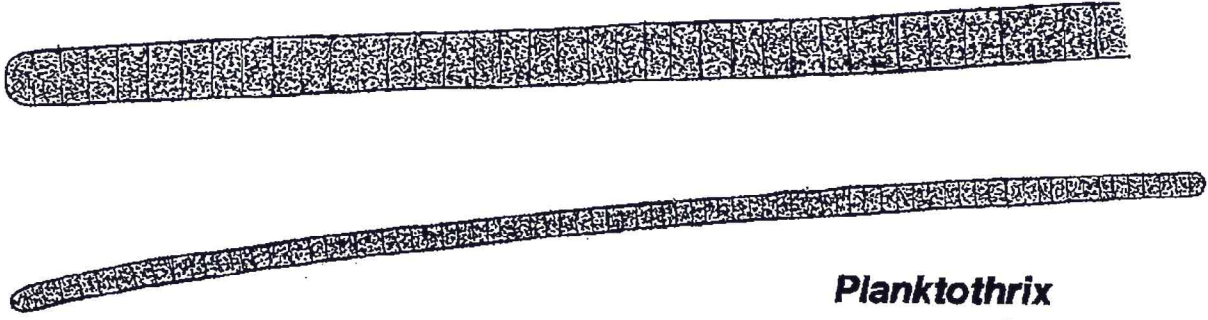


Figure 5

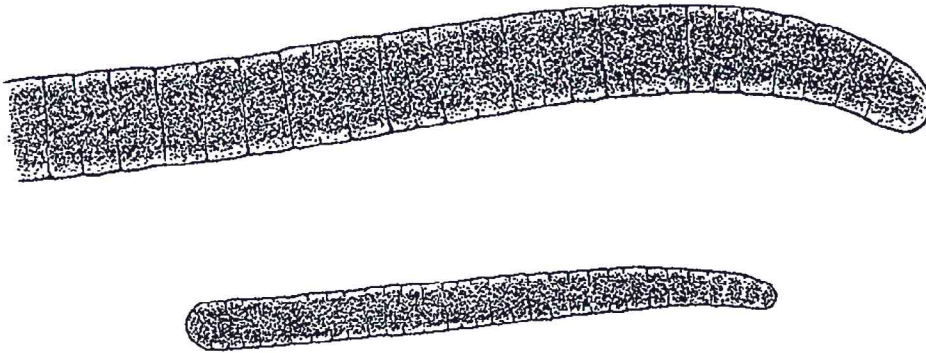
10 μ



***Planktothrix
mougeotii***

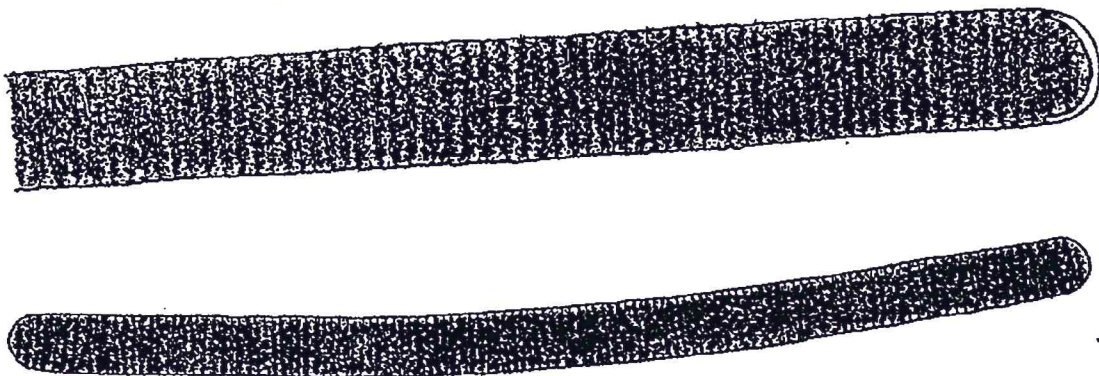
***Planktothrix perornata
var. attenuata***

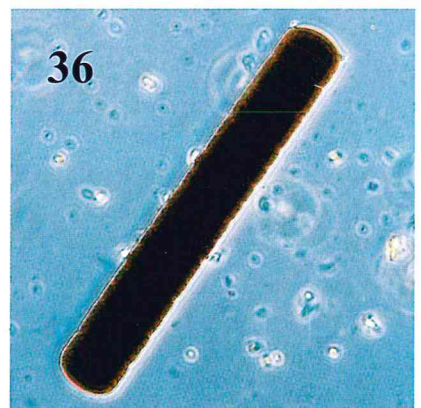
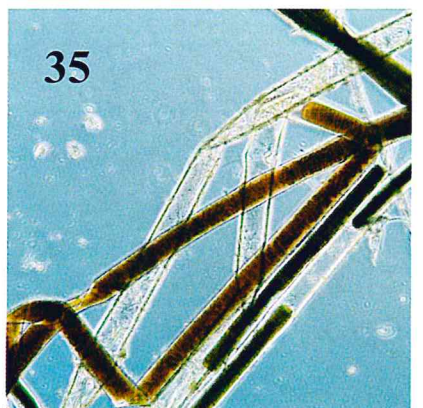
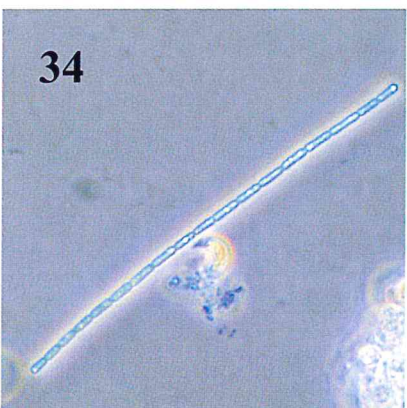
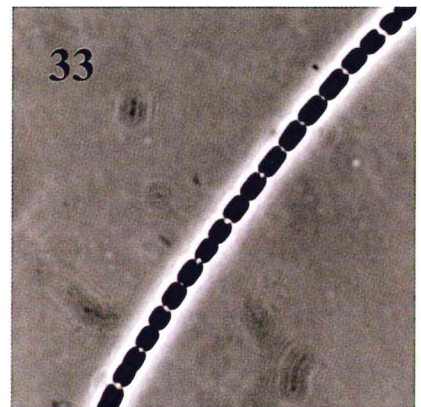
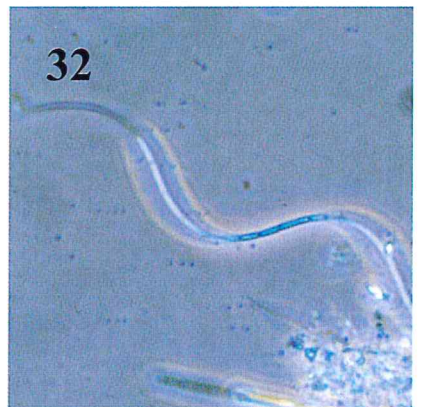
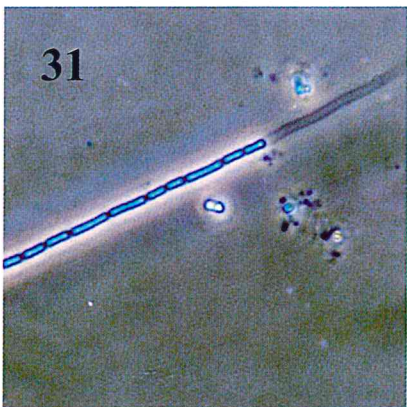
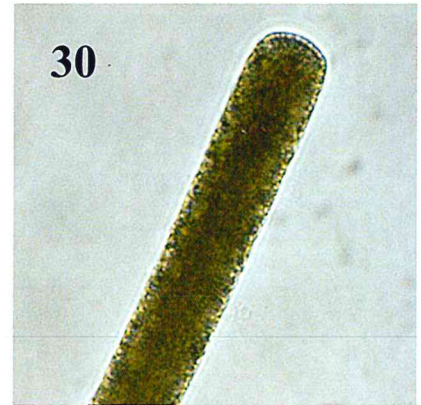
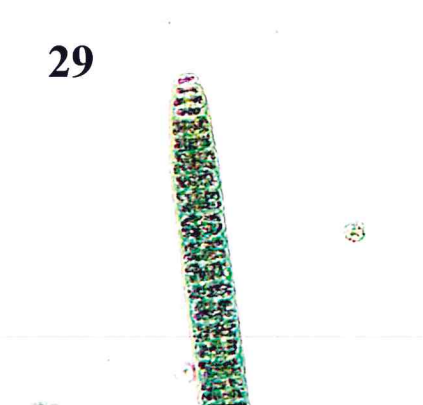
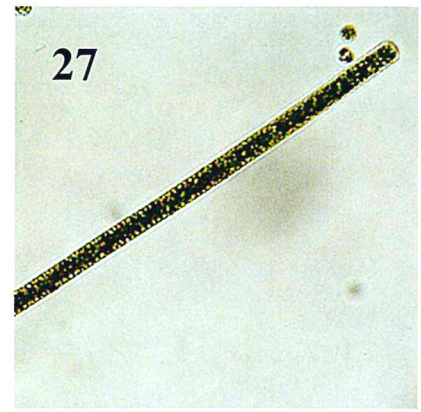
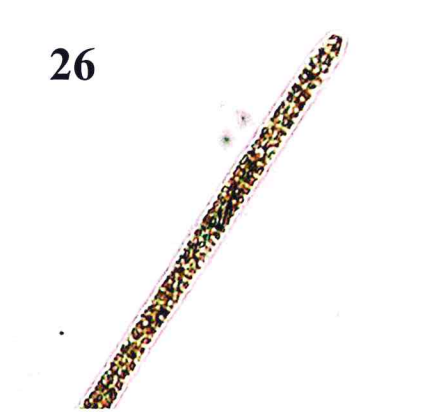
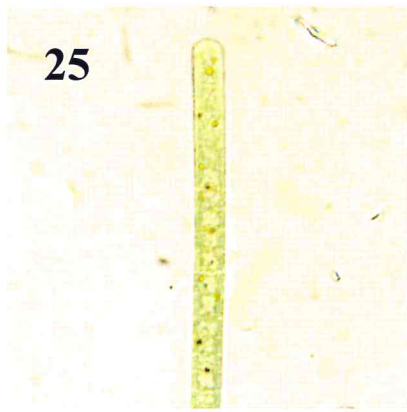
20 μ



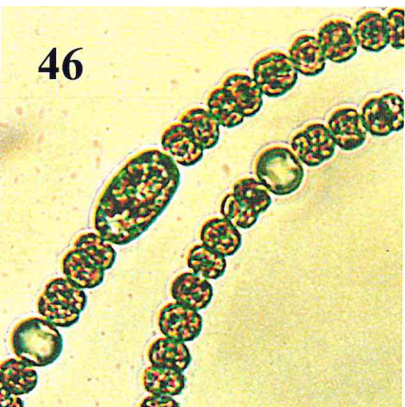
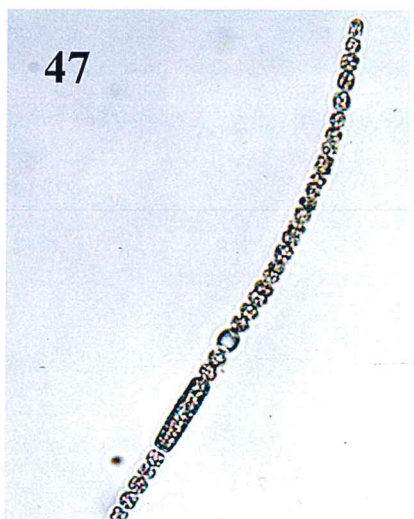
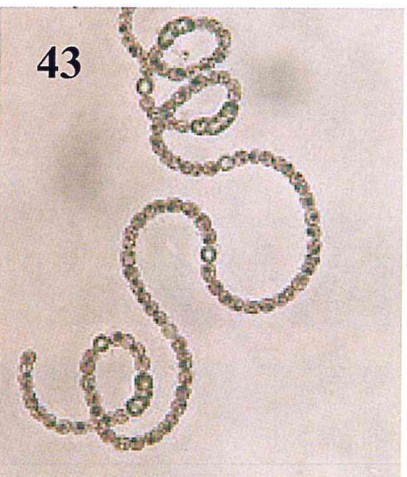
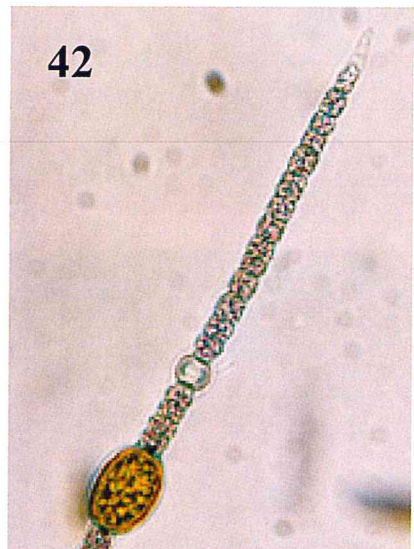
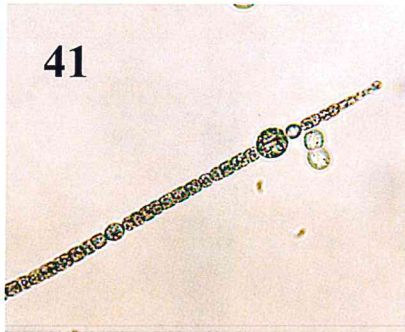
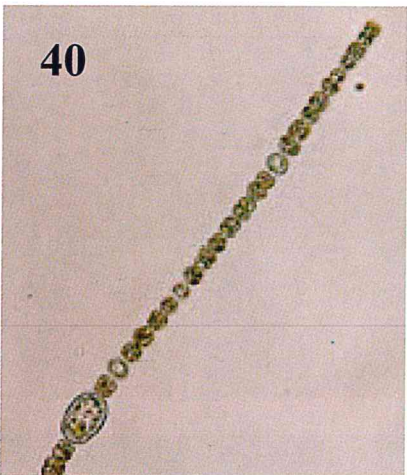
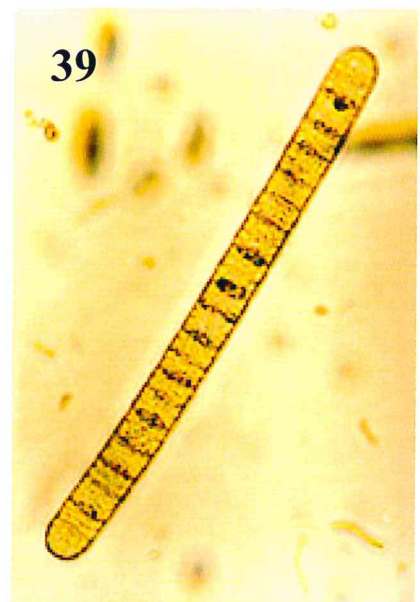
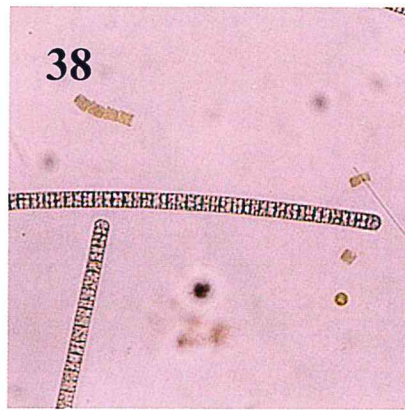
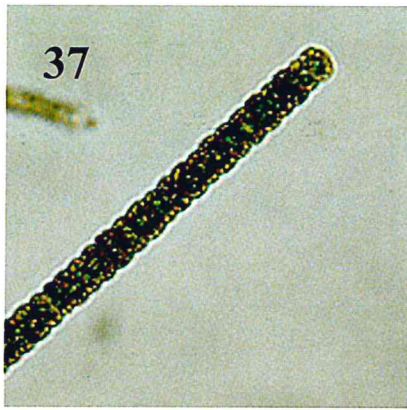
***Planktothrix
cf. planctonica***

20 μ



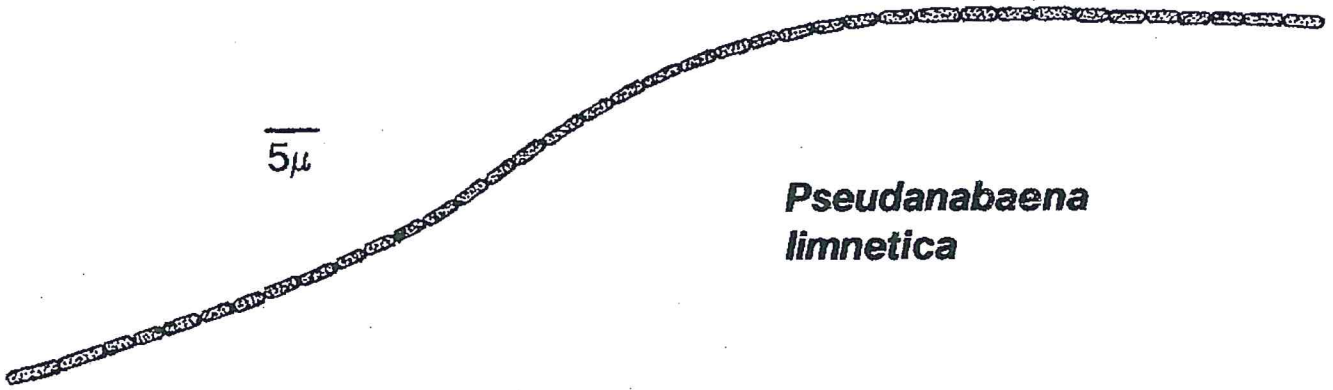


Photos 25-36: (25) *Phormidium retzii*; (26) *Planktothrix agardhii*; (27) *Planktothrix mougeotii*; (28) *Planktothrix perornata* f. *attenuata*; (29) *Planktothrix raciborskii*; (30) *Planktothrix* aff. *planctonica*; (31) *Planktolyngbya subtilis*; (32) *Planktolyngbya* aff. *contorta*; (33) *Pseudanabaena galeata*; (34) *Pseudanabaena limnetica*; (35-36) *Plectonema wollei*.



Photos 37-47: (37) *Trichodesmium iwanoffianum*; (38-39) *Tychonema bornetii*; (40) *Anabaena affinis*; (41) *Anabaena aphanizomenioides*.; (42) *Anabaena bergii* var. *limnetica*; (43-44) *Anabaena flos-aquae* f. *flos-aquae*; (45-46) *Anabaena circinalis*; (47) *Anabaena inequalis*.

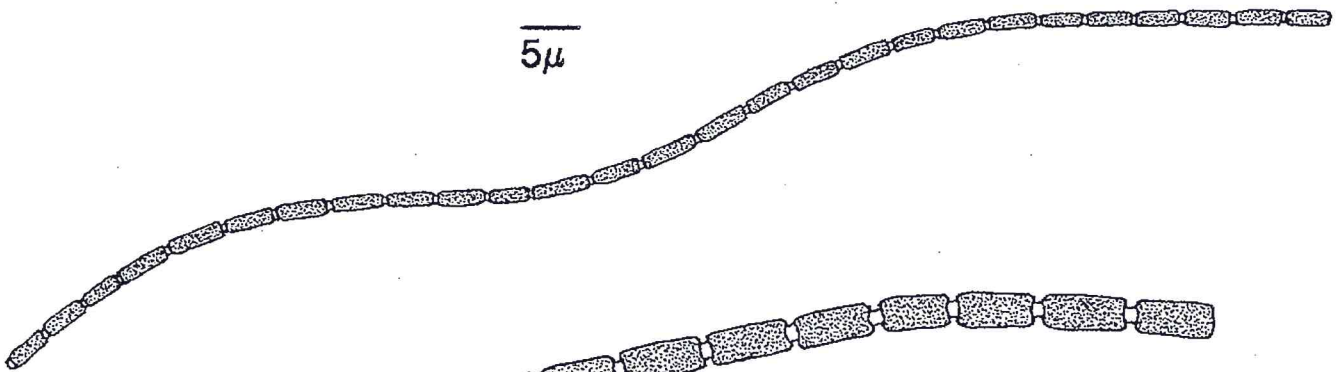
Figure 6



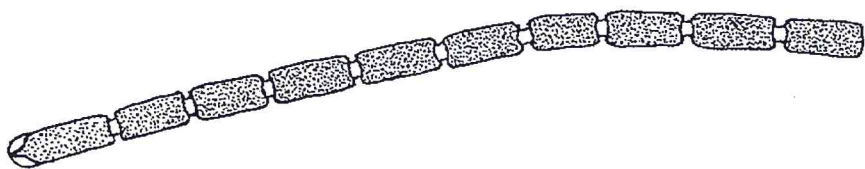
Pseudanabaena
limnetica



5μ



5μ



5μ

Pseudanabaena
galeata



ORDER NOSTOCALES

Key to the genera of the Nostocales

- 1a. Trichomes predominately isopolar 2
- 1b. Trichomes heteropolar 3

- 2a. Trichomes without false branching (**Nostocaceae**) 4
- 2b. Trichomes with false branching, originating between vegetative cells; false branches arising in pairs *Scytonema*

- 3a. Trichomes tapering from a basal heterocyst at one end to an apical hair at the other (**Rivulariaceae**) 5
- 3b. Trichomes rounded, widened, or narrowed at terminal parts; apical cell rounded (**Microchaetaceae**) 6

- 4a. Heterocytes absent 7
- 4b. Heterocytes present 8

- 5a. Trichomes solitary or few together *Calothrix*
- 5b. Trichomes arranged in a colony 9

- 6a. False branching rare; sheaths narrow 10
- 6b. False branching obligatory; sheaths up to twice wider than trichomes 11

- 7a. Trichomes may be attenuated at one or both ends; akinetes solitary or in series *Cylindrospermopsis* (in part)
- 7b. Trichomes distinctly tapered at both ends.....*Raphidiopsis*
(in part, variation also consistent with *Cylindrospermopsis*)

- 8a. Trichomes without intercalary heterocytes 12
- 8b. Trichomes with intercalary heterocytes 13

- 9a. Spherical colonies with radially arranged trichomes; akinetes present *Gloeotrichia*
- 9b. Colonies not spherical; akinetes absent 14

- 10a. Trichomes with widened ends *Camptylonemopsis*
- 10b. Trichomes cylindrical *Microchaete*

- 11a. One trichome within a sheath *Tolypothrix*
- 11b. Generally more than one trichome within a sheath, mainly at the bases *Coleodesmium*

- 12a. Heterocytes elongated and conical at one or both ends; or if absent, trichomes attenuated at one or both ends *Cylindrospermopsis*
(in part)
- 12b. Heterocytes spherical or ovate; trichomes not attenuated 15

- 13a. Intercalary heterocytes in pairs *Anabaenopsis* (in part)
- 13b. Intercalary heterocytes solitary 16

- 14a. Fasciculate colonies with sheaths that are thin, firm, slightly lamellated and sometimes widened at the end; profuse false branching *Dichothrix*
 14b. Hemispherical colonies; trichomes with their own sheaths and arranged in parallel, perpendicularly oriented to the substrate *Rivularia*
- 15a. Akinetes adjacent to terminal heterocytes; cells without gas vesicles *Cylindrospermum*
 15b. Akinetes not adjacent to terminal heterocytes; cells with gas vesicles *Anabaenopsis* (in part)
- 16a. Akinetes developed apo-heterocytically 17
 16b. Akinetes developed para-heterocytically 18
- 17a. Discoid vegetative cells much broader than long *Nodularia*
 17b. Vegetative cells spherical, barrel-shaped or cylindrical 19
- 18a. Trichomes more or less subsymmetric, especially in early stages of development; terminal cell often elongated and hyaline *Aphanizomenon*
 18b. Trichomes with a typical metameric structure; apical cell generally undifferentiated 20
- 19a. Solitary trichomes enclosed within a distinct, firm sheath *Aulosira*
 19b. Colony of tangled trichomes enclosed within thick mucilaginous matrix *Nostoc*
- 20a. Solitary trichomes or colonies embedded in a diffluent mucilage; trichomes straight, spirally coiled or irregularly contorted *Anabaena*
 20b. Macroscopic cylindrical and tube-like gelatinous colonies; trichomes generally straight and parallel to each other *Wollea*

Common Taxa of the Nostocales

Genus *Anabaena* Bory

Planktonic or attached to submerged substrates. Trichomes solitary or aggregated in floccose masses or united in a thin mucilaginous stratum; straight, flexuous, circinate, spirally coiled or irregularly twisted; uniformly broad or slightly attenuated; mucilaginous sheath sometimes present, usually inconspicuous. Vegetative cells spherical, ellipsoidal, barrel-shaped, quadrate or cylindrical; with or without gas vesicles. Heterocytes intercalary; spherical to cylindrical in shape. Akinetes spherical to cylindrical in shape, adjacent to or developing distant from the heterocytes, solitary or in series.

Checklist of Common Taxa

- Anabaena affinis* Lemmermann (P, BI, B, T?) (SA, Vic, Qld) Photo 40, Fig. 7
Anabaena aphanizomenioides Forti (P, BI) (NSW, Vic, SA, Qld, NT) Photo 41, Fig. 7
Anabaena bergii var. *limnetica* Couté & Preisig (P, BI, T?) (SA, NSW, Vic, Qld), Photo 42, Fig. 7
Anabaena circinalis Rabenhorst (P, BI, T, O) (NSW, Vic, SA, Qld, NT, WA, Tas) Photos 45,46, Fig.8
Anabaena flos-aquae f. *flos-aquae* (Lyngb.) Komárek (P, BI) (NSW, Vic, SA, Qld) Photos 43,44, Fig. 8
Anabaena inaequalis (Küetz.) Bornet & Flahault (P, BI) (SA, Vic, NSW, Qld) Photo 47, Fig. 7
Anabaena oscillarioides Bory (B) (NSW, Vic, SA, Qld) Photos 48,49
Anabaena planktonica Brunnthaler (P, BI, O) (SA, NSW, Vic, Qld, NT) Photo 50, Fig. 7
Anabaena smithii (Komárek) M. Watanabe (P, BI, O) (SA, NSW, Vic, Qld) Photo 51, Fig. 7
Anabaena crassa (Lemm.) Komárková-Legnerová & Cronberg (P, BI, O) (SA, Vic, NSW, Qld) Photo 52, Fig. 8
Anabaena spiroides f. *spiroides* (Elenk.) Komárek (P, BI, T?) (SA, NSW, Vic, Qld) Photos 54,55, Fig. 8
Anabaena sp. nova (P, BI) (SA, NSW, Vic, Qld) Photos 56,57, Fig. 8
Anabaena spiroides var. *minima* Nygaard (P, BI?) (SA) Photo 53, Fig. 8
Anabaena perturbata var. *tumida* (Nyg.) Cronberg & Komárek (P, BI) (NSW, SA, Vic) Photos 58,59, Fig. 8
Anabaena torulosa (Carm.) Lagerheim (Be, P, T?) (SA, Qld) Photo 60
Anabaena torulosa var. *tenuis* (Lemm.) Geitler (Be, P) (SA, Qld) Photo 61

Key to the Common Species

- 1a. Trichomes straight or slightly curved; apical cell often morphologically differentiated 2
 1b. Trichomes regularly or irregularly spiralled or coiled, or circinate, or irregularly twisted in an entangled mass; cells with gas vesicles; apical cell undifferentiated..... 10
- 2a. Trichomes 8 µm or more broad 3
 2b. Trichomes less than 8 µm broad 4
- 3a. Trichomes 8.5-12 µm broad surrounded by a broad hyaline mucilaginous envelope; darkly pigmented; vegetative cells spherical or depressed globose, with gas vesicles; heterocytes spherical; apical cells undifferentiated; akinetes oblong-ovate or oblong with conical ends, remote from the heterocytes *A. planktonica*
 3b. Identical to 3a, but akinetes spherical or broadly ovate. *A. smithii*
- 4a. Vegetative cells spherical or compressed at the poles, 4.5-6.0 µm broad, with gas vesicles; heterocytes spherical; akinetes ovate to oblong with rounded ends; either adjacent or remote from heterocytes apical cells rounded or shortly conical; trichomes uniformly broad, with a broad, hyaline mucilaginous envelope *A. affinis*
 4b. Vegetative cells not spherical 5
- 5a. Akinetes adjacent to the heterocytes on either side 6
 5b. Akinetes mostly remote from the heterocytes..... 7
- 6a. Cells quadrate or sub-spherical, 3-6 µm broad, with gas vesicles; heterocytes spherical or ovate; akinetes spherical or ovate, apical cells shortly rounded or elongate and club-shaped; trichomes slightly attenuated *A. aphanizomenioides*
 6b. Cells without gas vesicles; akinetes not spherical 8
- 7a. Akinetes broadly ovate, epispore dark brown; apical cells elongate, tapered and hyaline; trichomes slightly attenuated; cells quadrate or sub-spherical, 5-6 µm broad, with gas vesicles; heterocytes spherical or ovate..... *Anabaena bergii* var. *limnetica*
 7b. Akinetes cylindrical, as broad or slightly broader than the vegetative cells; often in series; apical cells rounded; trichomes uniformly broad, cells barrel-shaped, 4-5.5 µm broad with gas vesicles; heterocytes spherical *A. inaequalis*
- 8a. Trichomes solitary, uniformly broad and usually short; vegetative cells short barrel-shaped, 4-5 µm broad, clearly constricted; heterocytes spherical; akinetes oblong-ovate; apical cells rounded or rounded conical *A. oscillarioides*
 8b. Apical cells tapered and distinctly conical 9
- 9a. Trichomes 4-7 µm broad, generally long and flexuous; cells barrel-shaped, 5-6 µm broad, clearly constricted and separated by narrow connections; heterocytes spherical or ovate; akinetes oblong-ovate or oblong *A. torulosa*
 9b. As for 8a, but trichomes 2.5-3.5 µm broad; cells and akinetes oblong to cylindrical *A. torulosa* var. *tenuis*
- 10a. Mature akinetes spherical to oval in shape; trichomes regularly spiralled 11
 10b. Mature akinetes oblong oval to cylindrical in shape; trichomes twisted, circinate, regularly or irregularly spiralled 12

- 11a. Mature akinetes spherical; adjacent to the heterocytes on one or both sides; trichomes solitary, coils 20-30 μm broad and closely compacted; cells spherical, compressed at the poles, 5-6 μm broad, with gas vesicles; heterocytes spherical ***Anabaena sp. nova***
- 11b. Mature akinetes broadly oval, not spherical; remote from the heterocytes **13**
- 12a. Trichomes solitary but twisted and entangled; rarely coiled; vegetative cells spherical, compressed at the poles; 4-5.5 μm broad; akinetes cylindrical and reniform, remote from the spherical heterocytes ***A. flos-aquae f. flos-aquae***
- 12b. Trichomes circinate, flexuous, regularly or irregularly spiralled; vegetative cells greater than 6 μm broad **14**
- 13a. Vegetative cells approximately 4-5.5 μm broad, spherical or slightly longer than broad; heterocytes spherical; coils open, 15-25 μm broad, trichomes solitary ***A. spiroides var. minima***
- 13b. Vegetative cells spherical, compressed at the poles, darkly pigmented, approximately 7-9 μm broad; heterocytes spherical; coils open, 30-50 μm broad, trichomes solitary, enclosed in a broad hyaline mucilaginous envelope ***A. spiroides f. spiroides***
- 13c. Vegetative cells globose, compressed at the poles, darkly pigmented, approximately 9-12 μm broad; heterocytes spherical; coils 55-90 μm broad; trichomes solitary, enclosed in a broad hyaline mucilaginous envelope ***A. crassa***
- 14a. Trichomes mostly circinate or flexuous or forming broad, open spiralled coils greater than 50 μm in diameter; vegetative cells spherical or compressed at the poles, 7-8.5 μm broad; heterocytes spherical; akinetes cylindrical, slightly curved and remote from the heterocytes ***A. circinalis***
- 14b. Trichomes with compact spiralled coils 30-40 μm in diameter, forming an entangled aggregated mass enclosed in a common mucilaginous matrix; vegetative cells spherical or slightly longer than broad, 7-9 μm broad; heterocytes spherical; akinetes cylindrical and reniform, remote from the heterocytes..... ***A. perturbata var. tumida***

Genus *Anabaenopsis* (Wolosz.) Miller

Planktonic; trichomes solitary; metameric in structure, mostly circinate, sigmoidal or spirally coiled, seldom straight; generally with gas vesicles mucilaginous sheaths distinct and broad in many taxa, lacking in others. Heterocytes terminal and intercalary, the latter in pairs and formed by the unequal division of two adjoining vegetative cells; spherical or broadly ovate in shape. Vegetative cells short to long barrel-shaped or cylindrical, generally constricted at the cross-walls. Akinetes spherical to broadly ovate in shape, intercalary, solitary or in series, distant from the heterocytes with para-heterocytic development, generally in the middle of the trichome.

Checklist of Common Taxa

Anabaenopsis arnoldii Aptekarj (P,BI) (SA, NT) Photo 62, Fig. 9

Anabaenopsis elenkinii Miller (P,BI) (NSW, SA, Vic, Qld, WA) Photo 63, Fig. 9

Anabaenopsis tanganyikae (G.S. West) Woloszynska & Miller (P) (BI) (SA, Qld) Photo 64, Fig. 9

Key to the Common Species

- 1a. Vegetative cells spherical, distinctly compressed at the poles, 8-10 μm broad, with gas vesicles; heterocytes spherical; akinetes broadly ovate, often in series; trichomes solitary, constricted at the cross-walls, regularly coiled, coils 25-55 μm broad and closely compacted *A. arnoldii*
- 1b. Vegetative cells barrel-shaped or cylindrical and less than 8 μm broad 2
- 2a. Vegetative cells barrel-shaped, as long as broad or longer, 5-7.5 μm broad, with gas vesicles, constrictions at the cross-walls distinct; heterocytes spherical to slightly ovate; akinetes ovate to oblong-ovate, solitary or in series; trichomes solitary, shortly circinate, sometimes in spiral coils *A. elenkinii*
- 2b. Vegetative cells cylindrical, 3-4 μm broad, with gas vesicles; heterocytes spherical to ovate, rarely seen mid-trichome; akinetes oblong-ovate to cylindrical, solitary or in pairs; trichomes solitary, short, loosely spiralled or circinate; spiral coils 15-20 μm in breadth, constrictions at the cross-walls indistinct *A. tanganyikae*

Genus *Aphanizomenon* Morren

Planktonic; trichomes solitary or united in spindle-shaped bundles or parallel flakes, forming a plate-like thallus in some taxa. Trichomes narrow, more or less straight or slightly bent; sub-symmetric structure; generally with gas vesicles and without a gelatinous sheath; some taxa attenuated at the apices, others uniformly broad. Apical cells often elongated and tapered and hyaline in some taxa. Vegetative cells quadrate to cylindrical, cross-walls slightly constricted or not constricted; heterocytes intercalary, ovate to cylindrical in shape and few (1-3) per trichome; akinetes mostly cylindrical with flattened ends and solitary, but also in series, remote from the heterocysts in most taxa, developing para-heterocytically.

Checklist of Common Taxa

Aphanizomenon gracile Lemmermann (P,BI, O) (SA, Vic, NSW, Qld, NT) Photo 43, Fig. 65

Aphanizomenon issatschenkoi (Usacev) Proskina-Lavrenko (P,BI) (NSW, SA, Vic, Qld) Photo 44, Fig. 66

Aphanizomenon ovalisporum Forti (P,BI, T) (Qld, SA) Photo 67,68

Aphanizomenon volzii (Lemmermann) Komárek (P/Be) (Qld) Photo 69

Key to the Common Species

- 1a. Trichomes solitary, distinctly attenuated with elongated, tapered or even hair-like apical cells at one or both ends; vegetative cells cylindrical, 2.5-4 μm broad, with gas vesicles, narrowing towards the apices; heterocytes sub-cylindrical; akinetes cylindrical, usually solitary and remote from the heterocytes; cross-walls and constrictions at the cross-walls often indistinct *A. issatschenkoi*
- 1b. Trichomes slightly attenuated, but apical cells not distinctly elongated, tapered or hair-like **2**
- 2a. Akinetes always adjacent to the heterocytes; oval-shaped; cells rectangular, 4-4.5 μm broad, without gas vesicles; heterocytes sub-cylindrical; trichomes normally in fascicles, attached to aquatic vegetation; constricted at the cross-walls *A. volzii*
- 2b. Akinetes mostly distant from the heterocytes **3**
- 3a. Akinetes oval to sub-spherical; apical cell bluntly rounded ; vegetative cells cylindrical, 2.5-4 μm broad, with gas vesicles; heterocytes spherical or sub-spherical; trichomes solitary, slightly attenuated, constricted at the cross-walls *A. ovalisporum*
- 3b. Akinetes long cylindrical often with a collar-like extension at each end over the adjacent vegetative cell; apical cell rounded or club-shaped; vegetative cells quadrate to rectangular, 2.5-5.5 μm broad, with gas vesicles; heterocytes ovate to subcylindrical; trichomes solitary, slightly attenuated *A. gracile*

Genus *Cylindrospermopsis* Seenaya & Subba Raju

Planktonic; trichomes solitary, straight, slightly curved or spirally coiled, sub-symmetric structure; gas vesicles present; mucilaginous envelope absent. Heterocytes conical or long ovoid in shape, always terminal at one or both ends of the trichome developing from asymmetric division of the apical cell; the ends of the trichome attenuated when heterocytes not present; vegetative cells cylindrical with little or no constriction at the cross-walls; akinetes cylindrical or oblong-ovate, solitary or in pairs, intercalary, generally near to but remote from the heterocytes with para-heterocytic development.

Checklist of Common Taxa

Cylindrospermopsis raciborskii (Wolosz.) Seenaya & Subba Raju (P, BI, T) (Qld, NSW, Vic, SA, WA) Photos 71-80.

Cylindrospermopsis raciborskii (Wolosz.) Seenaya & Subba Raju

Description: Trichomes solitary, straight or open coiled forms, the latter often sigmoidal, often attenuated at the apices if heterocytes absent; gas vesicles present; mucilaginous sheath not evident. Spiral coils 15-30 μm in breadth, distance between spiral windings 20-35 μm . Vegetative cells quadrate to cylindrical; not constricted or slightly constricted at the cross-walls; cross-walls often indistinct; length 2.0-8.5 μm , breadth 2.5-4.0 μm ; heterocytes elongated and tapered to a narrowed point or roundly conical; generally without a pronounced curvature, length 3.5-10.5 μm , breadth 2.5-4.0 μm ; akinetes oblong-ovate to cylindrical and rounded at the ends with curved margins in coiled trichomes; length 7.5-16.0 μm , breadth 3.5-4.5 μm , solitary or in series, near to one end; either remote from or adjacent to the terminal heterocyte.

Within the reported morphological variability of *C. raciborskii* exists highly coiled forms that compare closely with *C. philippinensis* Taylor.

Genus *Cylindrospermum* Kützing

Trichomes straight, curved or loosely entangled, surrounded by a soft film of mucilage; forming an expanded mass of indefinite shape on submerged substrates; trichomes unbranched, symmetric with ovate or ellipsoid heterocytes at one or both ends of the trichome; akinetes ovate, ellipsoid or sub-cylindric, adjoining the terminal heterocytes and enclosed by a thick sheath; vegetative cells cylindric or barrel-shaped and constricted at the cross-walls.

Checklist of Common Taxa

Cylindrospermum licheniforme (Bory) Kützing (Be/P, T?) (Qld) Photo 70

Cylindrospermum licheniforme (Bory) Kützing

Description: Plant mass mucilaginous, pale blue-green to brownish, quadrate to barrel shaped vegetative cells, 3.5-7 μm broad, 4.5-8.5 μm long; gas vesicles absent; cross-walls constricted. Heterocytes oblong, 7-8 μm broad, 7-12 μm long and adjacent to akinetes. Akinetes elliptical to broadly elliptical, 10-14 μm broad, 20-43 μm long, reddish-brown and granular at maturity. Trichomes generally with heterocytes and akinetes at both ends and trichomes often circular. Mostly growing attached to submerged substrates, but common in the plankton of shallow, clear waters, or in surface waters of rivers following flooding.

Genus *Gloeotrichia* Agardh

Planktonic or attached globose or hemi-spherical colonies composed of radiating asymmetric trichomes, tapering from basal heterocytes to an apical hair; colonial mucilage gelatinous or firm; trichomes enclosed by a gelatinous sheath distinct at the basal part of the trichome; false branching rare; vegetative cells discoid to barrel-shaped at the base of trichomes, becoming more cylindrical distally, with or without gas vesicles; solitary basal heterocytes oval-shaped or globose, akinetes cylindrical, solitary, adjoining the heterocyte.

Checklist of Common Taxa

Gloeotrichia echimulata (J.E. Smith) P. Richter (Be/P,B, T) (Qld) Photo 81

Gloeotrichia raciborskii Woloszynska (Be/P,B) (Qld) Photos 82, 83

Key to the Common Species

1a. Planktonic; thallus soft, spherical, 0.5 – 10 mm diameter. Trichomes tapering from a spherical heterocyte to a long hair at the distal end 1-2 μm broad; radially arranged; sheath fine and colourless; vegetative cells cylindrical with gas vesicles; akinetes cylindrical with rounded ends, straight or commonly bent 6-18 μm broad and 44-55 μm long..... *G. echimulata*

1b. Thallus soft and gelatinous, green to brown colonies initially small, spherical and attached to macrophytes, later floating and amorphous to 63 cm in length; trichomes with layered radial structure, tapering from a spherical, basal heterocyte, 10-11 μm diameter; dull brown sheath at base of the trichomes; vegetative cells barrel-shaped to sub-globose, 7.5-10 μm broad, becoming long cylindrical distally, apical hairs present in mature trichomes; akinetes long ellipsoidal, 38-50 μm long and 11-15.5 μm broad *G. raciborskii*

Genus *Nodularia* Mertens

Planktonic or tychoplanktonic in aquatic environments; trichomes solitary or united in thin, loose mucilaginous layers or clusters; straight, bent, flexuous or spirally coiled; not differentiated at the apices; metameric in structure; usually with a colourless sheath closely enveloping the trichome, sometimes becoming diffluent. Vegetative cells distinctly broader than long and constricted at the cross-walls; heterocytes intercalary, similarly compressed; akinetes solitary or more often in series, intercalary with apo-heterocytic development.

Checklist of Common Taxa

Nodularia spumigena Mertens ex Bornet & Flahault; emend. Nordin & Stein (P, Bl, T) (WA, SA, Vic, NSW, Qld, NT) Photos 89,90, Fig. 12

Nodularia spumigena Mertens ex Bornet & Flahault

Description: Planktonic; trichomes solitary, long, straight or slightly curved or bent, uniformly broad; constricted at the cell cross-walls; broad and distinct mucilaginous sheath in some trichomes or very narrow and indistinct. Vegetative cells discoid, distinctly compressed, with gas vesicles, length 2.0-4.5 μm , breadth 7.0-12.0 μm ; heterocytes intercalary, at regular intervals along the trichome, subspherical or discoid, slightly longer than the vegetative cells; length 4.5-6.0 μm , breadth 7.5-11.5 μm ; akinetes intercalary; often in series episporous yellowish-brown in colour at maturity; subspherical, broader than long; length 6.5-10.5 μm , breadth 11.0-13.0 μm ; Common in brackish water lagoons and estuaries.

Genus *Nostoc* Vaucher

Benthic; globose or irregularly lobed macroscopic colonies growing on submerged substrates; composed of entangled trichomes enclosed in copious thick mucilage, which outwardly forms a firm integument; trichomes moniliform, unbranched without basal-distal differentiation, metameric structure; cells bead-like or barrel-shaped; heterocytes intercalary; akinetes either solitary or in series, forming apo-heterocytically

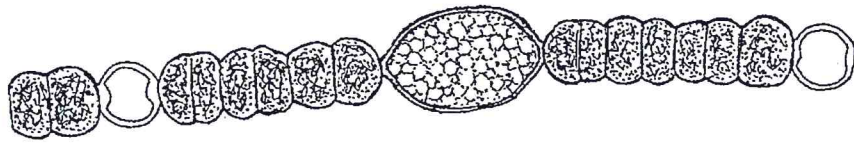
Checklist of Common Taxa

Nostoc linckia (Roth) Bornet and Flahault (B/P, Bl, T) (Qld) Photos 84-87

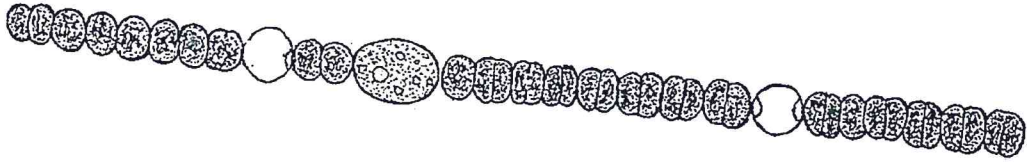
Nostoc linckia (Roth) Bornet and Flahault

Description: Macroscopic blue-green to greenish-black colonies; trichomes densely and closely entangled in copious mucilage. Vegetative cells are sub-globose or barrel-shaped, 3.5-5 μm in diameter, heterocytes sub-spherical, 6 μm long and 4.5 μm broad; akinetes globose, 6-9 μm long and 5-7 μm broad. Colonial formations are normally found in shallow clear waters, especially in areas of organic enrichment or following flooding in rivers. Single trichomes may occasionally be encountered within the phytoplankton of deeper river channels and dams.

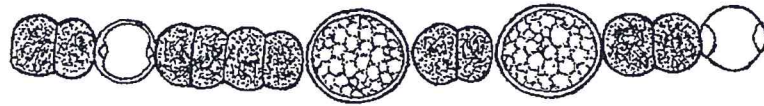
Figure 7



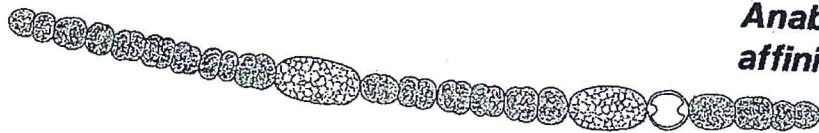
Anabaena planktonica



Anabaena smithii



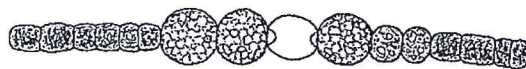
Anabaena affinis



Anabaena inaequalis



Anabaena aphanizomenioides



Anabaena bergii
var. *limnetica*

20 μ

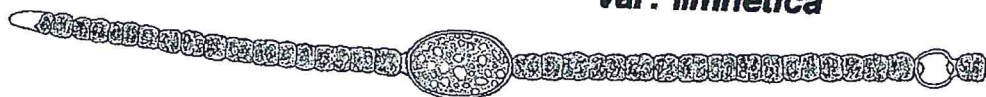
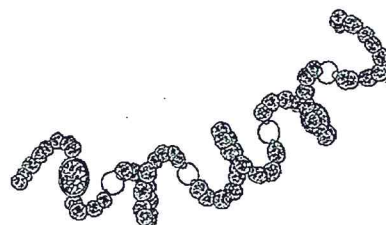
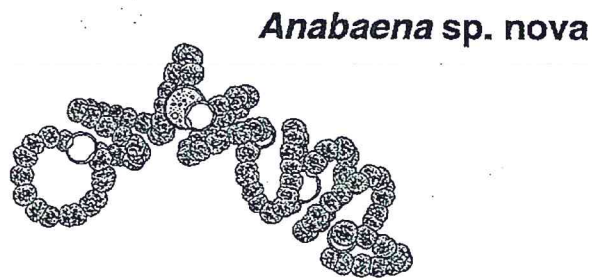
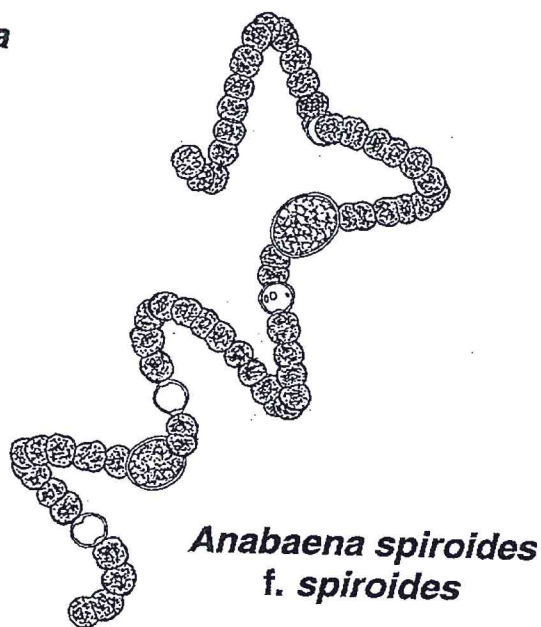
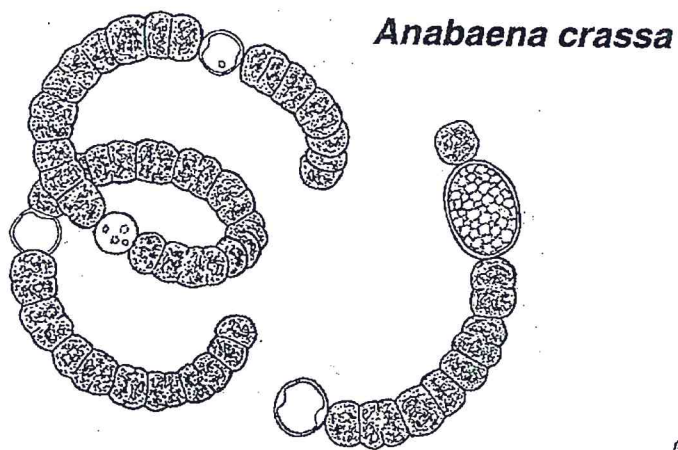
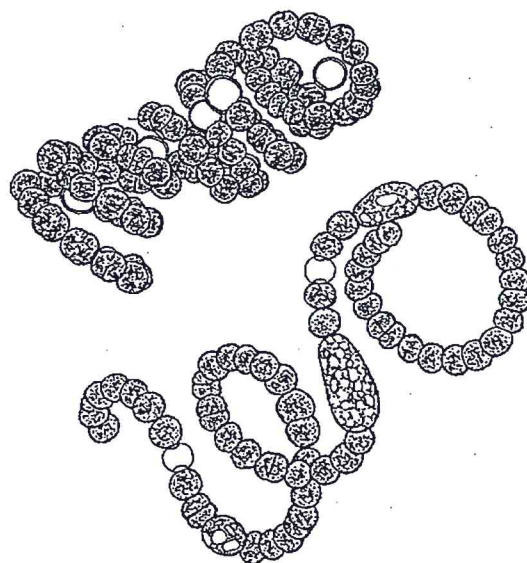
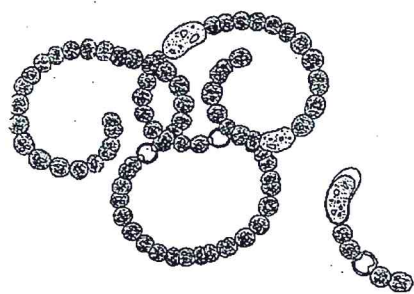


Figure 8



Anabaena flos-aquae
f. *flos-aquae* (Morphotype 1)

20 μ



Anabaena
circinalis

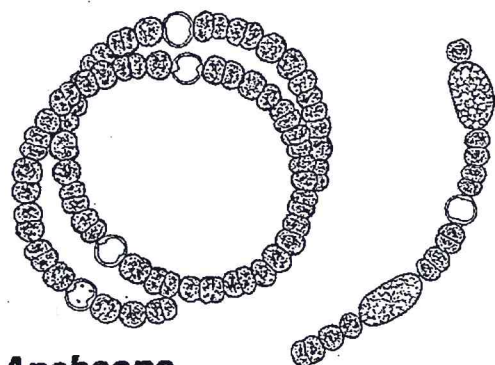
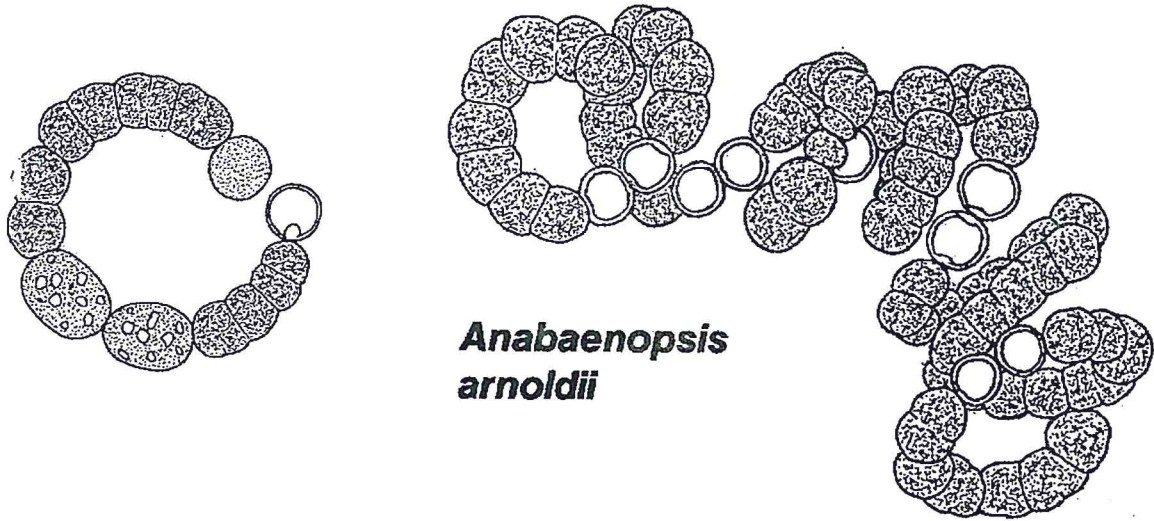


Figure 9



20 μ

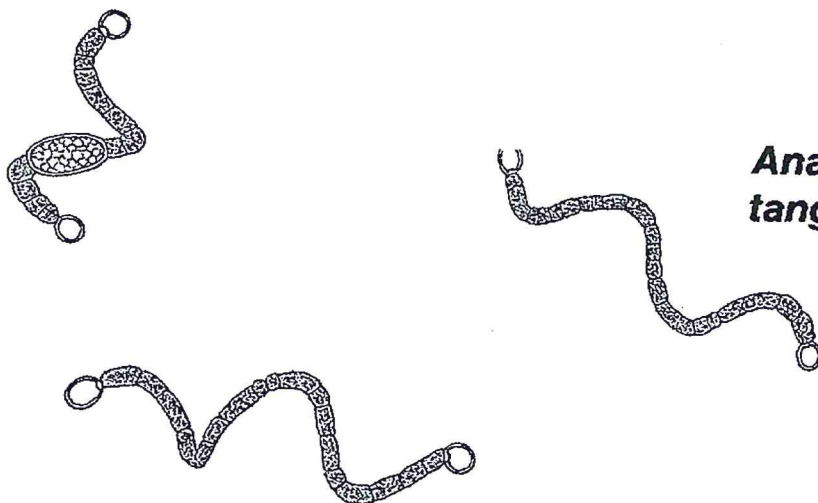
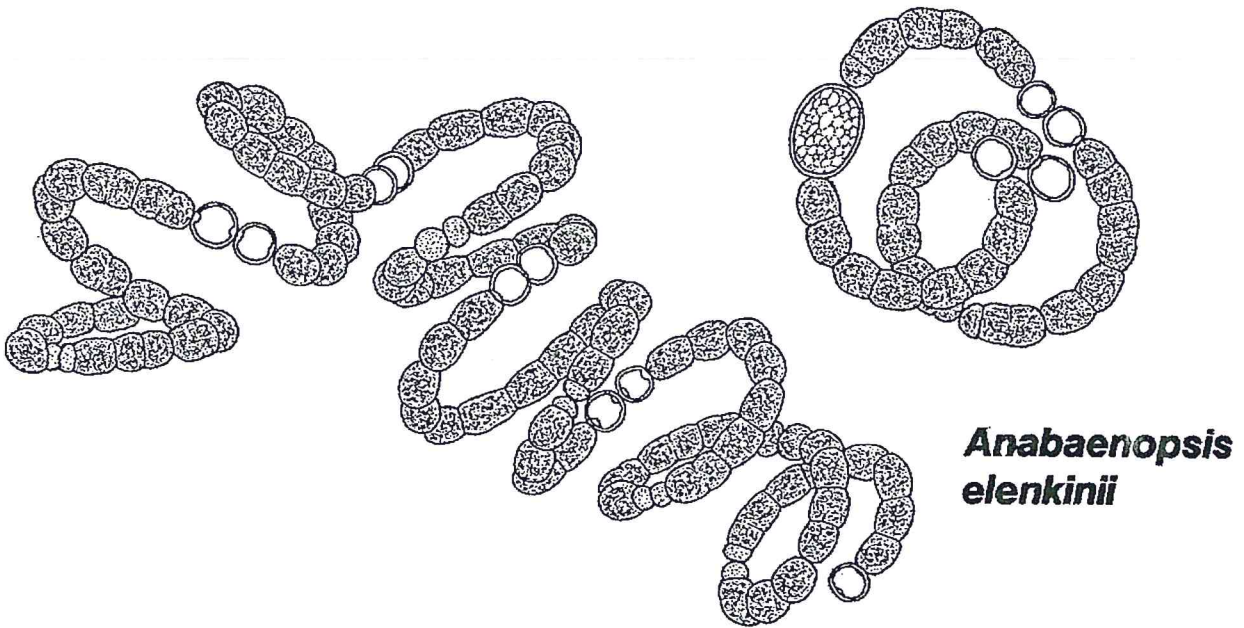
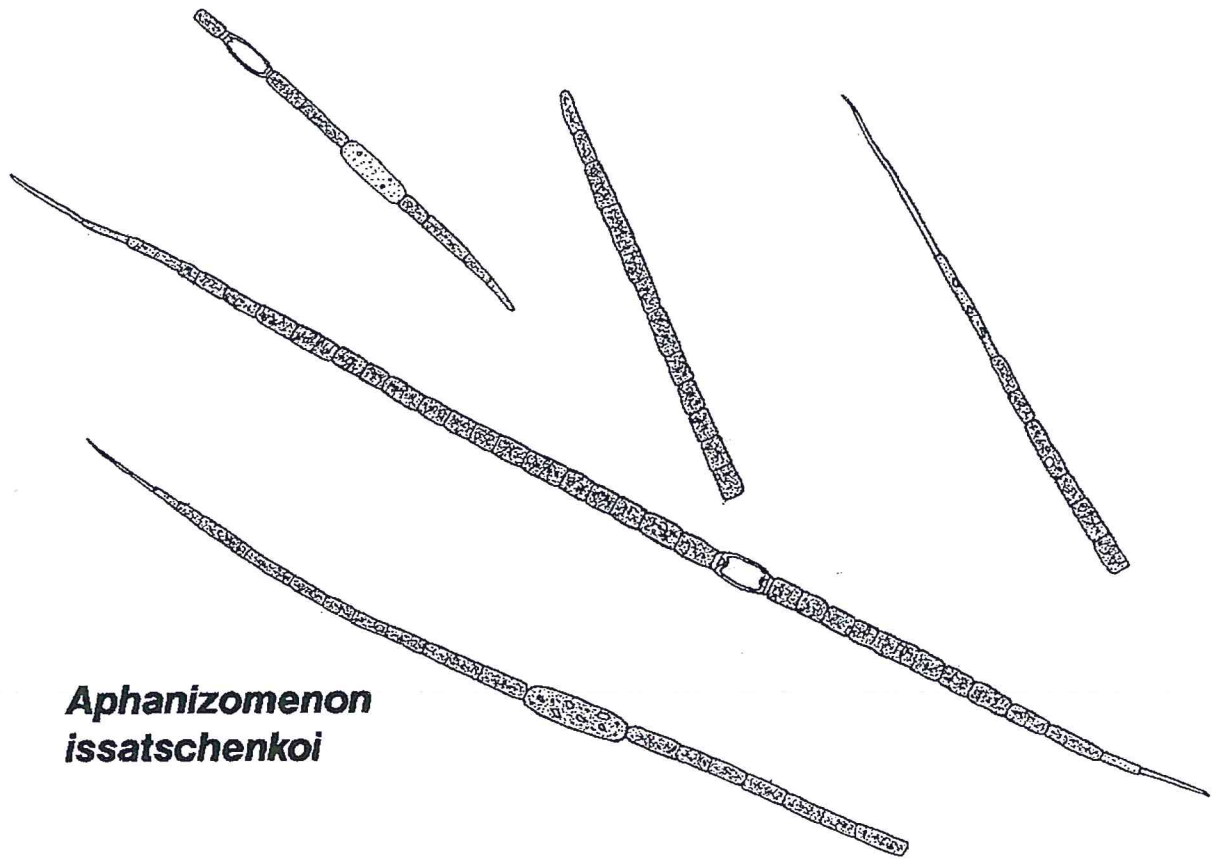
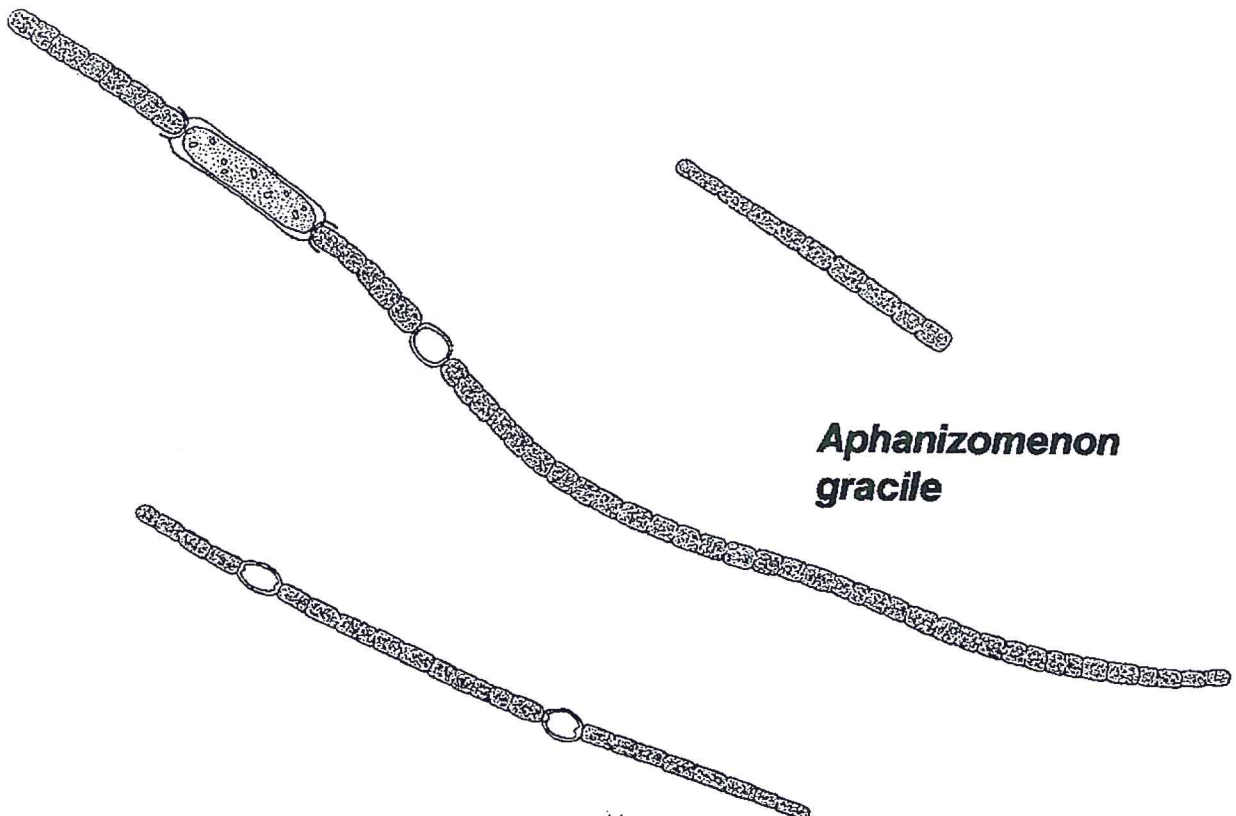


Figure 10



***Aphanizomenon
issatschenkoi***

20μ



***Aphanizomenon
gracile***

Figure 11

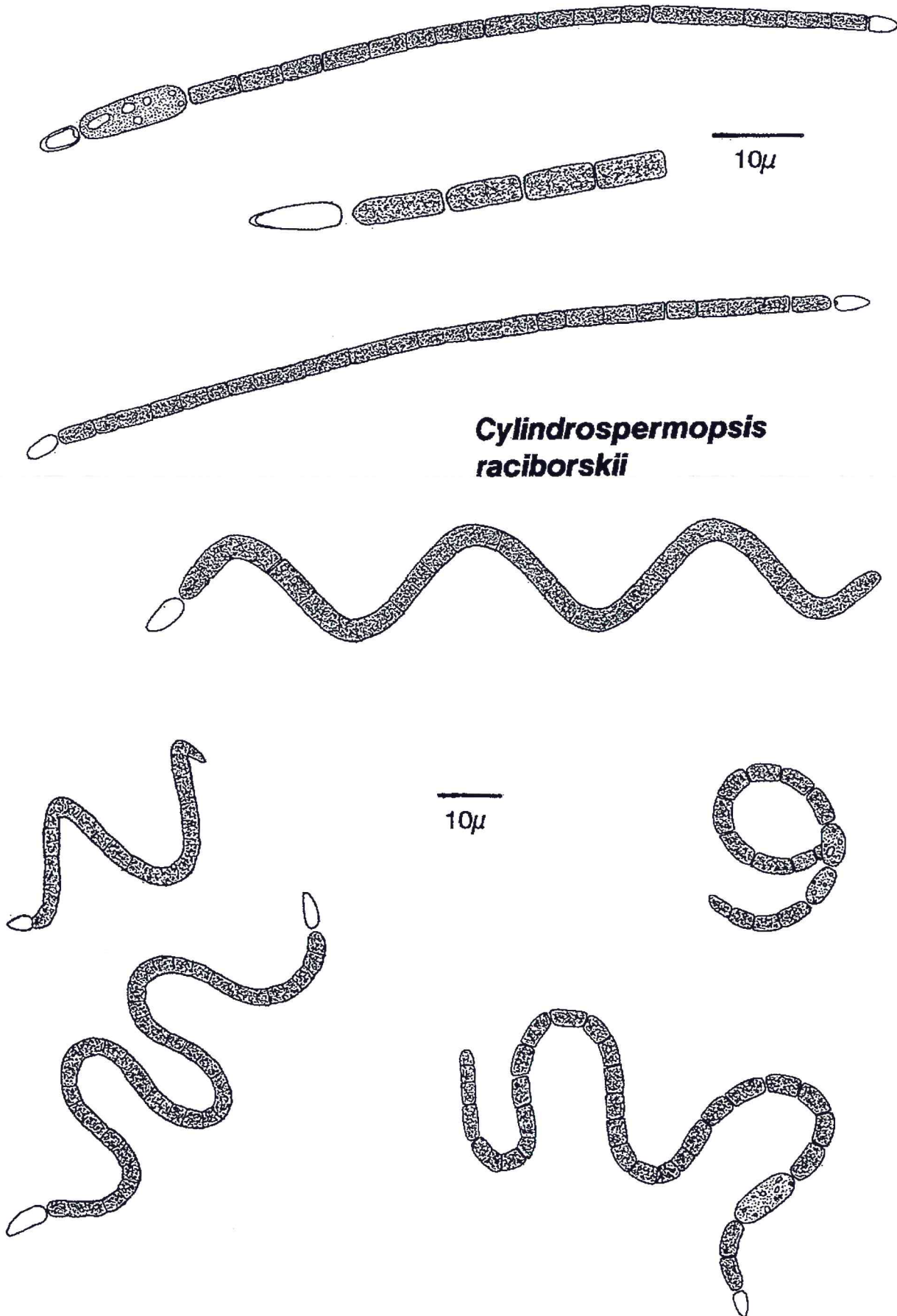
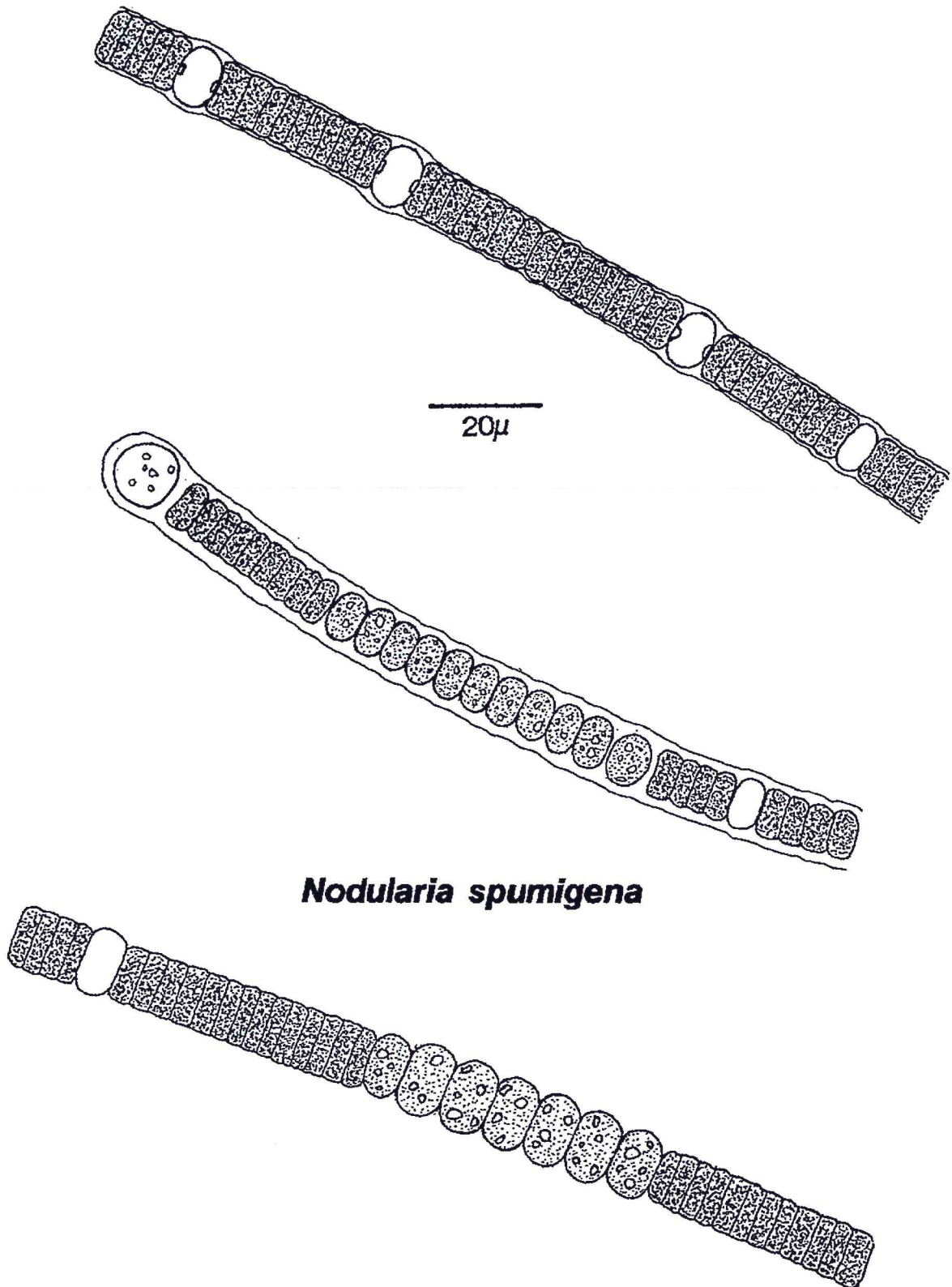
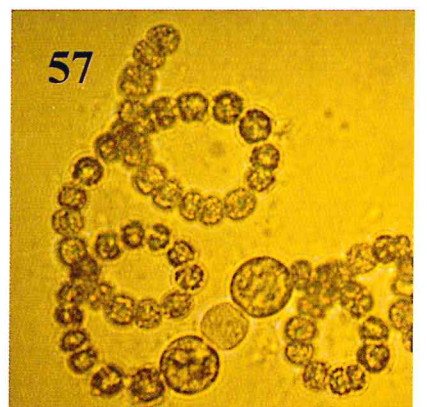
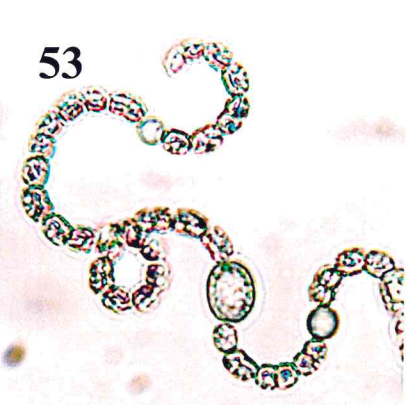
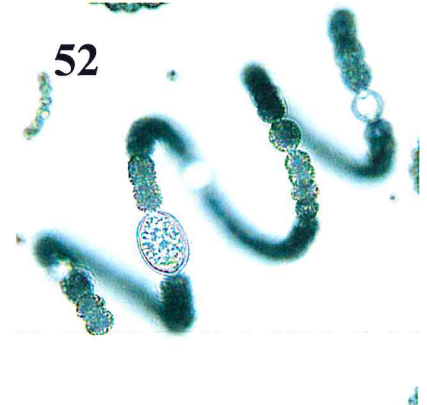
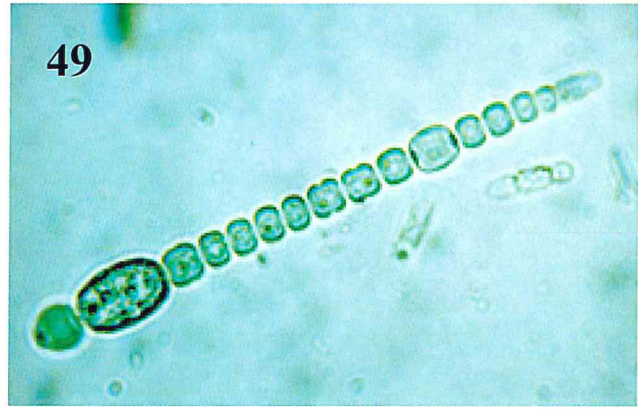


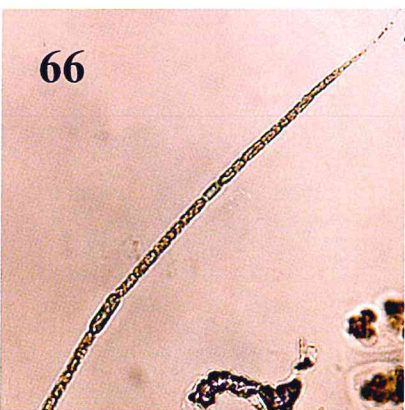
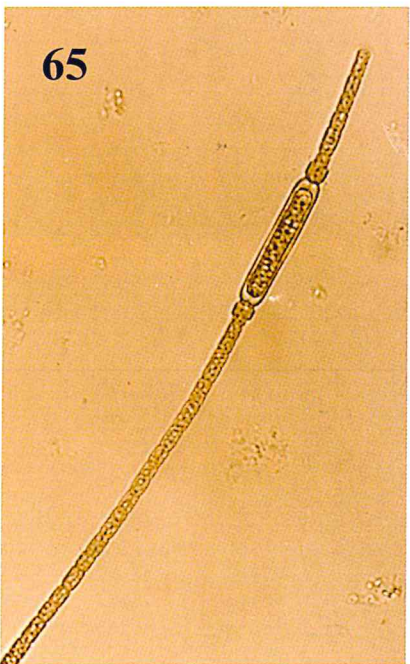
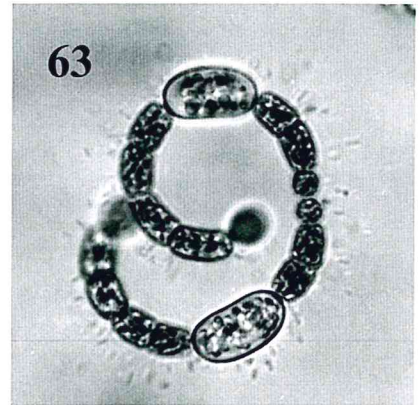
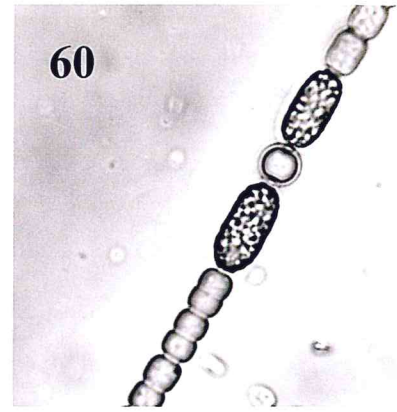
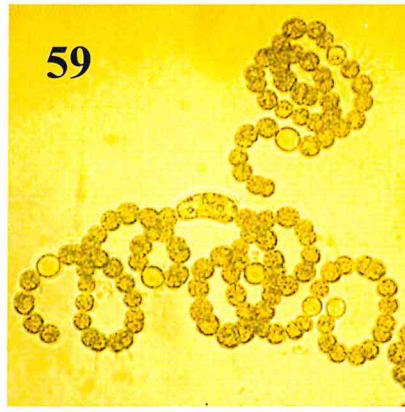
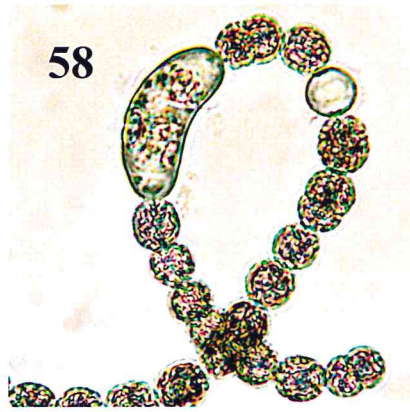
Figure 12



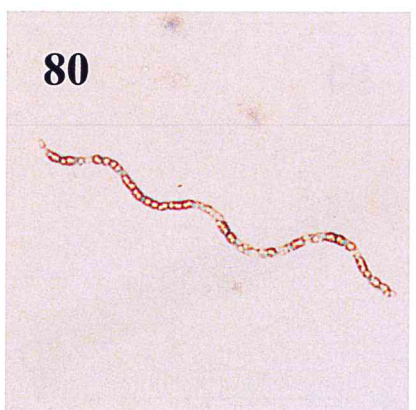
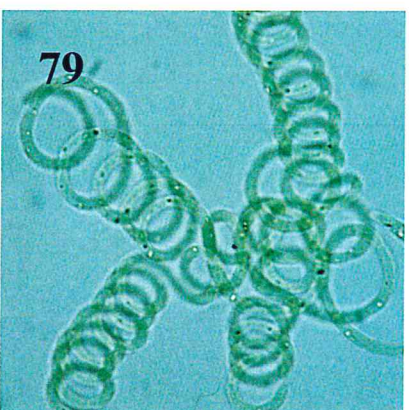
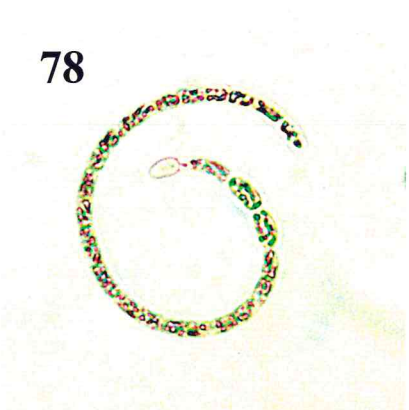
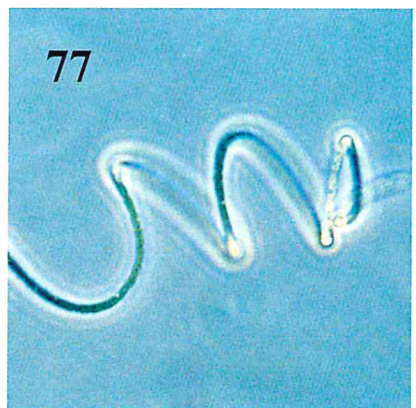
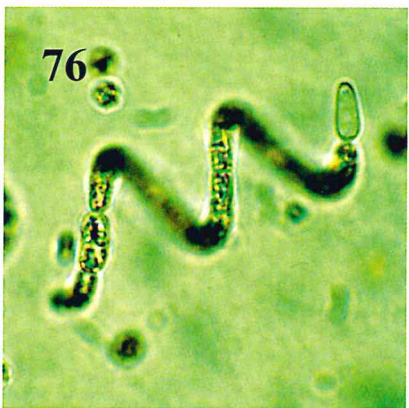
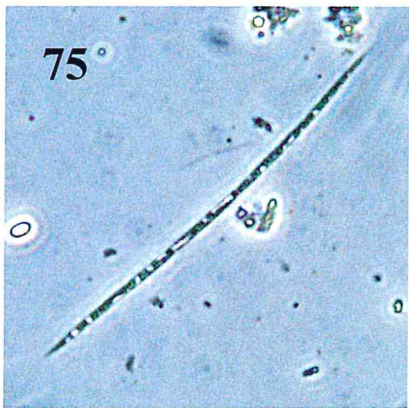
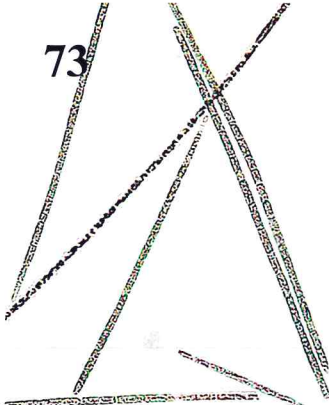
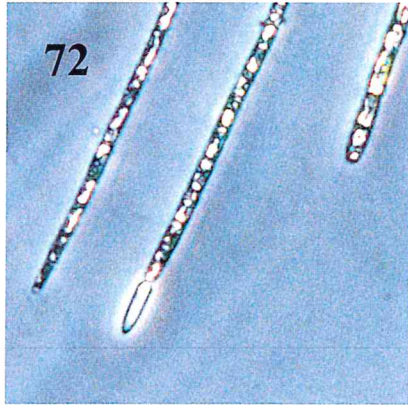
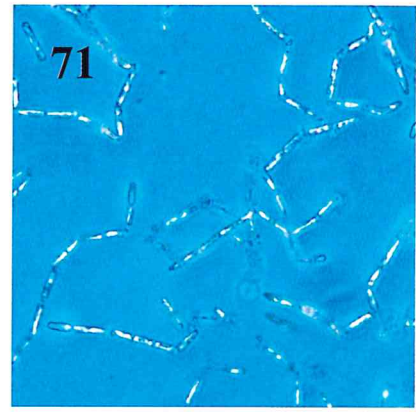
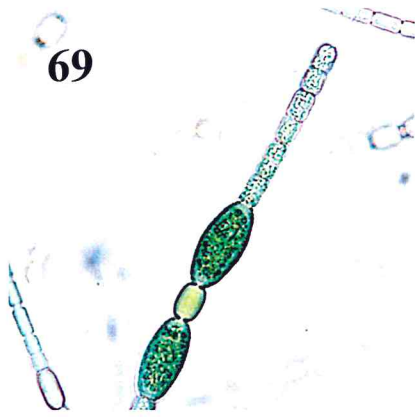
Nodularia spumigena



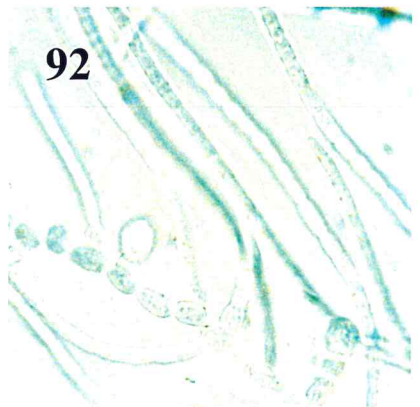
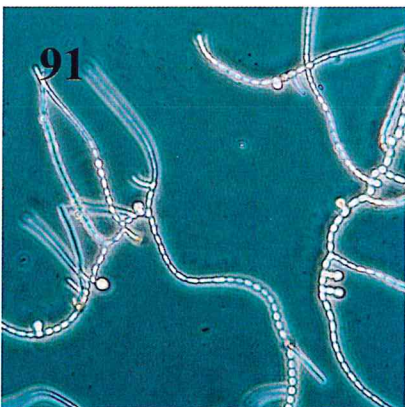
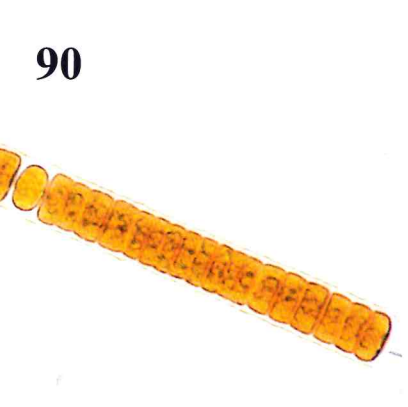
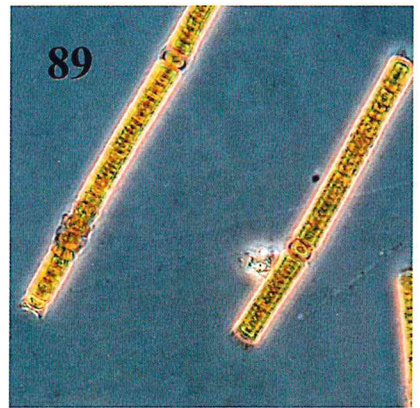
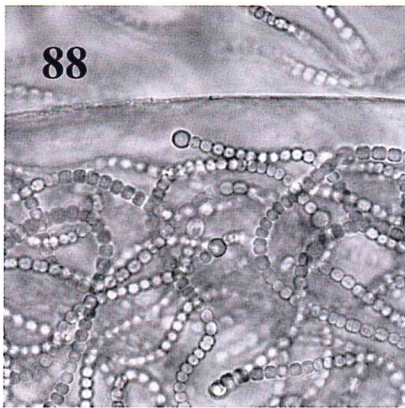
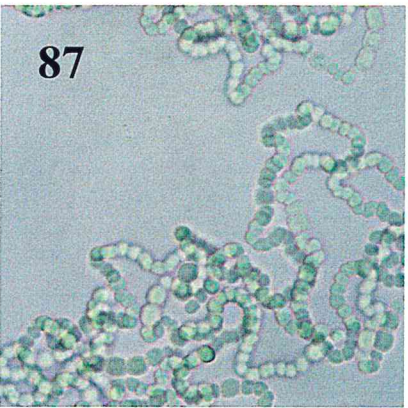
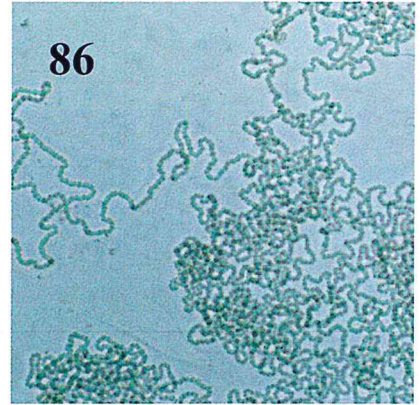
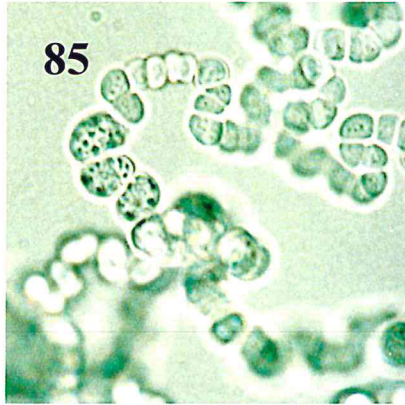
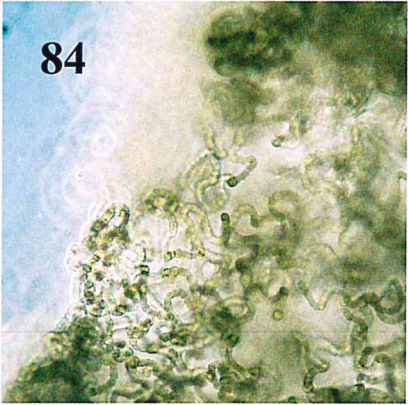
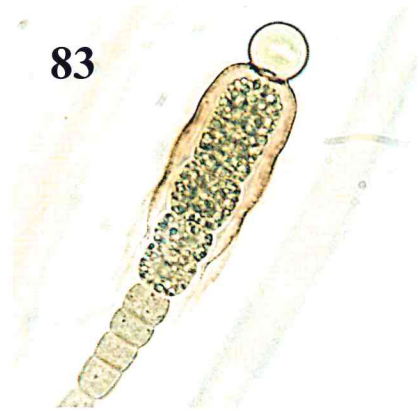
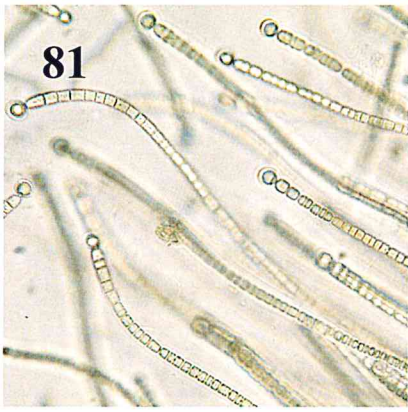
Photos 48-57: (48-49) *Anabaena oscillarioides*; (50) *Anabaena planktonica*; (51) *Anabaena smithii*; (52) *Anabaena crassa*; (53) *Anabaena spiroides* var. *minima*; (54-55) *Anabaena spiroides* f. *spiroides*; (56-57) *Anabaena* sp.nova.



Photos 58-68: (58-59) *Anabaena perturbata* var. *tumida*; (60) *Anabaena torulosa*; (61) *Anabaena torulosa* var. *tenuis*; (62) *Anabaenopsis arnoldii*; (63) *Anabaenopsis elenkinii*; (64) *Anabaenopsis tanganyikae*; (65) *Aphanizomenon gracile*; (66) *Aphanizomenon issatschenkoi*; (67-68) *Aphanizomenon ovalisporum*.



Photos 69-80: (69) *Aphanizomenon volzii*; (70) *Cylandrospermum licheniforme*; (71-80) Various morphotypes of *Cylandrospermopsis raciborskii*. (Note that the morphotype depicted in photo 71 has been associated with animal deaths and high toxicity.)



Photos 81-92: (81) *Gloeotrichia echinulata*; (82-83) *Gloeotrichia raciborskii*; (84-87) *Nostoc linckia*; (90) *Nostoc* sp. showing the thick mucilage characteristic of this genus; (89-90) *Nodularia spumigena*; (91-92) *Nostochopsis lobatus*.

ORDER STIGONEMATALES

Key to the genera of the Stigonematales

- 1a. At least main branch of filaments multiseriate 2
- 1b. All branches of filaments uniseriate 3

- 2a. Differentiation into main and secondary branches 4
- 2b. No differentiation into main and secondary branches; heterocytes intercalary or absent
..... *Capsosira*

- 3a. Heterocytes lateral or terminal at ends of short branches *Nostochopsis*
- 3b. Heterocytes intercalary or absent 5

- 4a. Secondary branches multiseriate, heterocytes intercalary or absent *Stigonema*
- 4b. Secondary branches uniseriate, erect *Fischerella*

- 5a. Branching predominately lateral or reverse Y-shaped (Mastigocladaceae) 6
- 5b. Branching predominately pseudodichotomous (V-shaped); branches attenuated towards the
ends into an apical hair..... *Loefgrenia*

- 6a. Branching lateral only *Hapalosiphon*
- 6b. Branching lateral or reverse Y-shaped *Mastigocladus*

Common Taxa of the Stigonematales

Genus *Nostochopsis* Wood em. Geitler

Benthic; thallus of erect filaments with soft sheaths arranged within a colonial mucilage to form an expanded gelatinous mass; trichomes all uniseriate, irregularly branched, branches nearly perpendicular to the main axes usually slightly tapered at the apices; vegetative cells barrel-shaped; heterocytes lateral and terminal on greatly reduced side branches; akinetes rare.

Checklist of Common Taxa

Nostochopsis lobatus Wood em. Geitler (Be) (Qld) Photos 91,92

Nostochopsis lobatus Wood em. Geitler

Description: Macroscopic gelatinous masses on rocks in shallow water. Trichomes and lateral branches uniseriate and constricted at the cross-walls. Cells of main axis cylindrical, tending oval where lateral branching is more frequent, 5.5-8 µm long, 3.5-5.5 µm broad. Lateral branches composed of cylindrical cells, 5-7 µm in length, 2-3 µm broad. Apical cells of lateral branches tapered or bluntly rounded. Heterocytes spherical or sub-spherical, 6-7.5 µm long, 5.5-7.0 µm broad, attached laterally to the main axis or attached laterally on the ends of short branches, 1-3 cells in length

REFERENCES

- Anagnostidis, K. and Komárek, J. (1985). Modern Approach to the Classification System of Cyanophytes. 1. Introduction. *Arch. Hydrobiol. Suppl.* **71 (1-2)**, *Algological Studies* 38-39: 291-302.
- Anagnostidis, K. and Komárek, J. (1986). Modern Approach to the Classification System of Cyanophytes. 2. Chroococcales. *Arch. Hydrobiol. Suppl.* **73 (2)**, *Algological Studies* 43: 157-226.
- Anagnostidis, K. and Komárek, J. (1988). Modern Approach to the Classification System of Cyanophytes. 3. Oscillatoriales. *Arch. Hydrobiol. Suppl.* **80 (1)**, *Algological Studies* 50-53: 327-472.
- Anagnostidis, K. and Komárek, J. (1990). Modern Approach to the Classification System of Cyanophytes. 5. Stigonematales. *Arch. Hydrobiol. Suppl.* **86**: 1-73.
- Baker, P.D. (1991). Identification of Common Noxious Cyanobacteria. Part I. Nostocales. Urban Water Research Association of Australia. Research Report No. 29.
- Baker, P.D. (1992). Identification of Common Noxious Cyanobacteria. Part II. Chroococcales and Oscillatoriales. Urban Water Research Association of Australia. Research Report No. 46.
- Baker, P.D., Humpage, A.R. and Steffensen, D.A. (1993). Cyanobacterial Blooms in the Murray-Darling Basin: Their Taxonomy and Toxicity. Australian Centre for Water Quality Research Report No. 8/93.
- Day, S.A., Wickham, R.P., Entwisle, T.J. and Tyler, P.A. (1995). Bibliographic Checklist of Non-Marine Algae in Australia. Flora of Australia Supplementary Series No. 4. Australian Biological Resources Study, Canberra.
- Fritsch, F.E. (1977). The Structure and Reproduction of the Algae. Volume II, pp. 939. Cambridge University Press.
- Komárek, J. and Anagnostidis, K. (1989). Modern Approach to the Classification System of Cyanophytes. 4. Nostocales. *Arch. Hydrobiol. Suppl.* **82 (3)**, *Algological Studies* 56: 247-345.
- Komárek, J. and Anagnostidis, K. (1999). *Cyanoprokaryota 1. Teil Chroococcales*. Gustav Fischer, Jena, Stuttgart, Lübeck, Ulm.
- Ling, H.U. and Tyler, P.A. (1986) A Limnological Survey of the Alligator Rivers Region. II. Freshwater Algae, exclusive of Diatoms. Supervising Scientist, Alligator Rivers Region, Research Report 3. Australian Government Publishing Service, Canberra.
- Mc Gregor, G. B and Fabbro, L. D. (2001) *A Guide to the Identification of Australian Freshwater Planktonic Chroococcales (Cyanoprokaryota/Cyanobacteria)*. Cooperative Research Centre for Freshwater Ecology, Thurgoona.
- McLeod, J.A. (1975). The Freshwater Algae of South-Eastern Queensland. PhD Thesis (Unpublished) University of Queensland.

GLOSSARY

Akinete: a resting cell or spore produced from a vegetative cell, which develops a thick wall about a concentrated reserve of food.

Amorphous: without definite shape.

Apical cell: the cell at the end of a trichome.

Apo-heterocytic: development of akinetes removed from heterocysts.

Attenuate: narrowed or tapered toward the ends.

Benthic: organisms attached or living on the bottom of an aquatic system.

Calyptra: a thickened covering at the end of a trichome.

Capitate: with a head-like swelling or enlargement at the apex.

Circinate: circular, rounded, coiled.

Clathrate: with intermittent spaces or openings

Colonial: a group of individuals, enclosed by a common sheath or joined together.

Confluent: merging into one another, as with soft mucilaginous sheaths which become intermingled.

Conical: shortly tapering to a fine point.

Constricted: pinched in or deeply incised.

Cross-walls: transverse walls between individual cells in a trichome

Cylindrical: elongate figure with parallel lateral margins and circular in cross-section

Cyanoprokaryote: photosynthetic microorganism that possess chlorophyll and produce oxygen during photosynthesis. Also known as blue-green algae, cyanophytes or cyanobacteria.

Depressed globose: not quite spherical: flattened at the poles

Dichotomous: a forked division into two parts (Y shaped).

Diffluent: diverging.

Discoïd: flattened plate circular in cross-section.

Ellipsoidal: elongate figure with convex lateral margins and rounded, narrowed ends.

Envelope: sheath or mass of mucilage which encloses a cell or colony.

Epispore: outer cell wall of an akinete.

Exocytes: cells which are the product of a particular mode of cell division in some cyanoprokaryotes.

False branching: a branch not formed by lateral cell division; lateral outgrowth initiated by cross-breakage of a filament.

Family: a systematic classification for a group of organisms and consisting of one or more genera.

Fascicle: a bundle or cluster of filaments, more or less parallel.

Fenestrate: with windows or openings between cells in a colony

Filament: a linear arrangement or thread of cells, together with the investing sheath.

Fission: division of a cell by splitting to form two, not necessarily equal parts; cell division without mitosis.

Flexuous: curved or wavy; not straight, firm or rigid.

Floccose, flocculent: loosely mattered or intermingled, cottony.

Forma: a systematic classification for organisms at the sub-specific level.

Fusiform: highly tapered at both ends, spindle shaped.

Gas vacuoles/pseudovacuoles: specialised intracellular organelles which contain hundreds of gas vesicles and allow buoyancy regulation of cells within the water column.

Gelatinous: with mucilage.

Genus: a systematic classification for grouping organisms and consisting of one or more species.

Globose: rounded but not spherical.

Granulose: containing granules within the cytoplasm.

Heterocyte/heterocyst: an oxygen-excluding modified vegetative cell produced by some cyanobacteria (Nostocales). These cells are the site of nitrogen fixation.

Hormocyte/hormocyst: a vegetative spore like body formed from a short section of a filament enclosed within mucilage.

Heteropolar: asymmetric polarity.

Homogeneous: similar throughout; not granulose.

Hormogonia, hormogonia : a fragment of a filament broken away from a mature trichome; multicellular reproductive structure.

Hyaline: colourless; translucent.

Iconotype: type specimen based on an illustration or photograph.

Intercalary: inserted between cells of a trichome rather than terminal or marginal.

Iso-diametric: equal diameters.

Isopolar: symmetric polarity.

Lamellate: layered.

Meristematic: cells with the ability to divide rapidly.

Metameric: referring to trichomes consisting of several identical sections.

Micrometre (μm): 1×10^{-6} metre.

Morphometric: quantitative morphological data.

Mucilage: a gelatinous or jelly-like substance.

Multiseriate: a filament where cells are arranged in more than one series of row.

Nannocyte: a very small daughter cell produced by multiple fission.

Necridium, necridia: a dead cell; common in some filamentous cyanobacteria and permits easy fragmentation.

Oblong: rectangular figure; cells with parallel lateral margins slightly longer than the breadth.

Oblong-ovate: as above but with slightly convex lateral margins.

Order: a systematic classification for the grouping of organisms and consisting of one or more families.

Oval, Ovate: slightly elongate figure with convex lateral margins and equally rounded ends.

Ovoid: egg-shaped, an elongate figure with unequal curvature at the poles, one being broader than the other.

Para-heterocytic: akinetes located adjacent or originating close to the heterocyst.

Parenchymatous: composed of a mass of cells formed by division in three dimensions.

Pseudo-parenchymatous: a filamentous mass in which individual filaments are not readily discernible.

Pseudo-filamentous: cells incidentally arranged in a linear series; not a true filament

Phototrophic: capable of fixing carbon using light energy.

Planktonic: free-floating or drifting aquatic organisms.

Polar Nodule: swelling on the inner wall of an heterocyst.

Prokaryotic: lacking a membrane bound nucleus and organelles.

Quadrangle: squarish or slightly rectangular.

Reniform: bean-shaped; kidney-shaped.

Sheath: a covering or envelope usually composed of mucilage.

Sigmoidal: shaped like the letter S.

Species: the smallest unit of systematic classification commonly used. Usually infers a group of organisms able to interbreed i.e. sexually reproduce.

Spherical: symmetrically rounded in three dimensions.

Stratum: a layer.

Sub: nearly, as in sub-symmetric.

Synonym: alternative systematic name referring to the same taxon as another name.

Taxon, taxa : general term for a taxonomic group whatever its rank.

Thallus: a plant body with little or no cellular differentiation into tissues.

Trichome: a thread of cells without the investing sheath.

True branching: Branching which occurs as a result of lateral division of a cell in a main filament.

Truncate: flatly rounded at the ends.

Tycho-planktonic: plankton in shallow water intermingled with miscellaneous vegetation.

Type: specimen or illustration on which later identifications can be based; nomenclatural designation.

Uni-cellular: single-celled.

Uniseriate: containing a single row or series of cells.

Variety: a systematic classification for organisms at the sub-specific level.

Vegetative cell: a cell that is not specialized for reproduction.

Vesicle: minute sac or cavity.